GUJARAT HAZARD RISK & VULNERABILITY ATLAS

GSDMA

GSDMA

The Gujarat State Disaster Management Authority
Government of Gujarat
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Gujarat Hazard Risk and Vulnerability Atlas

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DISCLAIMER

This Atlas has been prepared based on secondary information collected from various international, national and state-level sources and primary field information. Utmost care has been taken to verify and validate the information and datasets (as of February 2005). Due to limited availability of data, the information contained herein is based on a number of assumptions to support the analysis. The GSDMA, Government of Gujarat, and its allied departments and agencies who have worked on this assignment accept no responsibility, whatsoever, for any omissions or errors that may have crept in this document and hereby excludes any warranty express or implied as to accuracy, completeness, performance or any of its contents. No person shall be entitled to any claim for loss or damage etc. that may result pursuant to any action / investment / decision etc. taken based on the information contained herein either on account of inaccurate data / any inadvertent error / misrepresentation etc.

This document should be considered as work in progress that uses the best available methods and information to provide guidance to readers and users to enable risk reduction and mitigation based on a defined probabilistic hazard assessment methodology. This document does not override or supercede any existing Codes, hazard zonation or demarcation as available (in February 2005) and ratified by various Government of India or Government of Gujarat agencies until unless stated otherwise.

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FOREWORD



सत्यमेव जयते

Government of Gujarat

Following the devastating Kachchh earthquake of January 26, 2001, The Gujarat State Disaster Management Authority (GSDMA) was created as a statutory authority to coordinate a comprehensive earthquake recovery and mitigation programme. Through GSDMA, Government of Gujarat (GOG) commenced comprehensive earthquake rehabilitation programme with aid from the World Bank (WB) and Asian Development Bank (ADB). In a short span of four years, reconstruction of buildings in a number of urban areas and recovery of road, irrigation, power and telecommunication infrastructure has been completed.

Even more significant is the initiation of a programme of mitigating earthquake and other similar natural hazard risks by GOG with retrofitting of buildings, strengthening of infrastructure, development of a revised techno-legal regime, capacity building of institutions across the state and a restructuring of the planning and development processes in the state to mitigate risks in the medium-term.

This is crucial as Gujarat is one of the regions most exposed to multiple hazards in India. Hence it is one of the more risk prone regions of the world given its high population of over 50 million and vulnerability due to large semi-arid areas, economically and socially backward populations and non-engineered or partially engineered buildings and infrastructure.

In order to provide a guiding framework to undertake mitigation investments and activities, GSDMA commissioned the preparation of a Composite Risk Atlas for Gujarat based on six natural and man-made hazards and the physical, social and economic vulnerability of its people, assets and economy at Taluka-level. The hazards that have been examined in detail using advanced computer assisted GIS models, probabilistic analysis and detailed field studies include: earthquake, cyclone, storm surge, flood, chemical accident exposure (between 25 and 200 years) and most important for Gujarat – drought, over a period of a century. It is a matter of pride that this has been accomplished by a multidisciplinary team of Indian professional scientists, social scientists, engineers, planners and disaster management professionals over a period of 18 months.

This Atlas has been derived from one of the largest and most detailed digital GIS databases prepared in India and covers all the 226 talukas, and 25 districts of the state. GSDMA is making the Atlas available in digital and internet versions. This print version is being made available to you to enable more effective decision making on investments, infrastructure, industrial and urban development, drought management and mitigation and assist in the revision of Codes and technical specifications for buildings and critical infrastructure.

This is the first integrated state-level Atlas of its kind in the world that provides a Level-1 assessment of composite risk from all these natural hazards across 63 percent (90, 89 and 27 percent respectively for primary, secondary and tertiary sectors) of the economic value added and 72 (90, 100 and 41 percent respectively for primary, secondary and tertiary sectors) percent of the capital stock in Gujarat. The annualised estimate of risk exposure to the GVA is over Rs. 10 billion and Rs. 6.4 billion to the total capital stock of the state at 2001 prices. The most significant hazard is drought that constitutes 57 percent of the risk, followed by earthquakes (26 percent), cyclone and storm surge (12 percent) and flood (6 percent). While drought has the most impact on economic output or value added, earthquake, cyclone and storm surge and flood have large impacts on capital stocks and hence future economic potential. The Atlas provides geographically explicit, quantified estimates of risk that will enable a more sustainable development of Gujarat in the future.

This GIS assisted Atlas is expected to play a crucial role in the prioritisation of multi-hazard emergency preparedness, response and mitigation investments and interventions in Gujarat. Measures to modify the wind and earthquake codal zonation and provisions for the state have been initiated using the probabilistic methods defined in the Atlas that link the expected service life and criticality of a structure to hazard risk. The most vulnerable Talukas, possible areas of highest loss of human life, population concentrations, crops, buildings and lifeline infrastructure have been identified in a descending order of risk that enables planning, intervention and investments in a prioritised, phased manner – making effective use of scarce resources. This mitigation prioritisation is expected to transform the process of planning in the state once taken up by all relevant departments of the GoG.

The key challenge will be the effective dissemination of the information and methods used in the *Gujarat Hazard Risk, Vulnerability & Composite Risk Atlas* to a wide audience and integrate its findings into the day-to-day economic, planning and decision making activities of the State. If this is enabled over the next five years, Gujarat could become one of the first regions in the world to have taken the lessons of a devastating natural disaster and turned it into an opportunity of future development.

Shri. Narendra Modi

Chief Minister Gujarat State

Gandhinagar, September 2005

GUJARAT CHEMICAL HAZARD EXPOSURE ZONATION :TALUKA WISE INCIDENCE OF CHEMICAL STORAGE ACROSS MAH AND "A" TYPE INSTALLATIONS. Table No. HCHT - 01 of 01

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Sr. No	District	Taluka	MAH	A Type	Total Instances
1	Ahmadabad	Ahmadabad City	48	20	68
2	Ahmadabad	Barwala	-	-	-
3	Ahmadabad	Bavla	-	-	-
4	Ahmadabad	Daskroi	49	80	129
5	Ahmadabad	Detroj-Rampura	-		
6	Ahmadabad	Dhandhuka	-	-	-
7	Ahmadabad	Dholka	1	-	1
8	Ahmadabad	Mandal	-	-	-
9	Ahmadabad	Ranpur	-	-	-
10	Ahmadabad	Sanand	34	-	34
11	Ahmadabad	Viramgam	1	1	2
12	Amreli	Amreli	-	-	-
13	Amreli	Babra	1	-	1
14	Amreli	Bagasara	-	-	-
15	Amreli	Dhari	5	-	5
16	Amreli	Jafrabad	-	-	-
17	Amreli	Khambha	-	-	-
18	Amreli	Kunkavav Vadia	-	-	-
19	Amreli	Lathi	-	-	
20	Amreli	Lilia	-	-	-
21	Amreli	Rajula	2	-	2
22	Amreli	Savar Kundla	-	-	-
23	Anand	Anand	1	7	8
24	Anand	Anklav		-	-
25	Anand	Borsad		-	-
26	Anand	Khambhat	6	3	9
27	Anand	Petlad	-	-	-
28	Anand	Sojitra	-	-	
29	Anand	Tarapur	-	-	-
30	Anand	Umreth	-	-	-
31	Banas Kantha	Amirgadh	-	-	-
32	Banas Kantha	Bhabhar		-	-
33	Banas Kantha	Danta	-	1	1
34	Banas Kantha	Dantiwada	-	-	-
35	Banas Kantha	Deesa		28	28
36	Banas Kantha	Deodar	-	-	-
37	Banas Kantha	Dhanera	-	1	1
38	Banas Kantha	Kankrej	-	-	-
39	Banas Kantha	Palanpur	1	5	6
40	Banas Kantha	Tharad	-	1	1
41	Banas Kantha	Vadgam		1	1
42	Banas Kantha	Vav	-	1	1
43	Bharuch	Amod	7	-	7
44	Bharuch	Anklesvar	81	395	476
45	Bharuch	Bharuch	5	1	6
46	Bharuch	Hansot	-	1	-
47	Bharuch	Jambusar	4	1	5
48	Bharuch	Jhagadia	10	15	25
49	Bharuch	Vagra	15	6	21
50	Bharuch	Valia	5	-	5
51	Bhavnagar	Bhavnagar	2	10	12
52	Bhavnagar	Botad	-		-
53	Bhavnagar	Gadhada			-
54	Bhavnagar	Gariadhar	-	-	-
55	Bhavnagar	Ghogha	7	-	7
56	Bhavnagar	Mahuva	-		-
57	Bhavnagar	Palitana	-	1	1
58	Bhavnagar	Sihor	2	-	2
59	Bhavnagar	Talaja	-	1	1
60	Bhavnagar	Umrala	-	3	3
61	Bhavnagar	Vallabhipur	3	-	3
62	Dohad	Devgadbaria	-	-	-
63	Dohad	Dhanpur	-	-	
64	Dohad	Dohad	-	-	-
65	Dohad	Fatepura	-	-	-
66	Dohad	Garbada	-	-	-
67	Dohad	Jhalod	-	1	1
68	Dohad	Limkheda	-	-	-
69	Gandhinagar	Dehgam	4	17	21
70	Gandhinagar	Gandhinagar	4	12	16
71	Gandhinagar	Kalol	11	21	32
72	Gandhinagar	Mansa	3	9	12
73	Jamnagar	Bhanvad	-		-
74	Jamnagar	Dhrol	-	-	
75	Jamnagar	Jamjodhpur	-	-	-
76	Jamnagar	Jamnagar	4	2	6
77	Jamnagar	Jodiya	-	-	
78	Jamnagar	Kalavad	-	-	-
79	Jamnagar	Kalyanpur	-	-	-
80	Jamnagar	Khambhalia	-	3	3
81	Jamnagar	Lalpur	9	1	10
82	Jamnagar	Okhamandal	3	8	11
83	Junagadh	Bhesan	-	-	-
84	Junagadh	Junagadh	2	4	6
85	Junagadh	Keshod	-		
86	Junagadh	Kodinar		-	
87	Junagadh	Malia	-		
88	Junagadh	Manavadar	-	2	2
89	Junagadh	Mangrol	-	4	4
90	Junagadh	Mendarda	-	1	1
91	Junagadh	Patan-Veraval	3	58	61
92	Junagadh	Sutrapada	-	-	-
93	Junagadh	Talala	-	1	1
94	Junagadh	Una		-	-
95	Junagadh	Vanthali			
96	Junagadh	Visavadar			-
97	Kachchh	Abdasa	-	1	1
98	Kachchh	Anjar	2	-	2
99	Kachchh	Bhachau	3	4	7
100	Kachchh	Bhuj	4	7	11
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102	Kachchh	Lakhpat	-	3	3
103	Kachchh	Mandvi	-	-	-
104	Kachchh	Mundra	9	4	13
105	Kachchh	Nakhatrana	-	-	-
106	Kachchh	Rapar	-		-
107	Kheda	Balasinor	-	1	1
108	Kheda	Kapadvanj	-	1	1
109	Kheda	Kathlal	1	-	1
110	Kheda	Kheda	6	2	8
111	Kheda	Mahudha	-	-	-
112	Kheda	Matar	3	-	3
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GUJARAT : BACKGROUND

Gujarat is one of India's most prosperous states and is situated on the western coast, between 20.6 and 24.42 degrees North latitude and 68.10 and 74.28 degrees East longitude. With a total geographical area of 95,984 sqkm, it accounts for 6 percent of the area of the country. The state is bounded on the west and south by the Arabian Sea, and by the staes of Rajasthan on the north and north-east, Madhya Pradesh on the east, and Maharashtra on the south and south-east. It shares a boundary with Pakistan on the north-west. Gujarat has the longest (1,640 km.) coastline amongst India's maritime states. With a population of over 50 million or 5 percent of the national population (Census, 2001), nearly 6.5 percent of the national product and more than 12 percent of the national industrial output comes from Gujarat. (Economic Survey, 2004).

PRE-COLONIAL GUJARAT

The Indus valley civilization had an extensive presence across Gujarat. Even before the posited Aryan occupation, Gujarat is said to have had trade contracts with Sumer and the Persian Gulf in c. 3000-2250 BCE . Rock edicts in the Girnar hills indicate that Ashoka extended his domain into Gujarat and influence of Buddhism became an important faith. The Mauryas also promoted trade and helped in spread of culture. Around 2150 BCE, the area came under the influence of Bactarian Greeks who maintained trade contracts with Rome for nearly a century. From about 130-390 ACE the Scythians ruled Gujarat. The Guptas established their reign from 300 to 460 ACE. After the fall of the Gupta Empire in the sixth century, Gujarat flourished as an independent Hindu kingdom. The Maitraka dynasty, descended from a Gupta general, ruled from the sixth to the eighth centuries from their capital at Vallabhi, although they were briefly ruled by Harsha during the seventh century. The Arab rulers of Sind brought the Maitraka dynasty to an end in 770 ACE. A branch of the Pratihara clan ruled Gujarat after the eighth century. The first Parsi (Zoroastrian) refugees arrived in Gujarat from Iran in 775 ACE

The Solanki clan of Rajputs ruled Gujarat from c. 960 to 1243 ACE. Gujarat was a major centre of Indian Ocean trade at that time and their capital, Anhilwara (Patan) with population estimated at 100,000 in 1000 ACE was one of the largest cities in India.. After 1243 ACE, the Solankislost control of Gujarat to their feudatories, of whom the Vaghela chiefs of Dholka came to dominate. In 1292 ACE the Vaghelas became tributaries of the Yadava dynasty of Devagiri in the Deccan.

In 1298 ACE Ala-ud-din, Sultan of Delhi, destroyed Anhilwara and incorporated Gujarat into the Delhi Sultanate. Timur's sacking of Delhi at the end of the 14th century weakened the Sultanate. Gujarat's Muslim governor Zafar Khan Muzaffar asserted his independence, and his son, Sultan Ahmed Shah (1411-1442 ACE), established Ahmedabad as the capital. Cambay eclipsed Bharuch as Gujarat's most important trade port. The Sultanate of Gujarat remained independent until 1576, when the Mughal emperor Akbar conquered it and annexed it to the Mughal Empire. It remained a province of the Mughal Empire until the Marathas conquered it in the 18th century. (adapted from Wikipedia, the free encyclopedia, < http://en.wikipedia.org/wiki/Gujarat >, 2005)

COLONIAL GUJARAT

Portugal was the first European power to arrive in Gujarat, acquiring several enclaves along the Gujarat coast, including Daman, Diu, Dadra and Nagar Haveli. The British East India Company established a factory in Surat in 1614, which formed their first base in India, but it was eclipsed by Mumbai after the British acquired it from Portugal in 1668. The Company wrested control of much of Gujarat from the Marathas during the Second Anglo-Maratha War. Many local rulers, notably the Maratha Gaekwads of Baroda (Vadodara), made a separate peace with the British, and acknowledged British sovereignty in return for retaining local self-rule.

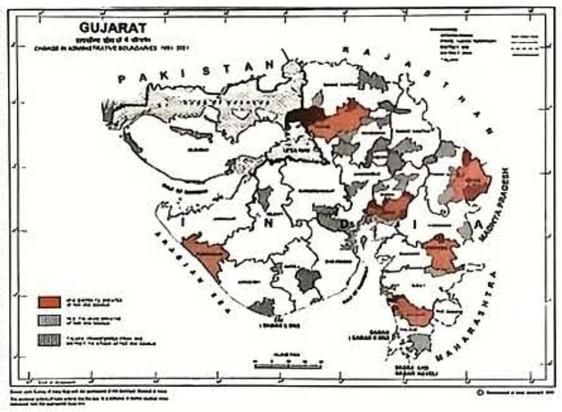
Gujarat was placed under the political authority of Bombay Presidency, with the exception of Baroda state, which had a direct relationship with the Governor-General of India. From 1818 to 1947, most of present-day Gujarat, including Kathiawar, Kutch, and the north and eastern Gujarat were divided into dozens of princely states, but several districts in central and south Gujarat, namely Ahmedabad, Broach (Bharuch), Kaira, Panch Mahals, and Surat, were ruled directly by British officials. (adapted from Wikipedia, the free encyclopedia, < http://en.wikipedia.org/wiki/Gujarat >, 2005)

POST INDEPENDENCE GUJARAT

After India's Independence and the partition in 1947, the Indian government grouped the former princely states of Gujarat into three larger units: Saurashtra, which included the former princely states on the Kathiawar peninsula; Kutch, and Bombay state, which included the former British districts of Bombay Presidency together with most of Baroda state and the other former princely states of eastern Gujarat. In 1956, Bombay state was enlarged to include Kutch, Saurashtra, and parts of Hyderabad state and Madhya Pradesh in central India. The new state had a mostly Gujarati-speaking north and a Marathi-speaking south. Agitation led to the split of Bombay state on linguistic lines on 1 May 1960, to become separate states of Gujarat and Maharashtra. (adapted from Wikipedia, the free encyclopedia, < http://en.wikipedia.org/wiki/Gujarat >, 2005.)

Gujarat was created from the 17 northern districts of former Bombay state: Ahmedabad, Amreli, Banaskantha, Bharuch, Bhavnagar, the Dangs, Jamnagar, Junagadh, Kheda, Kutch, Mehsana, Panchmahal, Rajkot, Sabarkantha, Surat, **Surendranagar**, and Vadodara.

In 1964 Gandhinagar district was formed from parts of Ahmedabad and Mahesana and in 1966 Valsad district was split from Surat. On October 2, 1997 Anand district was split from Kheda, Dahod was split from Panchmahal, Narmada from Bharuch, Navsari from Valsad and Porbandar was split from Junagadh district. In 2000 Patan district was formed from parts of Banaskantha and Mahesana.



ADMINISTRATIVE SUB-DIVISIONS

For the purpose of administration, Gujarat State (in 2004) comprises 25 districts, sub-divided into 226 Talukas, with18,618 villages and 242 towns. (Census of India, 2001.)

RELIEF, PHYSIOGRAPHY & GEOLOGY

Gujarat's relief shows large variations but the landscape is marked by plains of aggradational and degradational characteristics. Physiographically, it is made of three major zones; mainland Gujarat, Saurashtra and Kachchh each of which are characterised by their typical landform and coastline.

Geologically, about 55 percent of the state is covered by Quaternary alluvial deposits about 1.5 million years old. The remaining 45 percent is made up of a large variety of exposed rock formations of different ages spanning a period of more than 2,500 million years, preserving in them a long history of depositional environments, structural evolution and tectonic disturbances.

CLIMATE

The state falls within the subtropical climatic zone. The climate is strongly influenced by the northwest monsoon and physiography, creating a broad climatic range from humid to arid. Gujarat's mean annual rainfall varies between 300 mm to 2,500 mm with 10 to 70 rainy days in a year. The rainfall variability has a very broad range of 40 to 70 percent. The mean annual temperature is 26°C with mean maximum of 37° to 42° C and mean minimum of 8° to 10° C. Coastal areas enjoy a typical maritime climate.

VEGETATION

As a result of variations in climate, rock type, topography and the water regime, the vegetation ranges from typical desert plants to moist deciduous forests. Major concentrations of forests are located along the eastern border as well as the hills of Saurashtra. Most plains are devoid of forest cover. The major forest types in Gujarat are: tropical moist deciduous; tropical dry deciduous; tropical scrub; dry grassland and littoral and swampy forests. The forest areas of South Gujarat, Panchmahals, and the Aravali foothills of northeastern Gujarat, the Little Rann of Kachchh and the Gir Forest of South Saurashtra are major wild life reserves.

DEMOGRAPHY

The population of Gujarat was 50.6 million in 2001. The decadal growth rate of the 1990s has increased to 22.5 percent from 21.2 percent in the 1980, while the mean population density was 258 persons per sq km in 2001. The state's literacy rate increased from 61 percent in 1991 to 70 per cent in 2001. About 38 per cent of Gujarat's population resides in urban areas. (adapted from < http://www.gujaratindia.com/State%20Profile/profile2.htm >. [GoG, 2005])

AGRICULTURE

Gujarat's major food crops are rice, wheat, jowar, bajra, maize, tur, gram and groundnut. The major non food crops are cotton and tobacco. In 1999-2000, the gross cropped area and net cropped area were reported to be 10.7 million ha and 9.5 million ha respectively, while total net area irrigated was 3.0 million ha. In 1995-96 the average land holding size was reported at 2.6 Ha. (adapted from < http://www.gujaratindia.com/State%20Profile/profile2.htm >, GoG, 2005.)

ECONOMY

Gujarat has a highly diversified economy with about 78 percent of the SDP coming from outside the primary sector compared to 60 percent of India's economy. This is underpinned by a higher proportion of urban population in the state (38 percent compared to 28 percent for India in 2001), well developed infrastructure, money and capital markets allowing relatively easy access of its enterprising population to finance.

The estimated GSDP of Gujarat (Factor cost at constant 1993-94 prices) was Rs 830 billion in 2001-02, a 67 percent growth over 1993-94. The share of primary, secondary and tertiary sectors is estimated at 19 percent, 39 percent and 42 percent respectively at constant (1993-94) prices.

INFRASTRUCTURE

The total length of roads (except municipal roads) in the State was 74,031 km in 2002, with surfaced roads accounting for 96 percent of the total.

Gujarat's total installed power capacity (including central sector project) increased to 8,651 MW in 2001-02. The total power generation (including private sector and central sector share) was 50,069 GWH in 2001-02. The per capita consumption of electricity was 963 units in the same period. About17,940 feasible villages in the state (out of total 18,028 as per the 1991 census) have been electrified.

Gujarat is strategically positioned to service the vast north and central Indian hinterland. The state has 40 minor and intermediate ports geographically dispersed across south Gujarat (13 ports), Saurashtra (23 ports) and Kachchh (4 ports). The major port of Kandla, is under the administrative control of the Central Government. Gujarat has good air connections with national and international destinations connected via a set of 11 airports, the largest being the Ahmedabad international airport. (adapted from < http://www.gujaratindia.com/State%20Profile/profile2.htm >, GoG, 2005.)

HAZARD RISK AND VULNERABILITY ASSESSMENT

BACKGROUND

The state of Gujarat is exposed to multiple natural hazards especially drought, earthquake, cyclone, storm surge and flood (World Bank, 2001). In addition, due to its large area and population size, along with a high level of industrial development, the state is also exposed to multiple man-made hazards, especially industrial and chemical hazards (GSDMA, 2002).

Following the devastating Kachchh earthquake (January 2001) and the initiation of the World Bank and ADB supported Gujarat Earthquake Emergency Reconstruction Programme (GEERP), the Gujarat State Disaster Management Authority (GSDMA) was created as a statutory authority to address disaster management issues. In keeping with the Gujarat State Disaster Management Policy (GSDMP, 2002), the GSDMA is mandated to assess hazards, vulnerability and risks as a part of its pro-active disaster prevention and mitigation activities.

This World Bank-funded consultancy assignment: "*Hazard Risk and Vulnerability Assessment and Preparation of a Composite Risk Atlas for the State of Gujarat*" has three objectives:

1. An **assessment of Hazard Risk** and preparation of **Hazard Risk Maps** for earthquake cyclones and accompanying storm surge and flood events, drought and chemical hazards at taluka-level
2. An **assessment of physical, social and economic vulnerability** and preparation of **Vulnerability Maps** at taluka-level
3. Production of a **Composite Risk Atlas** based on probabilistic estimates of composite hazard risk and vulnerability at taluka-level

VULNERABILITY ATLAS OF INDIA

An important indigenous attempt at addressing risk that meets the key constraints of the Gujarat environment is the Vulnerability Atlas of India (BMTPC, 1997). This presents a pragmatic method of assessing hazard risk and vulnerability in Indian conditions, but falls short of presenting a composite risk assessment because of significant methodological challenges. The primary hazards assessed in the Vulnerability Atlas are earthquake, cyclone and storm surge and flooding.

The seismic risk assessment was based on established methods derived from periodical update of the Bureau of Indian Standards (BIS) national seismic zonation; the epicentres of earthquakes of Richter M 5.0 and above (ISET, 1983; IMD, 2002) and their magnitude and intensity; and a standard vulnerability of building types based on the MSK Intensity Scale (applied to the Census of India classification of materials of construction).

The cyclone and storm surge risk assessment was undertaken using the Bureau of Indian Standards (BIS) basic wind speed zones, design wind pressures and data on storm severity, and probable maximum storm surge (PMS) (Ghosh, 1983). The assessment of building vulnerability has been undertaken qualitatively based on engineering judgment and not based on an internationally recognised wind intensity and damage scale.

The flood hazard risk assessment was undertaken utilising maps of data on areas liable to flooding, currently available flood protection measures (CWC, 1987), and probable maximum precipitation (PMP) (1998). The assessment of building vulnerability has been undertaken qualitatively using engineering judgment.

The Vulnerability Atlas of India is however limited in excluding drought, the most serious hazard affecting Gujarat; excluding lifeline infrastructure and not using probabilistic hazard risk assessment methods or empirically determined fragility functions. Since it focused on districts as a unit of enquiry its utility in enabling local planning (at the taluka or block level) is limited. It nevertheless, remains a trendsetter and provided a base for this assignment to be undertaken.

METHODOLOGY

In keeping with the objectives of the assignment, the Gujarat Hazard Risk and Vulnerability Atlas was undertaken in three activity clusters, further broken down into 29 sub-tasks.

1. Hazard risk assessment and mapping.
2. Definition of elements at risk, vulnerability assessment and mapping.
3. Composite risk assessment and mapping

A simplified flowchart of the overall methodology is presented in the adjoining figure. The methodology for this study was finalised based on a review of available data with the Government of Gujarat, the Government of India, and other public domain secondary sources (both national and international). The focus is on the use of publicly or officially available information streams that are robust, reliable and capable of validation.

Box (1): GSDMA Hazard Risk & Vulnerability Assessment & Composite Risk Atlas

INCEPTION & BASE DATA COLLECTION
- Review of data availability
- Finalisation of methodology

↓

HAZARD RISK ASSESSMENT
- Hazard Catalogue development
- Hazard Analysis
- Hazard mapping
- Design of future Hazard assessment system

↓

VULNERABILITY ASSESSMENT
- Definition of Elements at Risk
- Field Physical vulnerability assessment
- Field Social & Socio-economic vulnerability assessment
- Field Economic vulnerability assessment
- Vulnerability mapping
- Design of future Vulnerability assessment system

↓

COMPOSITE RISK ASSESSMENT & ATLAS PREPARATION
- Composite Hazard risk mapping
- Composite Vulnerability mapping
- Composite Risk mapping
- Composite Risk Atlas preparation
- Design of future Composite Risk Atlas preparation system

DEFINITION OF TERMS

Disaster: A serious disruption of the functioning of a community or a society causing widespread human, material, economic or environmental losses which exceed the ability of the affected community/ society to cope using its own resources. A disaster results from the combination of hazards, conditions of vulnerability and insufficient capacity or measures to reduce the potential negative consequences of risks.

Hazard: A potentially damaging physical event, phenomenon and/or human activity, which may cause the loss of life or injury, property damage, social and economic disruption, or environmental degradation. Hazards can be single, sequential, or combined in their origin and effects, and are characterized by location, intensity, and probability.

Vulnerability: a set of conditions and processes resulting from physical, social, economical, and environmental factors, that increase the susceptibility of a community to the impact of hazards. Positive factors that increase the ability of people and the society they live in to cope effectively with hazards, that increase their resilience, or that otherwise reduce their susceptibility, are considered **Capacities**.

Resilience: the capacity of a system, community or society to resist or to change in order to obtain an acceptable level in functioning and structure. Determined by the degree by which a social system is capable of organising itself and the ability to increase its capacity for learning and adaptation, including the capacity to recover from a disaster.

Risk Assessment: a process of determining the nature and extent of risk by analysing potential hazards and evaluating existing conditions of vulnerability/capacity that could pose a potential threat or harm to people, property, livelihoods and the environment on which they depend. The process of conducting a risk assessment is based in a review of both technical features of hazards such as their location, intensity and probability, and an analysis of the physical, social and economic dimensions of vulnerability, while taking particular account of the pertinent coping capabilities.

Hazard Risk (HR): The probability of occurrence within a specific time period in a given area of potentially damaging phenomena.

Vulnerability (V): The degree of loss to a given element at risk or a set of elements resulting from the occurrence of a hazard of a given magnitude. This is expressed on a scale from 0 (no damage) to 1 (total loss).

Elements at Risk (E): The population, housing, critical buildings, lifeline infrastructure and utilities and productive activities at risk in a given area.

Specific Risk (Rs): The expected degree of loss to a particular element at risk due to particular phenomena as a function of both hazard risk and vulnerability.

Composite Risk (CR): The expected total loss in a particular area due to the effect of expected hazard risks. Computation of composite risk is expressed mathematically as:

Composite Risk (CR) = $\sum$ Elements at Risk **(E)** x Specific Risk **(Rs)**

= $\sum$ Elements at Risk **(E)** x Hazard Risk **(HR)** x Vulnerability **(V)**

Based on this, a systematic determination of composite risk is undertaken via a four-part assessment:

1. **Assessment of elements at risk**: This included an enumeration of:
   a. *Physical elements*: housing, critical buildings and lifeline infrastructure
   b. *Socio-economic elements*: various categories of population, especially the economically and socially vulnerable.
   c. *Economic elements*: productive activities especially, agriculture, industry and trade
2. **Hazard Risk Analysis**: An analysis of earthquake, cyclone and storm surge, flood hazard risk and chemical hazard exposure on a taluka-wide basis across Gujarat
3. **Vulnerability Assessment**: empirical assessment of vulnerability for the above elements at risk by hazard intensity based on analysis of historical data, field surveys, secondary research and recall case studies.
4. **Composite Risk Assessment**: The mathematical and geographical analysis of composite risk using a GIS based database and its representation in the form of an Atlas and appropriate maps at district and taluka level.

COMPOSITE RISK ASSESSMENT

Composite risk assessment across large geographic regions is a relatively new area of application in disaster management and mitigation practice (FEMA, 1999; UNECLAC, 2002). Most such public assessments have been undertaken for advanced economies (FEMA, 1999; 2000) and for urban areas in transition or developing economies (UNECLAC, 2002). Other risk assessment assignments have been undertaken in South Asia for single hazards cyclone (World Bank, 1997) and earthquakes (Arya, 1992, TARU, 1998; Geohazards, 2000;) or as a rapid overview of multiple states (RSMI, 2002).

This assignment has produced the first working example of Composite Risk assessment in South Asia, and one of the first of its king in the world. Therefore, considerable innovation and pragmatism has been utilised in the design of its methodology to enable its replicability, robustness and effectiveness in assisting policy and intervention development.

THE WAY FORWARD

This Atlas has set a new benchmark for a Level-1 composite probabilistic multiple hazard risk assessments in data scarce environments. It is unique in that its unit of enquiry is the taluka - a mean area of 730 sq.km. - for which an assessment of approximately three-fourths of the Gujarat economy and its population has been undertaken. This makes the Atlas one of the more detailed map based planning tools available. In addition, the risk assessment has been undertaken separately for capital assets, economic activity and potential loss of life, enabling unbundling of risk and mitigation interventions at various return periods.

The Atlas is designed to assist in medium and long-range development and investment planning, disaster mitigation planning and assisting a wide range of government departments, autonomous bodies and public institutions in Gujarat to take location and hazard specific intervention decisions. It will also be invaluable to private industry, the insurance sector, civil society and even private individuals in estimating the risk they are exposed to, take location and mitigation measures. It is not designed to assist in disaster relief or response operations as it is a probabilistic assessment over varying return periods. It can however be used to assist in preparedness prioritisation and planning. Further, Level-2 analysis priorities can also be defined for high-risk areas.

Every methodology used, sources of data and limitations of each section of the Atlas have been documented in detail in a series of fifteen technical papers. The underlying digital database is available with GSDMA, which is taking appropriate steps to update and modify the database at appropriate intervals. In addition, a process of institutionalization of training, support and use of the Atlas as a planning and investment prioritisation tool is also being undertaken by GSDMA.

This Atlas is a work in progress. It is only a milestone in the gradual process of improvement of India's response to natural and man-made hazards. It therefore will need to be updated and modified as better data, research and perspectives become available.

Gujarat Hazard Risk Zonation : Administrative Divisions, Major Urban Centres & Key Features

GSDMA

69°00' E 70°00' E 71°00' E 72°00' E 73°00' E 74°00' E

24°00' N 23°00' N 22°00' N 21°00' N 20°00' N

BANAS KANTHA
Palanpur
Siddhapur
PATAN
Mahesana
MAHESANA
Himatnagar
SABAR KANTHA
GANDHINAGAR
Ahmedabad
Lakhpat
KACHCHH
Bhuj
Jakhau
Anjar
SURENDRANAGAR
Surendranagar
AHMEDABAD
Kheda
KHEDA
PANCHMAHAL
Godhra
Dahod
DAHOD
Anand
ANAND
Vadodara
VADODARA
Jamnagar
JAMNAGAR
Dwarka
RAJKOT
Botad
BHARUCH
Ankleshwar
NARMADA
Bhavnagar
BHAVNAGAR
Porbandar
PORBANDAR
Junagadh
Amreli
AMRELI
JUNAGADH
Rajula
Una
Surat
SURAT
Songadh
Navsari
NAVSARI
THE DANGS
Valsad
VALSAD
Vapi

LEGEND

- Major Ports
- GMB Ports
- Private Sector Ports
- Joint Sector Ports
- Other Ports
- Power Stations
- Airports
- Major Towns
- National Highway
- State Highway
- State Boundary
- District Boundary
- Taluka Boundary
- Major River
- Mud Flats and Rann

Source : TARU Analysis, 2004; SRTM; GMB, GoG; BISAG, GoG.

0 100 km

N

Projection : Lambert Azimuthal Equal Area
Datum : WGS 84

MAP No. : ADNM - 01 OF 02

Date : 24/6/2005

Gujarat Hazard Risk Zonation : Admistrative Subdivisions (2001)

GSDMA

69°00' E 70°00' E 71°00' E 72°00' E 73°00' E 74°00' E

24°00' N 23°00' N 22°00' N 21°00' N 20°00' N

LEGEND

- State Boundary
- District Boundary
- Taluka Boundary
- Mud Flats & Rann
- Taluka Headquarter
- 0101 Taluka Code

Source : BISAG, GoG.

0 100 km

N

Projection : Lambert Azimuthal Equal Area
Datum : WGS 84

MAP No. : ADNM - 02 OF 02

Date : 24/6/2005

GUJARAT HAZARD RISK ZONATION : ADMINISTRATIVE SUBDIVISIONS AND TALUKA HEADQUARTERS

TABLE No. ADNT - 01 OF 01

GSDMA

Sr. No	Taluka Code	Taluka	District	Taluka Headquarter	Latitude (Degrees North)	Longitude (Degrees East)
1	0101	Lakhpat	Kachchh	Dayapar	68 90	23.64
2	0102	Rapar	Kachchh	Rapar	70.65	23.57
3	0103	Bhachau	Kachchh	Bhachau	70.33	23.30
4	0104	Anjar	Kachchh	Anjar	70.03	23.11
5	0105	Bhuj	Kachchh	Bhuj	69.66	23.28
6	0106	Nakhatrana	Kachchh	Nakhatrana	69.25	23.37
7	0107	Abdasa	Kachchh	Naliya	68.82	23.26
8	0108	Mandvi	Kachchh	Mandvi	69.35	22.84
9	0109	Mundra	Kachchh	Mundra	69.71	22.83
10	0110	Gandhidham	Kachchh	Gandhidham	70.14	23.07
11	0201	Vav	Banas Kantha	Vav	71.50	24.39
12	0202	Tharad	Banas Kantha	Tharad	71.62	24.39
13	0203	Dhanera	Banas Kantha	Dhanera	72.02	24.50
14	0204	Dantiwada	Banas Kantha	Dantiwada	72.35	24.35
15	0205	Amirgadh	Banas Kantha	Amirgadh	72.64	24.39
16	0206	Danta	Banas Kantha	Ambaji	72.82	24.33
17	0207	Vadgam	Banas Kantha	Vadgam	72.50	24.07
18	0208	Palanpur	Banas Kantha	Palanpur	72.44	24.18
19	0209	Deesa	Banas Kantha	Deesa	72.18	24.26
20	0210	Deodar	Banas Kantha	Deodar	71.78	24.10
21	0211	Bhabhar	Banas Kantha	Bhabher	71.60	24.05
22	0212	Kankrej	Banas Kantha	Shihori	71.96	24.03
23	0301	Santalpur	Patan	Varahi	71.43	23.78
24	0302	Radhanpur	Patan	Radhanpur	71.59	23.83
25	0303	Vagdod	Patan	Vagdod	72.14	23.99
26	0304	Sidhpur	Patan	Sidhpur	72.37	23.93
27	0305	Patan	Patan	Patan	72.12	23.85
28	0306	Harij	Patan	Harij	71.91	23.69
29	0307	Sami	Patan	Sami	71.80	23.67
30	0308	Chanasma	Patan	Chanasma	72.10	23.71
31	0401	Satlasana	Mahesana	Satlasana	72.81	24.02
32	0402	Kheralu	Mahesana	Kheralu	72.62	23.88
33	0403	Unjha	Mahesana	Unjha	72.39	23.79
34	0404	Visnagar	Mahesana	Visnagar	72.55	23.70
35	0405	Vadnagar	Mahesana	Vadnagar	72.63	23.78
36	0406	Vijapur	Mahesana	Vijapur	72.75	23.56
37	0407	Mahesana	Mahesana	Mahesana	72.40	23.61
38	0408	Becharaji	Mahesana	Becharaji	72.04	23.49
39	0409	Kadi	Mahesana	Kadi	72.32	23.30
40	0501	Khedbrahma	Sabar Kantha	Khedbrahma	73.05	24.04
41	0502	Vijaynagar	Sabar Kantha	Vijaynagar	73.37	24.02
42	0503	Vadali	Sabar Kantha	Vadali	73.02	23.94
43	0504	Idar	Sabar Kantha	Idar	72.98	23.85
44	0505	Bhiloda	Sabar Kantha	Bhiloda	73.26	23.77
45	0506	Meghraj	Sabar Kantha	Meghraj	73.51	23.50
46	0507	Himatnagar	Sabar Kantha	Himatnagar	72.96	23.59
47	0508	Prantij	Sabar Kantha	Prantij	72.86	23.45
48	0509	Talod	Sabar Kantha	Talod	72.94	23.37
49	0510	Modasa	Sabar Kantha	Modasa	73.29	23.45
50	0511	Dhansura	Sabar Kantha	Dhansura	73.22	23.34
51	0512	Malpur	Sabar Kantha	Malpur	73.46	23.36
52	0513	Bayad	Sabar Kantha	Bayad	73.22	23.23
53	0601	Kalol	Gandhinagar	Kalol	72.49	23.25
54	0602	Mansa	Gandhinagar	Mansa	72.67	23.42
55	0603	Gandhinagar	Gandhinagar	Gandhinagar	72.65	23.23
56	0604	Dehgam	Gandhinagar	Dehgam	72.82	23.15
57	0701	Dhandhuka	Ahmadabad	Mandal	71.91	23.30
58	0702	Sanand	Ahmadabad	Detroj-Rampura	72.19	23.33
59	0703	Ranpur	Ahmadabad	Viramgam	72.04	23 12
60	0704	Mandal	Ahmadabad	Sanand	72.38	22.99
61	0705	Ahmadabad City	Ahmadabad	Ahmadabad	72.59	23.02
62	0706	Daskroi	Ahmadabad	Ahmadabad	72 59	23.02
63	0707	Detroj-Rampura	Ahmadabad	Dholka	72.44	22.73
64	0708	Bavla	Ahmadabad	Bavla	72.36	22.81
65	0709	Dholka	Ahmadabad	Ranpur	71.71	22.36
66	0710	Barwala	Ahmadabad	Barwala	71.90	22.15
67	0711	Viramgam	Ahmadabad	Dhandhuka	72.00	22.38
68	0801	Halvad	Surendranagar	Halvad	71.19	23.01
69	0802	Dhrangadhra	Surendranagar	Dhrangadhra	71.47	23.00
70	0803	Dasada	Surendranagar	Patdi	71.79	23.20
71	0804	Lakhtar	Surendranagar	Lakhtar	71.78	22.86
72	0805	Wadhwan	Surendranagar	Wadhwan	71.69	22.70
73	0806	Muli	Surendranagar	Muli	71.46	22 64
74	0807	Chotila	Surendranagar	Chotila	71.20	22.42
75	0808	Sayla	Surendranagar	Sayla	71.49	22.54
76	0809	Chuda	Surendranagar	Chuda	71 68	22.48
77	0810	Limbdi	Surendranagar	Limbdi	71.80	22.56
78	0901	Maliya	Rajkot	Maliya	70.77	23.13
79	0902	Morvi	Rajkot	Morvi	70.82	22.80
80	0903	Tankara	Rajkot	Tankara	70.77	22.65
81	0904	Wankaner	Rajkot	Wankaner	70.94	22 61
82	0905	Paddhari	Rajkot	Paddhari	70 61	22.42
83	0906	Rajkot	Rajkot	Rajkot	70.81	22.31
84	0907	Lodhika	Rajkot	Lodhika	70.63	22.11
85	0908	Kotda Sangani	Rajkot	Kotda Sangani	70.84	22.05
86	0909	Jasdan	Rajkot	Jasdan	71.20	22.04
87	0910	Gondal	Rajkot	Gondal	70.80	21.97
88	0911	Jamkandorna	Rajkot	Jamkandorna	70.51	21.89
89	0912	Upleta	Rajkot	Upleta	70.27	21.74
90	0913	Dhoraji	Rajkot	Dhoraji	70.45	21 73
91	0914	Jetpur	Rajkot	Jetpur	70.63	21 76
92	1001	Okhamandal	Jamnagar	Dwarka	68.99	22.24
93	1002	Khambhalia	Jamnagar	Khambhalia	69.65	22.20
94	1003	Jamnagar	Jamnagar	Jamnagar	70.08	22.46
95	1004	Jodiya	Jamnagar	Jodiya	70.30	22.72
96	1005	Dhrol	Jamnagar	Dhrol	70.43	22.56
97	1006	Kalavad	Jamnagar	Kalavad	70.38	22.21
98	1007	Lalpur	Jamnagar	Lalpur	69.97	22.19
99	1008	Kalyanpur	Jamnagar	Kalyanpur	69.42	22.02
100	1009	Bhanvad	Jamnagar	Bhanvad	69.78	21.94
101	1010	Jamjodhpur	Jamnagar	Jamjodhpur	70.02	21.90
102	1101	Porbandar	Porbandar	Porbandar	69.61	21 64
103	1102	Ranavav	Porbandar	Ranavav	69.75	21.69
104	1103	Kutiyana	Porbandar	Kutiyana	69.98	21.63
105	1201	Manavadar	Junagadh	Manavadar	70.13	21.49
106	1202	Vanthali	Junagadh	Vanthali	70.31	21 49
107	1203	Junagadh	Junagadh	Junagadh	70 47	21 51
108	1204	Bhesan	Junagadh	Bhesan	70.72	21.54
109	1205	Visavadar	Junagadh	Visavadar	70.74	21 32
110	1206	Mendarda	Junagadh	Mendarda	70.45	21.32
111	1207	Keshod	Junagadh	Keshod	70.25	21.31
112	1208	Mangrol	Junagadh	Mangrol	70.13	21 13
113	1209	Malia	Junagadh	Malia	70 31	21.15
114	1210	Talala	Junagadh	Talala	70 53	21.05

GUJARAT HAZARD RISK ZONATION : ADMINISTRATIVE SUBDIVISIONS AND TALUKA HEADQUARTERS
TABLE No. ADNT - 01 OF 01

GSDMA

Sr. No	Taluka Code	Taluka	District	Taluka Headquarter	Latitude (Degrees North)	Longitude (Degrees East)
115	1211	Patan-Veraval	Junagadh	Patan Veraval	70.37	20.91
116	1212	Sutrapada	Junagadh	Sutrapada	70.50	20.85
117	1213	Kodinar	Junagadh	Kodinar	70.70	20.80
118	1214	Una	Junagadh	Una	71.03	20.83
119	1301	Kunkavav Vadia	Amreli	Vadia	70.81	21.68
120	1302	Babra	Amreli	Babra	71.30	21.85
121	1303	Lathi	Amreli	Lathi	71.39	21.72
122	1304	Lilia	Amreli	Lilia	71.35	21.55
123	1305	Amreli	Amreli	Amreli	71.21	21.60
124	1306	Bagasara	Amreli	Bagasara	70.95	21.48
125	1307	Dhari	Amreli	Dhari	71.02	21.33
126	1308	Savar Kundla	Amreli	Savarkundla	71.31	21.34
127	1309	Khambha	Amreli	Khambha	71.26	21.13
128	1310	Jafrabad	Amreli	Jafrabad	71.36	20.87
129	1311	Rajula	Amreli	Rajula	71.45	21.03
130	1401	Botad	Bhavnagar	Botad	71.67	22.17
131	1402	Vallabhipur	Bhavnagar	Vallabhipur	71.89	21.88
132	1403	Gadhada	Bhavnagar	Gadhada	71.58	21.97
133	1404	Umrala	Bhavnagar	Umrala	71.80	21.84
134	1405	Bhavnagar	Bhavnagar	Bhavnagar	72.14	21.79
135	1406	Ghogha	Bhavnagar	Ghogha	72.28	21.69
136	1407	Sihor	Bhavnagar	Sihor	71.97	21.71
137	1408	Gariadhar	Bhavnagar	Gariadhar	71.58	21.54
138	1409	Palitana	Bhavnagar	Palitana	71.81	21.51
139	1410	Talaja	Bhavnagar	Talaja	72.04	21.36
140	1411	Mahuva	Bhavnagar	Mahuva	71.77	21.08
141	1501	Tarapur	Anand	Tarapur	72.66	22.48
142	1502	Sojitra	Anand	Sojitra	72.72	22.54
143	1503	Umreth	Anand	Umreth	73.11	22.70
144	1504	Anand	Anand	Anand	72.95	22.55
145	1505	Petlad	Anand	Petlad	72.75	22.47
146	1506	Khambhat	Anand	Khambhat	72.64	22.31
147	1507	Borsad	Anand	Borsad	72.90	22.41
148	1508	Anklav	Anand	Anklav	73.00	22.37
149	1601	Kapadvanj	Kheda	Kapadvanj	73.07	23.01
150	1602	Virpur	Kheda	Virpar	73.48	23.19
151	1603	Balasinor	Kheda	Balasinor	73.34	22.95
152	1604	Kathlal	Kheda	Kathlal	72.98	22.89
153	1605	Mehmedabad	Kheda	Mehmedabad	72.75	22.81
154	1606	Kheda	Kheda	Kheda	72.69	22.77
155	1607	Matar	Kheda	Matar	72.66	22.70
156	1608	Nadiad	Kheda	Nadiad	72.86	22.69
157	1609	Mahudha	Kheda	Mahudha	72.94	22.81
158	1610	Thasra	Kheda	Thasra	73.21	22.80
159	1701	Khanpur	Panch Mahals	Khanpur	73.68	23.27
160	1702	Kadana	Panch Mahals	Kadana	73.84	23.28
161	1703	Santrampur	Panch Mahals	Santrampur	73.88	23.19
162	1704	Lunawada	Panch Mahals	Lunawada	73.61	23.13
163	1705	Shehera	Panch Mahals	Shehera	73.63	22.95
164	1706	Morwa (Hadaf)	Panch Mahals	Morva (Hadaf)	73.83	22.93
165	1707	Godhra	Panch Mahals	Godhra	73.60	22.79
166	1708	Kalol	Panch Mahals	Kalol	72.49	23.25
167	1709	Ghoghamba	Panch Mahals	Ghoghamba	73.64	22.56
168	1710	Halol	Panch Mahals	Halol	73.46	22.49
169	1711	Jambughoda	Panch Mahals	Jambughoda	73.73	22.37
170	1801	Fatepura	Dohad	Fatepura	74.03	23.25
171	1802	Jhalod	Dohad	Jhalod	74.15	23.09
172	1803	Limkheda	Dohad	Limkheda	74.01	22.83
173	1804	Dohad	Dohad	Dohad	74.26	22.83
174	1805	Garbada	Dohad	Garbada	74.33	22.69
175	1806	Devgadbaria	Dohad	Devgadbaria	73.91	22.70
176	1807	Dhanpur	Dohad	Dhanpur	74.10	22.64
177	1901	Savli	Vadodara	Savli	73.21	22.56
178	1902	Vadodara	Vadodara	Vadodara	73.20	22.30
179	1903	Vaghodia	Vadodara	Vaghodia	73.39	22.30
180	1904	Jetpur Pavi	Vadodara	Jetpur Pavi	73.84	22.35
181	1905	Chhota Udaipur	Vadodara	Chhota Udaipur	74.01	22.30
182	1906	Kavant	Vadodara	Kavant	74.05	22.09
183	1907	Nasvadi	Vadodara	Nasvadi	73.72	22.05
184	1908	Sankheda	Vadodara	Sankheda	73.58	22.17
185	1909	Dabhoi	Vadodara	Dabhoi	73.43	22.13
186	1910	Padra	Vadodara	Padra	73.08	22.24
187	1911	Karjan	Vadodara	Karjan	73.12	22.05
188	1912	Sinor	Vadodara	Sinor	73.33	21 91
189	2001	Tilakwada	Narmada	Tilakwada	73.59	21.95
190	2002	Nandod	Narmada	Rajpipla	73.50	21.88
191	2003	Dediapada	Narmada	Dediapada	73.60	21 64
192	2004	Sagbara	Narmada	Sagbara	73.80	21.55
193	2101	Jambusar	Bharuch	Jambusar	72.80	22.05
194	2102	Amod	Bharuch	Amod	72.86	21.99
195	2103	Vagra	Bharuch	Vagra	72.85	21.86
196	2104	Bharuch	Bharuch	Bharuch	73.00	21.70
197	2105	Jhagadia	Bharuch	Jhagadia	73.13	21 74
198	2106	Anklesvar	Bharuch	Anklesvar	72.99	21.62
199	2107	Hansot	Bharuch	Hansot	72.82	21.57
200	2108	Valia	Bharuch	Valia	73.19	21.56
201	2201	Olpad	Surat	Olpad	72.77	21.33
202	2202	Mangrol	Surat	Mangrol	70.13	21 13
203	2203	Umarpada	Surat	Umarpada	73.48	21.46
204	2204	Nizar	Surat	Nizar	74.20	21.47
205	2205	Uchchhal	Surat	Uchchhal	73.77	21.17
206	2206	Songadh	Surat	Songadh	73.56	21.16
207	2207	Mandvi	Surat	Mandvi	69.35	22.84
208	2208	Kamrej	Surat	Kamrej	72.98	21.29
209	2209	Surat City	Surat	Surat City	72.82	21.22
210	2210	Chorasi	Surat	Surat City	72.82	21.22
211	2211	Palsana	Surat	Palsana	72.98	21.07
212	2212	Bardoli	Surat	Bardoli	73.13	21.13
213	2213	Vyara	Surat	Vyara	73.38	21 12
214	2214	Valod	Surat	Valod	73.26	21 05
215	2215	Mahuva	Surat	Mahuva	71.77	21 08
216	2301	The Dangs	The Dangs	Ahwa	73.68	20 75
217	2401	Navsari	Navsari	Navsari	72.94	20.95
218	2402	Jalalpore	Navsari	Jalalpore	72 89	20.94
219	2403	Gandevi	Navsari	Gandevi	73.00	20.81
220	2404	Chikhli	Navsari	Chikhli	73.06	20.75
221	2405	Bansda	Navsari	Bansda	73.37	20 75
222	2501	Valsad	Valsad	Valsad	72.90	20.61
223	2502	Dharampur	Valsad	Dharampur	73.17	20.53
224	2503	Pardi	Valsad	Pardi	72.94	20.50
225	2504	Kaprada	Valsad	Kaprada	73.24	20.34
226	2505	Umbergaon	Valsad	Umbergaon	72 76	20 19

DROUGHT HAZARD RISK

DROUGHT HAZARD RISK

An area is affected by drought when the annual precipitation is lower than 60 percent of the normal values, at least during two consecutive years in more than 50 percent of its area (WMO).

Deficit rainfall is recorded when annual rainfall is less than 80% of normal and scanty when less than 60% (IMD). Two major groups of indices are used across the world to monitor droughts.

RAINFALL BASED METHODS

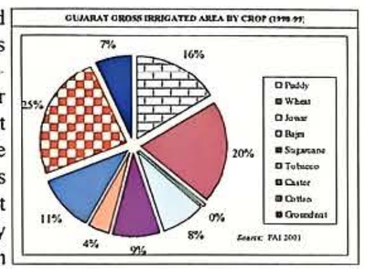
- Rainfall Ratio Method: The most common method used is the ratio of actual rainfall to the average rainfall. The Indian Meteorological Department (IMD) uses this method to identify drought-affected areas.
- Decile Method: Historical rainfall data is arranged in ascending order and rainfall for each 10 percent of the years is determined. The I Decile is the rainfall amount not exceeded by the lowest 10 percent of the years. The fifth decile is the median rainfall for the whole data set. The tenth decile is recorded rainfall not exceeded by 90 percent of the years.

SOIL MOISTURE BASED METHODS

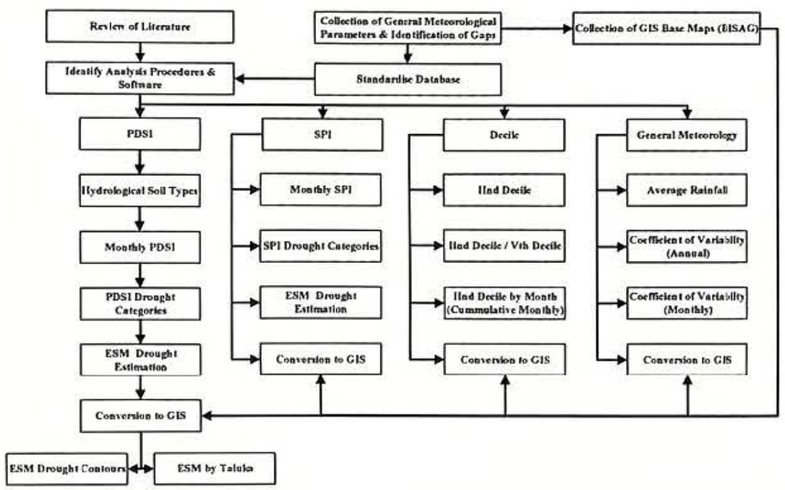
- The Palmer Drought Severity Index (PDSI) uses temperature and rainfall information to determine dryness based on a supply and demand water balance equation.
- Standardised Precipitation Index (SPI) was designed to quantify precipitation deficit across multiple time scales, i.e., 3, 6, 12, 24, and 48-month time scales (McKee *et al*, 1993).

IRRIGATION

The irrigated area is about 30 percent of net cropped area in Gujarat. Ground water irrigation contributes about 78 percent of the irrigated area. About one-fourth of the Gross Irrigated Area (GIA) is under cotton and about one-fifth of the GIA is under wheat (Rabi crop). Most other crops except sugarcane are cultivated during the Kharif. Cropping intensity is of only 115 percent despite about 30 percent net sown area under irrigation and irrigation intensity of 123 percent indicates that most of the irrigation availability is restricted to the Kharif crop.



DROUGHT HAZARD RISK ASSESSMENT



DATA SOURCES

The following data sets were used to assess drought risk across the state:

i) Daily rainfall data (1900-1990), Gujarat Agricultural University, Anand.
ii) Daily/Monthly rainfall data (1980-2002), State Water Data Centre, Gandhinagar.
iii) Monthly rainfall data (1980-2003), Dept of Agriculture (GoG), Gandhinagar.
iv) Monthly rainfall data (1980-2002), Directorate of Economics and Statistics (GoG), Gandhinagar.
v) Daily rainfall data (1980-2002, with gaps), Flood Control Cell, Gandhinagar.
vi) District Statistical Handbooks (1980-2002), Directorate of Economics and Statistics (GoG), Gandhinagar.
vii) Production and Yield data (1980-2002), Department of Agriculture (GOG), Gandhinagar.
viii) Temperature and Pan Evaporation (1980-2002), State Water Data Centre, Gandhinagar.
ix) ClimWat database (FAO), Rome.

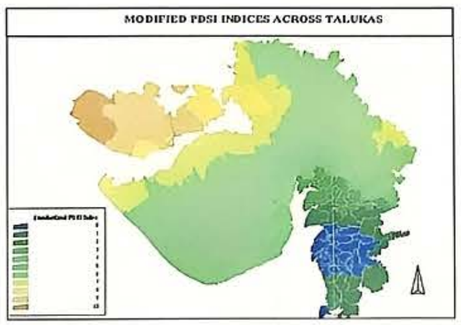
The Decile method was used to analyze both monthly and annual taluka-level rainfall patterns and map drought across Gujarat. The analysis indicates that in most parts of Kachchh, the probability of rainfall is less than 200 mm once in five years. More than half the talukas of Gujarat lie in the second decile range of range of 200-399mm. This rainfall is insufficient even for millets and other dry land crops. The whole of Saurashtra and most parts of northern Gujarat have a probability of less than 400mm rainfall once in five years. Less than one-third the area of Gujarat lying in the southern region has a probability of more than 400 mm once in five years.

SECOND DECILE RAINFALL ACROSS TALUKAS

District	Annual Second Decile rainfall (in mm.)							
	0-199	200-399	400-599	600-799	800-999	1000-1199	1200-1400	Total
Ahmedabad		9	2					11
Amreli		10	1					11
Anand		1	7					8
Banaskantha	2	10						12
Bharuch			6	2				8
Bhavnagar		11						11
Dahod			5	2				7
Gandhinagar		4						4
Jamnagar	1	9						10
Junagadh		8	6					14
Kachchh	10							10
Kheda		2	8					10
Mehsana		9						9
Narmada			1	3				4
Navsari					2	1	2	5
Panchmahals		11						11
Patan	1	7						8
Porbandar		3						3
Rajkot		14						14
Sabarkantha		13						13
Surat			2	6	7			15
Surendranagar		10						10
Dangs						1		1
Vadodara			11	1				12
Valsad						1	4	5
Gujarat	14	136	46	12	9	3	6	226

Source: TARU analysis, 2004

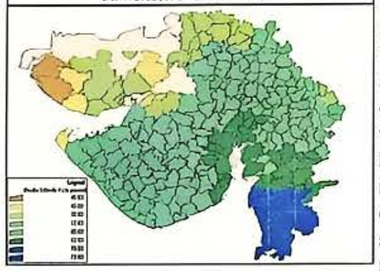
MODIFIED PDSI INDICES ACROSS TALUKAS



PDSI was calculated using the PDSI software (University of Nebraska). Self-calculated PDSI value outputs were used to prepare the maps of extreme, severe and moderate droughts. It was found that in most stations, the percentage of moderate drought years is nearly equivalent to sum of percentages of extreme and severe drought years.

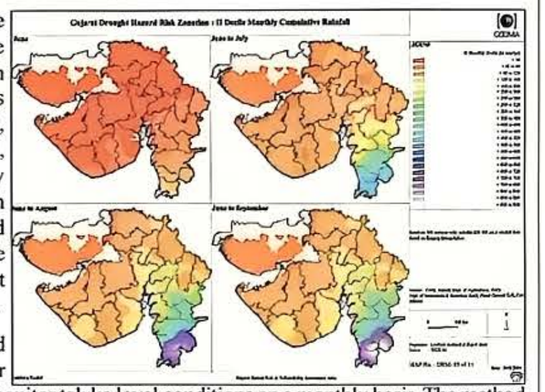
It must be noted that PDSI indicates drought risks in terms of rainfall and moisture availability. In large parts of central and northern Gujarat, ground water is the main source of irrigation. These areas are less affected by drought compared to predominantly rain-fed regions. While PDSI assesses drought based on climatology and water holding capacity of soils, it cannot assess the differential impacts of droughts especially in regions with alternate sources of irrigation.

RATIO OF SECOND DECILE TO FIFTH DECILE (ANNUAL) ACROSS TALUKAS



The ratio of II Decile to V Decile can be used as an indicator to analyse droughts, especially in semi-arid and arid regions. This ratio is highly variable with the ratios going down to less than 50 percent in arid areas and reaching up to 75 percent or more in case of sub-humid areas. Arid areas in north and western Gujarat show lower ratios while the southern high rainfall regions show the highest ratios. Higher ratios indicate that even during once in five-year droughts, higher rainfall can be expected in the southern humid regions than in arid and semi-arid regions.

The II Decile Cumulative Monthly Rainfall map may be utilised to ascertain meteorological drought conditions on real time basis. This analysis, based on the decile method, measures in real time the adequacy of rainfall on monthly basis. With proper assumptions and calibration the method could be utilised to track real time drought conditions on a fortnightly basis.



The same methodology was used to assess drought conditions for the year 2004 to help GSDMA monitor taluka level conditions on a monthly basis. The method is simple but does not take into account the frequency of rainfall with long dry spells interspersed with very high short term precipitation.

CONCLUSIONS

Gujarat exhibits very large diversity in climate and therefore, drought indicators have to be carefully examined before their application for zonation. While southern Gujarat lies in the sub-humid to humid region, the northern and western regions are arid. Therefore, three major indicators were examined in addition to testing for diversity in standard meteorological parameters using mean and standard deviation of rainfall and coefficient of variability.

Several indicators have been used worldwide to assess droughts. With limited availability of validated rainfall data of comparable time-series at taluka levels, it is advisable to use simple indicators that can be updated regularly. It is to be noted that these drought indicators assess risks alone and do not address vulnerability issues.

Of the three indicators examined, SPI did not have sufficient discrimination over accuracy and reflect the ground situation. The PDSI provided good spatial diversity. While PDSI may be good indicator for assessing agricultural droughts, calculation of PDSI requires rainfall, available water holding capacity of soils and mean weekly/monthly temperature data. While it was not possible to get temperature data of all stations, average monthly temperature data only could be used.

The decile method is easy to understand, simple to calculate and requires only monthly rainfall data. Monthly deciles may be used in Gujarat for drought monitoring and preparedness at taluka level. If vulnerability data is also available and regularly updated, the decile method can be fine-tuned to address drought preparedness challenges.

It is suggested that over time, PDSI values may be developed as the official drought assessment indicator in Gujarat. This would necessitate building a database of validated rainfall and temperature data for each taluka. The availability of full climatic station data at the taluka level would need to be ensured to use the PDSI.

Gujarat Drought Hazard Risk Zonation: Topographical Features

GSDMA

69°00' E 70°00' E 71°00' E 72°00' E 73°00' E 74°00' E

24°00' N 23°00' N 22°00' N 21°00' N 20°00' N

Lakhpat
Bhuj
Jakhau
Anjar
Jamnagar
Dwarka
Porbandar
Junagadh
Amreli
Rajula
Una
Botad
Bhavnagar
Surendranagar
Palanpur
Siddhapur
Mahesana
Himatnagar
Ahmedabad
Kheda
Anand
Godhra
Dahod
Vadodara
Bharuch
Ankleshwar
Surat
Navsari
Valsad
Vapi
Songadh
Aravali Range
Satpura Range
Western Ghats

LEGEND

Altitude in Meters

0
2
5
10
25
50
75
100
125
150
175
200
225
300
1170

Major Towns

Source: SRTM, 2003; BISAG, GoG.

0 100 km

N

Projection : Lambert Azimuthal Equal Area
Datum : WGS 84

MAP No. : HDRM - 01 OF 05

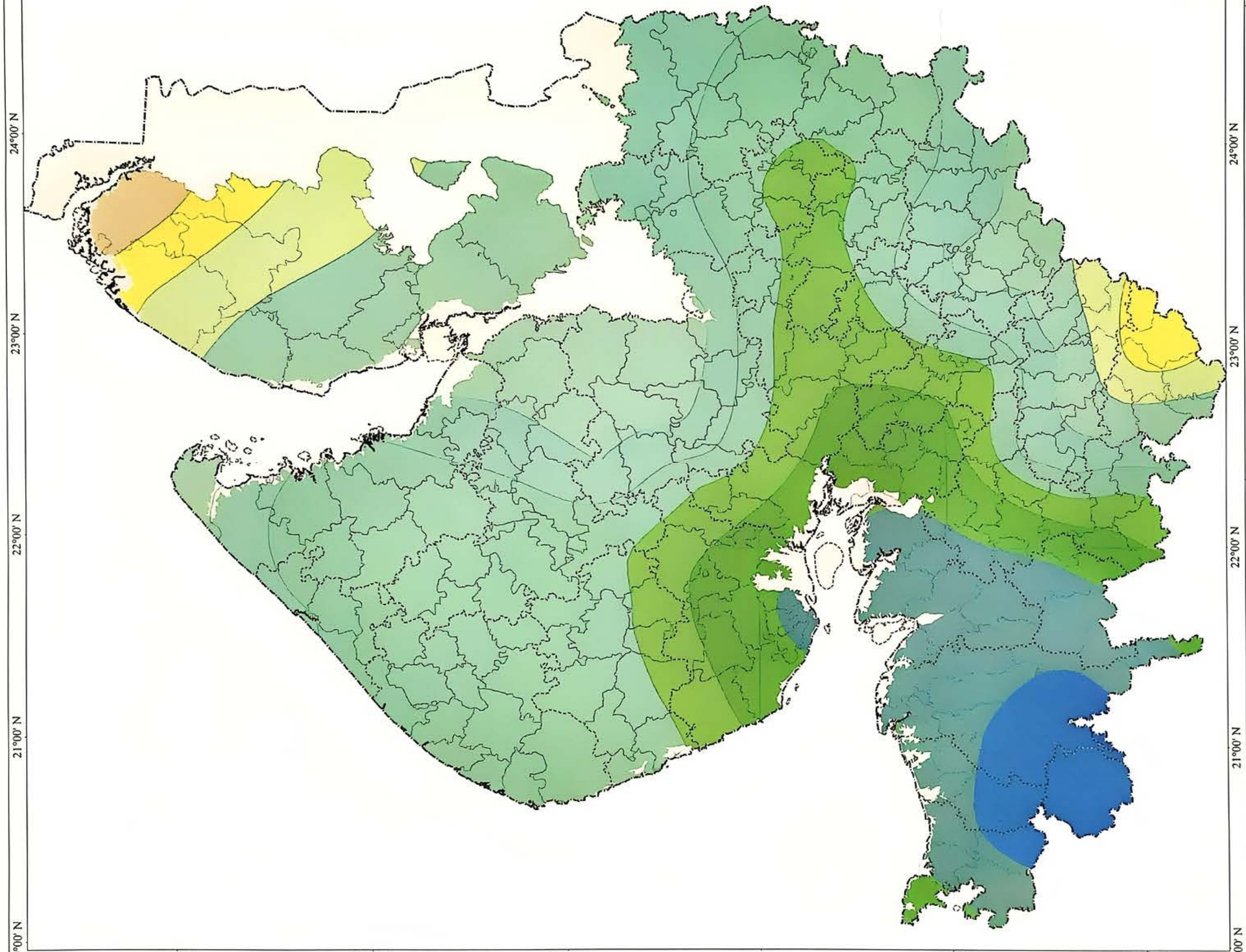
Date : 24/6/2005

Gujarat Drought Hazard Risk Zonation: Coefficient of Variability of Annual Rainfall

GSDMA

69°00' E 70°00' E 71°00' E 72°00' E 73°00' E 74°00' E

24°00' N 23°00' N 22°00' N 21°00' N 20°00' N



LEGEND

CV of Annual Rainfall
< 40
> 40 to 45
> 45 to 50
> 50 to 55
> 55 to 60
> 60 to 65
> 65 to 70
> 70 to 75
> 75 to 80
> 80 to 85
> 85

Coefficient of Variability (CV) = (Standard Deviation/Mean) X 100
Based on 175 stations with variable (30-100 yrs.) rainfall data.
Based on Kriging Interpolation.

Source : GAU, Anand; Department of Agriculture, GoG;
Department of Economics & Statistics, GoG;
Flood Control Cell, GoG; BISAG, GoG.

0 100 km

N

Projection : Lambert Azimuthal Equal Area
Datum : WGS 84

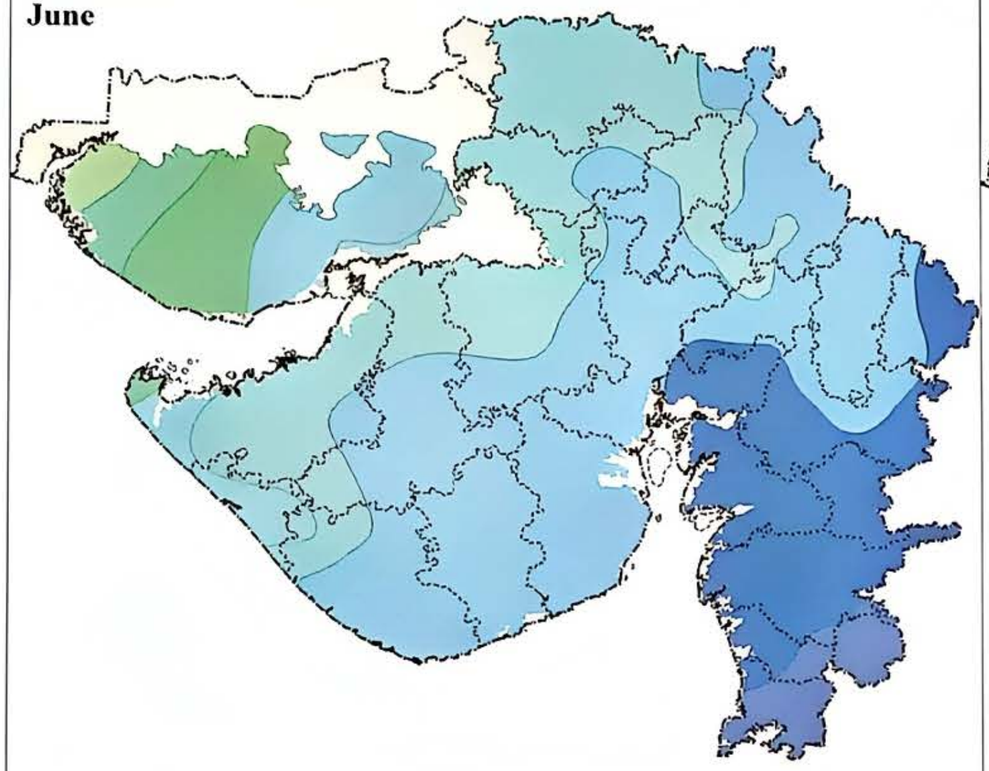
MAP No. : HDRM - 02 OF 05

Date : 24/8/2005

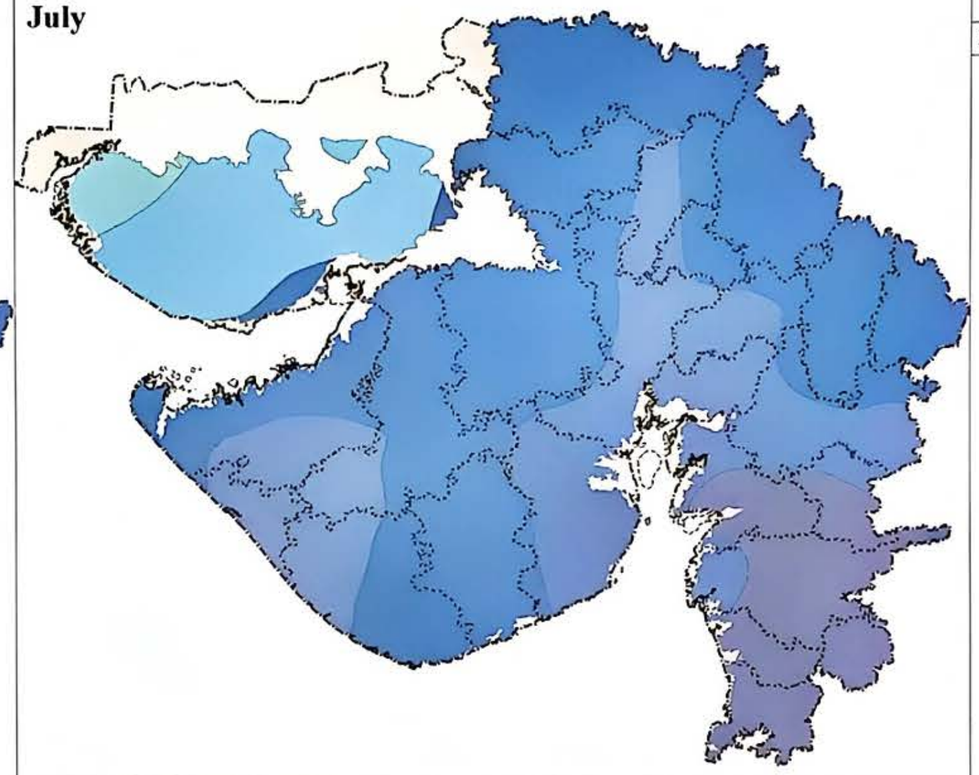
Gujarat Drought Hazard Risk Zonation: Coefficient of Variability of Monthly Rainfall

GSDMA

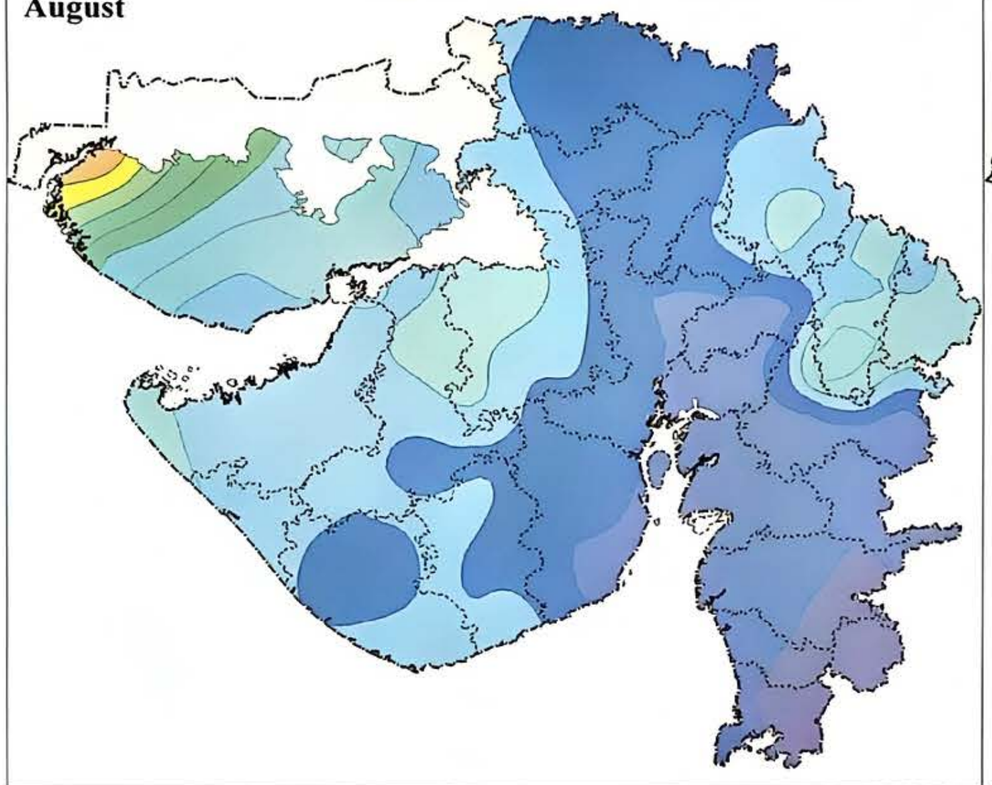
June



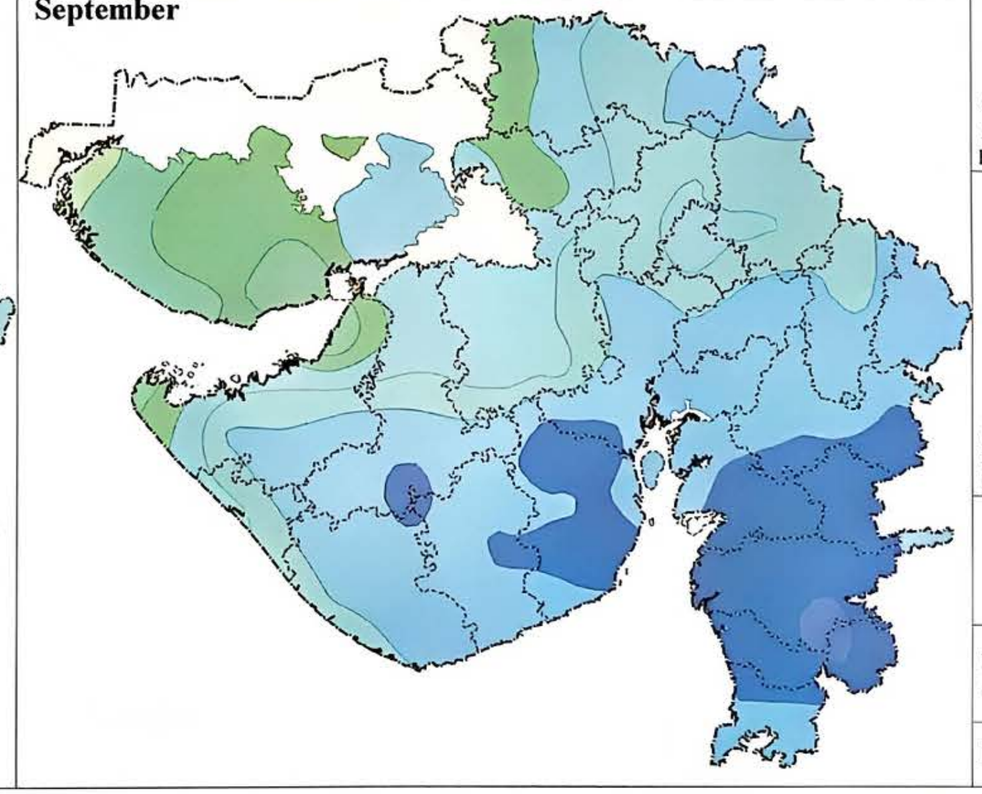
July



August



September



LEGEND

CV of Monthly Rainfall

- > 40 to 60
- > 60 to 80
- > 80 to 100
- > 100 to 120
- > 120 to 140
- > 140 to 160
- > 160 to 180
- > 180 to 200
- > 200 to 220
- > 220 to 240
- > 240 to 260
- > 260 to 280

Coefficient of Variability (CV) = (Standard Deviation/Mean) X 100
Based on 197 stations with variable (30-100 yrs.) rainfall data.
Based on Kriging Interpolation.

Source : GAU, Anand; Department of Agriculture, GoG;
Department of Economics & Statistics, GoG;
Flood Control Cell, GoG; BISAG, GoG.

0 100 km

N

Projection : Lambert Azimuthal Equal Area
Datum : WGS 84

MAP No. : HDRM - 03 OF 05

Date : 24/8/2005

Gujarat Drought Hazard Risk Zonation : Talukawise II Decile by V Decile Rainfall

GSDMA

69°00' E 70°00' E 71°00' E 72°00' E 73°00' E 74°00' E

24°00' N 23°00' N 22°00' N 21°00' N 20°00' N

LEGEND

II Decile/V Decile
(in percent)

- < 40
- > 40 to 45
- > 45 to 50
- > 50 to 55
- > 55 to 60
- > 60 to 65
- > 65

Based on 198 stations with variable (30-100 yrs.) rainfall data.
Based on Kriging Interpolation.

Source : GAU, Anand; Department of Agriculture, GoG;
Department of Economics & Statistics, GoG;
Flood Control Cell, GoG; BISAG, GoG.

0 100 km

N

Projection : Lambert Azimuthal Equal Area
Datum : WGS 84

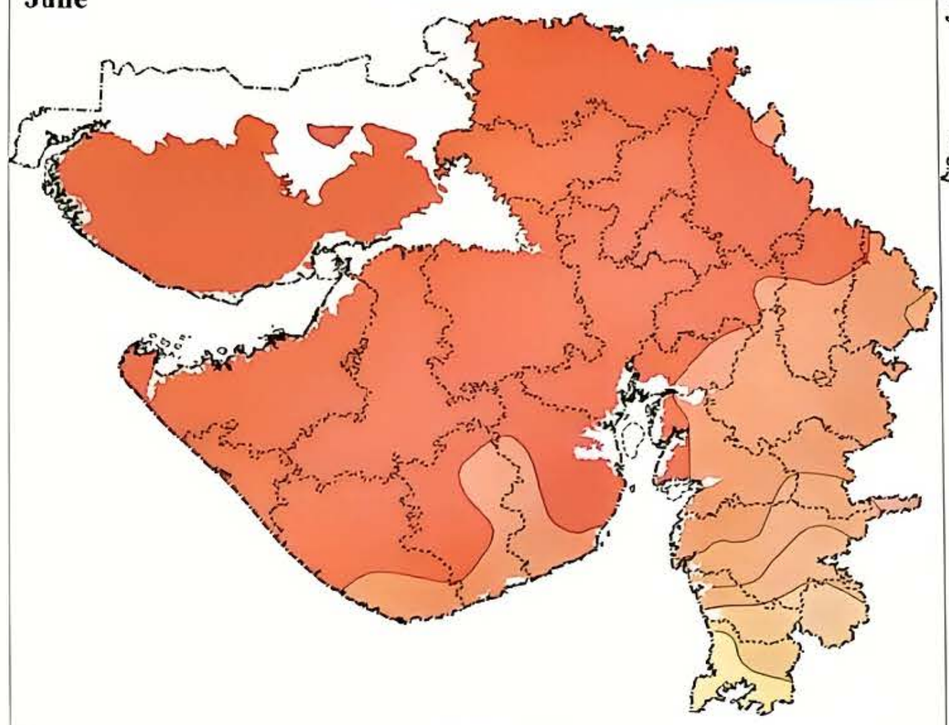
MAP No. : HDRM - 04 OF 05

Date : 24/6/2005

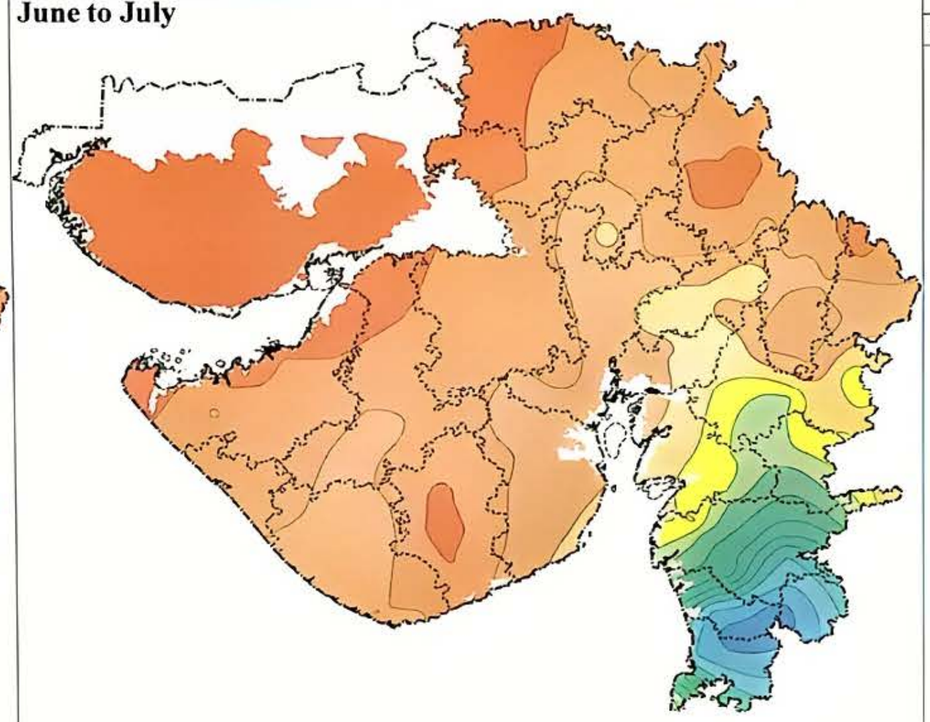
Gujarat Drought Hazard Risk Zonation : II Decile Monthly Cumulative Rainfall

GSDMA

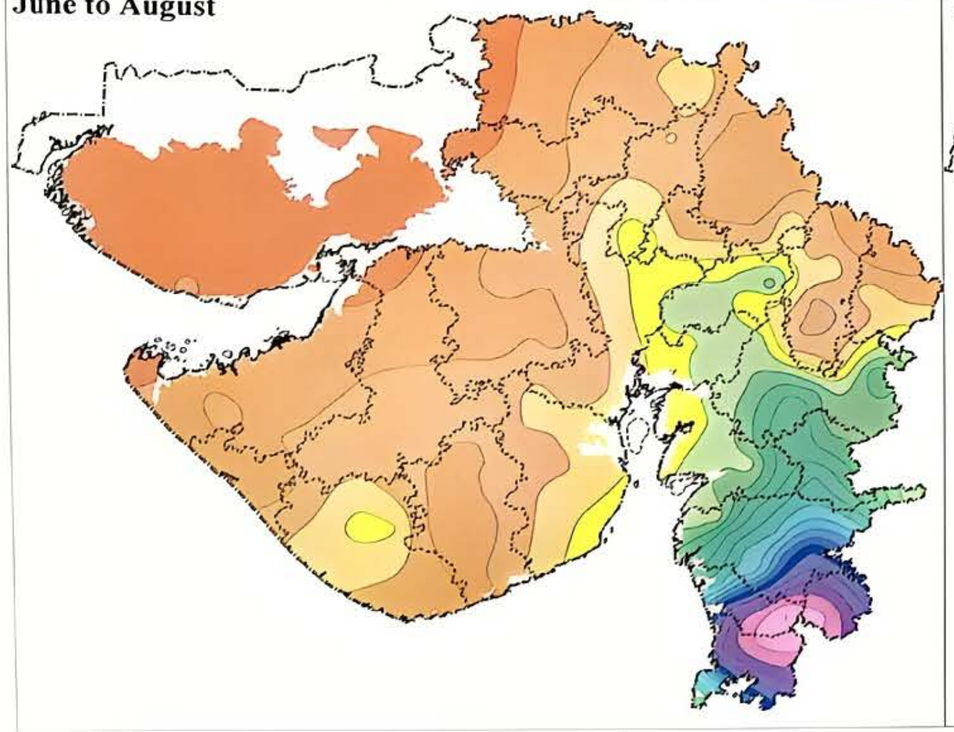
June



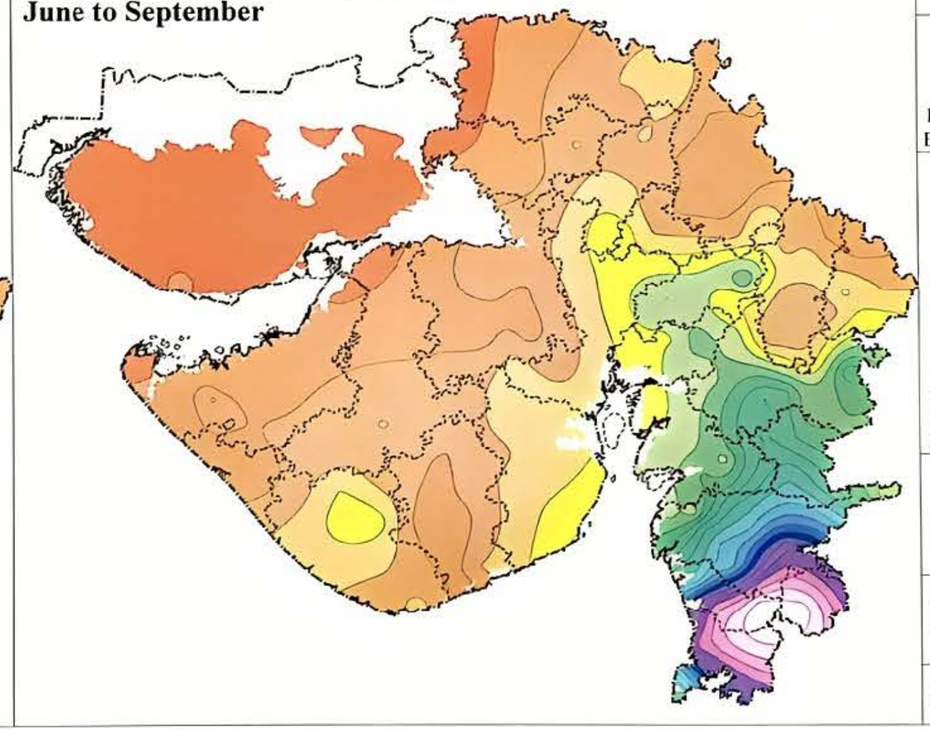
June to July



June to August



June to September



LEGEND

II Monthly Decile (in mm/yr)

- > 40
- > 40 to 80
- > 80 to 120
- > 120 to 160
- > 160 to 200
- > 200 to 240
- > 240 to 280
- > 280 to 320
- > 320 to 360
- > 360 to 400
- > 400 to 440
- > 440 to 480
- > 480 to 520
- > 520 to 560
- > 560 to 600
- > 600 to 640
- > 640 to 680
- > 680 to 720
- > 720 to 760
- > 760 to 800
- > 800 to 840
- > 840 to 880
- > 880 to 920

Based on 196 stations with variable (30-100 yrs.) rainfall data.
Based on Kriging Interpolation.

Source : GAU, Anand; Department of Agriculture, GoG;
Department of Economics & Statistics, GoG;
Flood Control Cell, GoG; BISAG, GoG.

0 100 km

N

Projection : Lambert Azimuthal Equal Area
Datum : WGS 84

MAP No. : HDRM - 05 OF 05

Date : 21/6/2005

METEOROLOGICAL DROUGHT HAZARD RISK

Table No. HDRT - 01 of 01

GSDMA

Sr. No	District	Taluka	Meteorological Drought Index Normalised II D / V D
1	Ahmadabad	Ahmadabad City	63
2	Ahmadabad	Barwala	64
3	Ahmadabad	Bavla	63
4	Ahmadabad	Daskroi	63
5	Ahmadabad	Detroj-Rampura	59
6	Ahmadabad	Dhandhuka	64
7	Ahmadabad	Dholka	64
8	Ahmadabad	Mandal	59
9	Ahmadabad	Ranpur	63
10	Ahmadabad	Sanand	62
11	Ahmadabad	Viramgam	60
12	Amreli	Amreli	61
13	Amreli	Babra	61
14	Amreli	Bagasara	61
15	Amreli	Dhari	58
16	Amreli	Jafrabad	59
17	Amreli	Khambha	58
18	Amreli	Kunkavav Vadia	62
19	Amreli	Lathi	62
20	Amreli	Lilia	62
21	Amreli	Rajula	60
22	Amreli	Savar Kundla	59
23	Anand	Anand	63
24	Anand	Anklav	63
25	Anand	Borsad	63
26	Anand	Khambhat	64
27	Anand	Petlad	63
28	Anand	Sojitra	64
29	Anand	Tarapur	64
30	Anand	Umreth	63
31	Banas Kantha	Amirgadh	52
32	Banas Kantha	Bhabhar	52
33	Banas Kantha	Danta	54
34	Banas Kantha	Dantiwada	51
35	Banas Kantha	Deesa	52
36	Banas Kantha	Deodar	52
37	Banas Kantha	Dhanera	50
38	Banas Kantha	Kankrej	54
39	Banas Kantha	Palanpur	53
40	Banas Kantha	Tharad	51
41	Banas Kantha	Vadgam	53
42	Banas Kantha	Vav	51
43	Bharuch	Amod	63
44	Bharuch	Anklesvar	64
45	Bharuch	Bharuch	63
46	Bharuch	Hansot	66
47	Bharuch	Jambusar	63
48	Bharuch	Jhagadia	65
49	Bharuch	Vagra	64
50	Bharuch	Valia	66
51	Bhavnagar	Bhavnagar	65
52	Bhavnagar	Botad	63
53	Bhavnagar	Gadhada	63
54	Bhavnagar	Gariadhar	62
55	Bhavnagar	Ghogha	64
56	Bhavnagar	Mahuva	61
57	Bhavnagar	Palitana	62
58	Bhavnagar	Sihor	63
59	Bhavnagar	Talaja	63
60	Bhavnagar	Umrala	64
61	Bhavnagar	Vallabhipur	64
62	Dohad	Devgadbaria	58
63	Dohad	Dhanpur	57
64	Dohad	Dohad	55
65	Dohad	Fatepura	53
66	Dohad	Garbada	56
67	Dohad	Jhalod	53
68	Dohad	Limkheda	55
69	Gandhinagar	Dehgam	60
70	Gandhinagar	Gandhinagar	60
71	Gandhinagar	Kalol	60
72	Gandhinagar	Mansa	57
73	Jamnagar	Bhanvad	58
74	Jamnagar	Dhrol	55
75	Jamnagar	Jamjodhpur	59
76	Jamnagar	Jamnagar	57
77	Jamnagar	Jodiya	52
78	Jamnagar	Kalavad	60
79	Jamnagar	Kalyanpur	53
80	Jamnagar	Khambhalia	57
81	Jamnagar	Lalpur	59
82	Jamnagar	Okhamandal	45
83	Junagadh	Bhesan	62
84	Junagadh	Junagadh	61
85	Junagadh	Keshod	58
86	Junagadh	Kodinar	57
87	Junagadh	Malia	59
88	Junagadh	Manavadar	57
89	Junagadh	Mangrol	57
90	Junagadh	Mendarda	60
91	Junagadh	Patan-Veraval	58
92	Junagadh	Sutrapada	57
93	Junagadh	Talala	59
94	Junagadh	Una	58
95	Junagadh	Vanthali	59
96	Junagadh	Visavadar	61
97	Kachchh	Abdasa	38
98	Kachchh	Anjar	49
99	Kachchh	Bhachau	46
100	Kachchh	Bhuj	44
101	Kachchh	Gandhidham	50
102	Kachchh	Lakhpat	34
103	Kachchh	Mandvi	45
104	Kachchh	Mundra	50
105	Kachchh	Nakhatrana	41
106	Kachchh	Rapar	47
107	Kheda	Balasinor	63
108	Kheda	Kapadvanj	63
109	Kheda	Kathlal	64
110	Kheda	Kheda	64
111	Kheda	Mahudha	64
112	Kheda	Matar	65
113	Kheda	Mehmedabad	64
114	Kheda	Nadiad	64

METEOROLOGICAL DROUGHT HAZARD RISK

Table No. HDRT - 01 of 01

GSDMA

Sr. No	District	Taluka	Meteorological Drought Index Normalised II D / V D
115	Kheda	Thasra	63
116	Kheda	Virpur	61
117	Mahesana	Becharaji	59
118	Mahesana	Kadi	60
119	Mahesana	Kheralu	55
120	Mahesana	Mahesana	58
121	Mahesana	Satlasana	55
122	Mahesana	Unjha	55
123	Mahesana	Vadnagar	56
124	Mahesana	Vijapur	56
125	Mahesana	Visnagar	57
126	Narmada	Dediapada	67
127	Narmada	Nandod	66
128	Narmada	Sagbara	66
129	Narmada	Tilakwada	65
130	Navsari	Bansda	72
131	Navsari	Chikhli	74
132	Navsari	Gandevi	74
133	Navsari	Jalalpore	74
134	Navsari	Navsari	74
135	Panch Mahals	Ghoghamba	59
136	Panch Mahals	Godhra	60
137	Panch Mahals	Halol	61
138	Panch Mahals	Jambughoda	60
139	Panch Mahals	Kadana	55
140	Panch Mahals	Kalol	61
141	Panch Mahals	Khanpur	57
142	Panch Mahals	Lunawada	59
143	Panch Mahals	Morwa (Hadaf)	56
144	Panch Mahals	Santrampur	54
145	Panch Mahals	Shehera	60
146	Patan	Chanasma	58
147	Patan	Harij	56
148	Patan	Patan	56
149	Patan	Radhanpur	52
150	Patan	Sami	55
151	Patan	Santalpur	50
152	Patan	Sidhpur	54
153	Patan	Vagdod	55
154	Porbandar	Kutiyana	56
155	Porbandar	Porbandar	54
156	Porbandar	Ranavav	55
157	Rajkot	Dhoraji	60
158	Rajkot	Gondal	60
159	Rajkot	Jamkandorna	61
160	Rajkot	Jasdan	60
161	Rajkot	Jetpur	62
162	Rajkot	Kotda Sangani	59
163	Rajkot	Lodhika	58
164	Rajkot	Maliya	46
165	Rajkot	Morvi	49
166	Rajkot	Paddhari	57
167	Rajkot	Rajkot	57
168	Rajkot	Tankara	54
169	Rajkot	Upleta	60
170	Rajkot	Wankaner	54
171	Sabar Kantha	Bayad	61
172	Sabar Kantha	Bhiloda	54
173	Sabar Kantha	Dhansura	59
174	Sabar Kantha	Himatnagar	56
175	Sabar Kantha	Idar	56
176	Sabar Kantha	Khedbrahma	54
177	Sabar Kantha	Malpur	59
178	Sabar Kantha	Meghraj	56
179	Sabar Kantha	Modasa	57
180	Sabar Kantha	Prantij	57
181	Sabar Kantha	Talod	57
182	Sabar Kantha	Vadali	56
183	Sabar Kantha	Vijaynagar	53
184	Surat	Bardoli	73
185	Surat	Chorasi	72
186	Surat	Kamrej	71
187	Surat	Mahuva	73
188	Surat	Mandvi	69
189	Surat	Mangrol	67
190	Surat	Nizar	63
191	Surat	Olpad	68
192	Surat	Palsana	74
193	Surat	Songadh	69
194	Surat	Surat City	71
195	Surat	Uchchhal	67
196	Surat	Umarpada	68
197	Surat	Valod	72
198	Surat	Vyara	71
199	Surendranagar	Chotila	57
200	Surendranagar	Chuda	61
201	Surendranagar	Dasada	57
202	Surendranagar	Dhrangadhra	56
203	Surendranagar	Halvad	51
204	Surendranagar	Lakhtar	59
205	Surendranagar	Limbdi	61
206	Surendranagar	Muli	57
207	Surendranagar	Sayla	59
208	Surendranagar	Wadhwan	59
209	The Dangs	The Dangs	70
210	Vadodara	Chhota Udaipur	60
211	Vadodara	Dabhoi	64
212	Vadodara	Jetpur Pavi	61
213	Vadodara	Karjan	63
214	Vadodara	Kavant	62
215	Vadodara	Nasvadi	64
216	Vadodara	Padra	63
217	Vadodara	Sankheda	62
218	Vadodara	Savli	63
219	Vadodara	Sinor	65
220	Vadodara	Vadodara	64
221	Vadodara	Vaghodia	62
222	Valsad	Dharampur	72
223	Valsad	Kaprada	71
224	Valsad	Pardi	73
225	Valsad	Umbergaon	69
226	Valsad	Valsad	75

EARTHQUAKE HAZARD RISK

SEISMIC HAZARD ANALYSIS

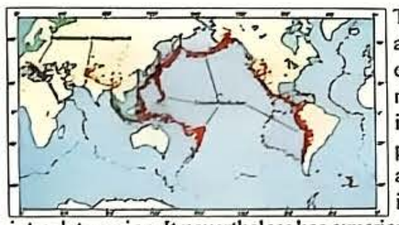
Seismic risk assessment estimates the expected loss from probabilistic seismic hazard exposure or deterministic earthquake scenarios to assist risk mitigation and disaster management (Reiter, 1968; Schneider, 1999; Field, 2000). Seismic hazard risk is typically measured in terms of Modified Mercalli Intensity (MMI), Peak Ground Acceleration (PGA), Peak Ground Velocity (PGV), Spectral Acceleration (SA) or Response Spectrum (RS). The output of this process can be represented as an intensity or risk value for location; or in the form of a macro seismic hazard risk map or a hazard curve (Chandler, 2001).

DETERMINISTIC SEISMIC HAZARD ASSESSMENT

Deterministic methods are based on earthquake scenarios caused by a particular event and its impact over a region and do not usually consider the probability of seismic hazards using historical records. Deterministic methods calculate the expected maximum ground motion at a particular location based on seismogenic potential (Zhonga *et. al.*, 2003).

PROBABILISTIC SEISMIC HAZARD ASSESSMENT

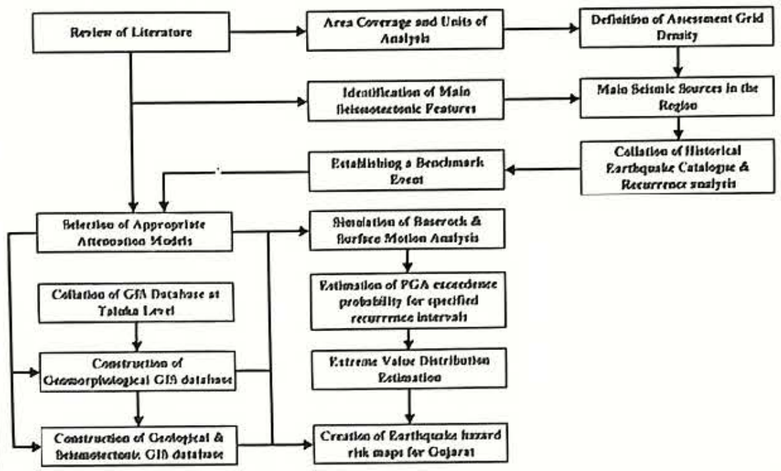
Probabilistic seismic assessment methods integrate both the intensity of seismic hazards and their temporal probability over specified recurrence period into the analysis (Field, 2000). They are currently accepted globally as the better informed method for seismic assessment (Cornell, 1968; McGuire, 1987, 1995; EPRI, 1989). This Atlas presents the first regional Probabilistic Seismic Hazard Assessment (PSHA) in South Asia.



The bulk of the world's earthquakes are located along plate boundaries. These interplate earthquakes are typically of larger intensity and magnitude than those that occur within the interplate continental regions. Within India, the plate boundary around the Himalayan frontal arc is one of the most seismically active regions in the world. Gujarat, however, lies within the intraplate region. It nevertheless has experienced some of the highest magnitude intraplate earthquakes in South Asia, specifically the 1819 (Allah Bund) and 2001 (Kachchh) earthquakes.

PROBABILISTIC SEISMIC HAZARD ASSESSMENT FOR GUJARAT

The analysis followed an eight-step process to produce a Level-1 PSHA for Gujarat using the 226 Talukas of the state as the unit of enquiry as presented below.



MAIN SEISMOTECTONIC FEATURES

Seismic risk and the tectonic framework for Gujarat is defined by three major grabens (that create the Kachchh, Cambay and Narmada basins), the West Coast Fault and three orogenic features: the Delhi, Aravalli and Satpura trends. Bound by the tri-junction of these grabens and marginal faults, lies the uplifted Saurashtra horst. A number of active faults are located within the three major basins and along the southern Saurashtra coast. Basalts occupy the bulk of Saurashtra, the highlands of Kachchh and the eastern edge of south Gujarat, while the northeastern margin of Gujarat is dominated by granitoids. Sedementaries are located across much of Kachchh and the western and eastern margin of Saurashtra.

EARTHQUAKE CATALOGUE

The collation of a comprehensive earthquake catalogue for Gujarat and its environs was undertaken from multiple sources.

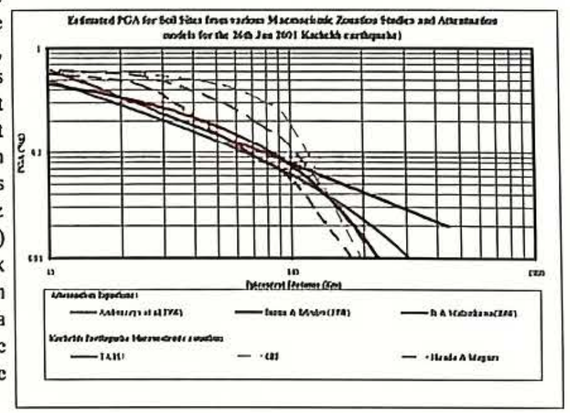
1. USGS National Earthquake Information Center (1973- 2003)
2. NEIC Significant Worldwide earthquakes (2150 BCE-1994)
3. USGS NEIC India Catalogue (1594-1975)
4. ANSS Composite Catalogue (1975-2003)
5. IRIS Composite Catalogue (1965-2003)
6. International Seismological Center Earthquake Catalogue for 2002 (1938-1999)
7. GSI Seismo-tectonic Atlas of India and its Environs (1903-1993)
8. ISET Earthquakes in India & Neighborhood (26 BCE-1979)

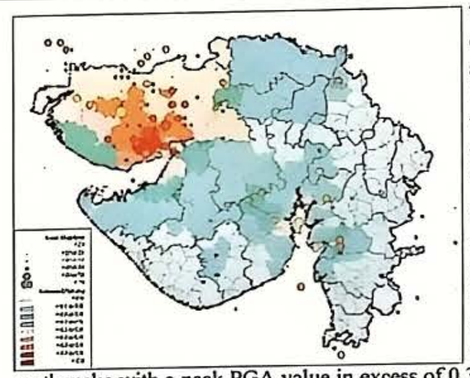
The catalogue was normalized (to standard USGS format), recurrence analysis and a process of exclusion of repetition, identification of the main events and removal of all the dependent events like the foreshock and aftershocks, consists of 140 events over the 1594 to 2003 period.

The area surrounding Gujarat (i.e. Gujarat and its Environs) 19° N to 27° N and 67o E to 76o E has been taken as the region within which the Gujarat earthquakes catalogue has been constructed. The primary unit of analysis for this assignment is the 226 Talukas of Gujarat. Analysis has been derived from a 0.1° x 0.1° grid over 1,620 points across the state.

ATTENUATION MODEL

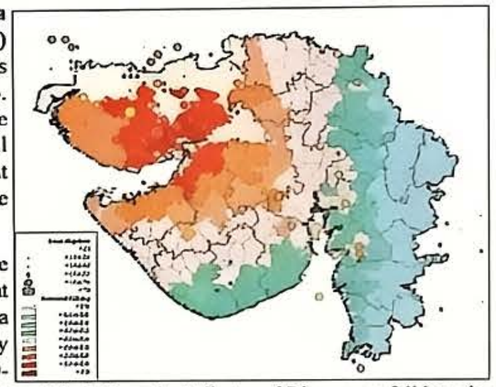
There is no earthquake attenuation model available for Gujarat. A detailed sensitivity analysis was undertaken to select an appropriate attenuation model for Gujarat. Taking the most conservative zonation (TARU, 2001) for soil sites as the basis, the most effective fit amongst 10 major attenuation models which was provided by Si & Midorikawa (2000) that plots the Peak Ground Acceleration (PGK) in g as a function of distance from the earthquake options.





The estimated mean taluka earthquake PGA zonation (in g) for a 50-year return period is presented in the adjoining map. This zonation would typically be used for the design of houses which would have mean design service life of 50 years.

Four moderate to very high intensity pockets are located in Kachchh and north coastal Rajkot and Jamnagar districts clustered around the major events in this region – the 1956 Anjar earthquake and the 2001 Kachchh earthquake with a peak PGA value in excess of 0.36 g. Five moderate intensity pockets emerge in Baruch, Bhavnagar, Sabarkantha districts and north coastal Saurashtra with mean PGA values that reaching up to 0.16 g.



The estimated mean taluka earthquake PGA zonation (in g) for a 100-year return period is presented in the adjoining map. This zonation would typically be used for the design of critical buildings and infrastructure that need to have a mean design service life of 100 years.

All of Kachchh, almost the entire coastline of northern Saurashtra that adjoins Kachchh and a small area in Patan district fall into the very severe intensity zone over a 100-year return period. The cities of Ahmedabad, Baruch, Rajkot, and Bhavnagar fall into the severe intensity zone, while Bhuj and Jamnagar fall in the very severe intensity zone over this time frame.

The boundaries of key geological structural features in Gujarat emerge in this zonation map with the broad boundaries of the Cambay Graben and the eastern hilly region emerging due a mix of the influence of active faults, historical earthquake events and ground amplification due to the deep alluvium within the basins.

CONCLUSION

The following set of maps presents a Level-1 earthquake hazard risk assessment for Gujarat in the face of considerable challenges of lack of seismotectonic, geomorphological and instrumental earthquake data at appropriate levels of resolution. The limitations in the available data set constrain both the application of more sophisticated modeling methods and increased spatial resolution for which specialized microzonation studies and addition research will be necessary.

The zonation is derived from estimated Peak Ground Acceleration (PGA) in g that is also represented in equivalent BIS:1893 ground shaking intensity classes. The resultant zonation (especially over longer return periods) varies from the BIS:1893 zonation that by default covers all potential recurrence intervals. It also 'fits' better with known seismic sources, the historical earthquake record and the structural features of the region.

The utility of a multiple return period zonation is the better fit between design life of structures and potential hazard exposure, that helps reduce oversafe specifications for ordinary non-engineered buildings, while maintaining higher and more stringent norms for critical buildings and lifeline infrastructure.

Gujarat Earthquake Hazard Risk Zonation: Seismotectonic Features

GSDMA

69°00' E 70°00' E 71°00' E 72°00' E 73°00' E 74°00' E

24°00' N 23°00' N 22°00' N 21°00' N 20°00' N

Luni-Sukri-Lineament
Allaiı Bund Fault
Kutch Mainland Fault
Island Belt Fault
Katrol Bhuj Fault
F4
F3
F5
Kim Fault
Marginal Fault - 1
West Coast Lineament
Marginal Fault - 2
Jaisalmer Barmer
Jaisalmer Barmer
Chambal Jamnagar
Rakshabdev Lineament
Dhundhpur Fault
Paldi Fault
Son-Narmada Fault
Tapti North Fault
Upper Godavari Fault

LEGEND

Event Magnitude (Mw)
- < 2.0
- > 2.0 to 3.0
- > 3.0 to 4.0
- > 4.0 to 5.0
- > 5.0 to 7.0
- > 7.00

Faults and Lineaments
- Major Lineaments
- Neo Fault
- Fault Involving Cover
- Fault Involving Basement And Cover

Geology
- Eolian plains
- Alluvium
- Basalt
- Sedimentaries
- Granitoids & Meta Sedimentaries
- Water bodies

Based on Catalogue of 140 main earthquake events, over 1592 to 2003.

Source: TARU Analysis, 2004;
TARU Gujarat Earthquake Catalogue, 2004;
USGS, National Earthquake Information Center , 1973-2003;
ANSS Composite Catalogue, 1975-2003;
IRIS Composite Catalogue, 1965-2003;
Earthquake Catalogue, 2002, International Seismological Center, Berkshire, UK;
Seimotectonic Atlas of India and its Environs, GSI, 2000;
Earthquake in India & Neighborhood, ISET, 1983;
BISAG, GoG.

0 100 km

N

Projection : Lambert Azimuthal Equal Area
Datum : WGS 84

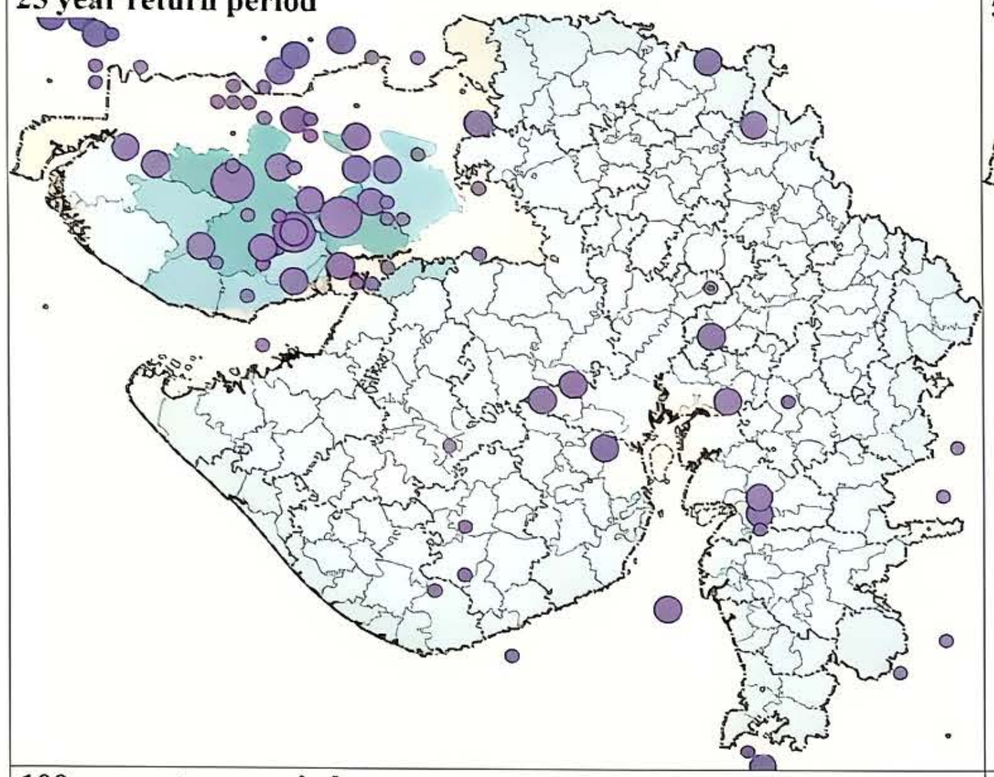
MAP No. : HSIM - 01 OF 01

Date : 21/6/2005

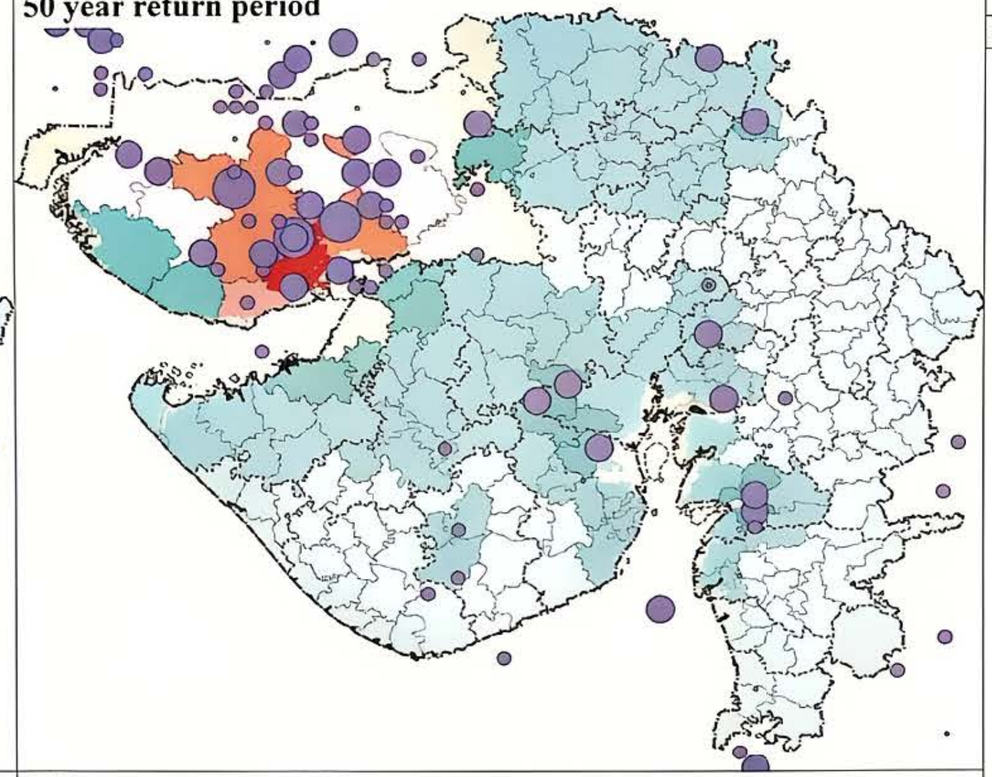
Gujarat Earthquake Hazard Risk Zonation: Estimated Mean Taluka Peak Ground Acceleration (PGA) (in g)

GSDMA

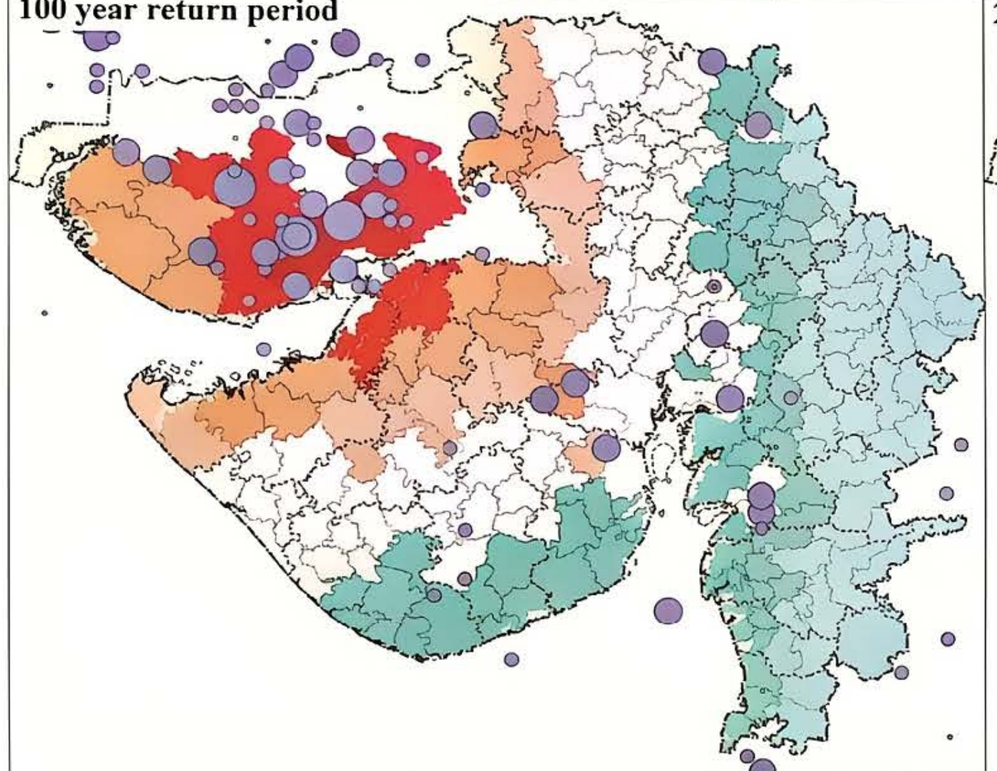
25 year return period



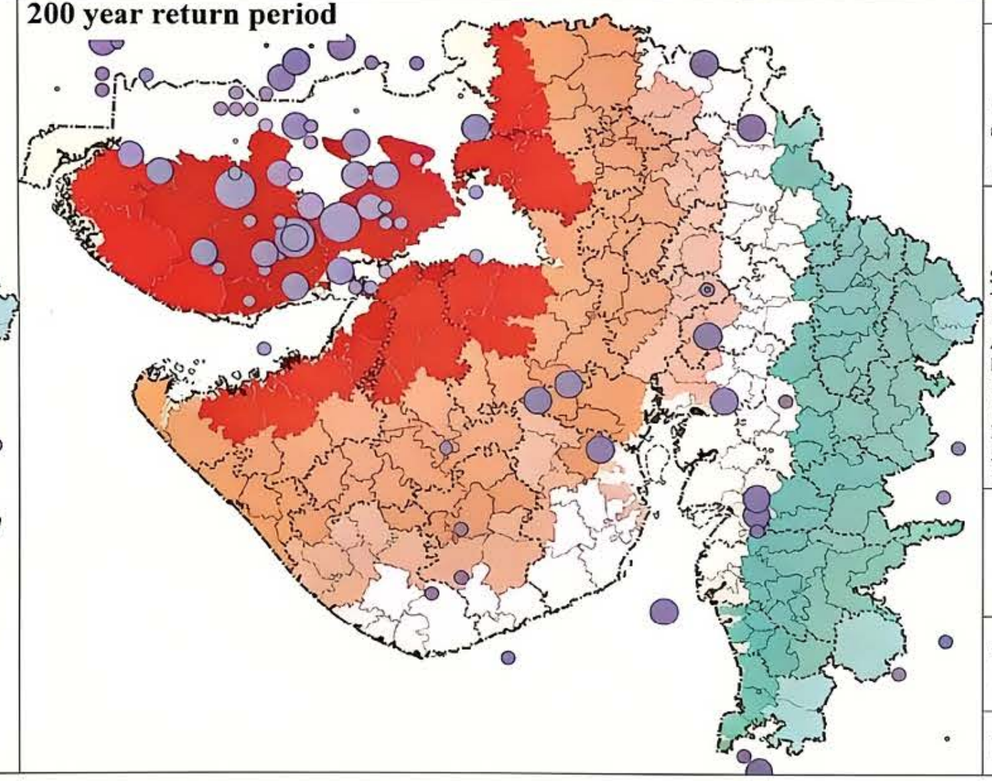
50 year return period



100 year return period



200 year return period



LEGEND

Event Magnitude

- < 2.0
- > 2.0 to 3.0
- > 3.0 to 4.0
- > 4.0 to 5.0
- > 5.0 to 7.0
- > 7.0

Estimated PGA in g

- < 0.05
- > 0.05 to 0.08
- > 0.08 to 0.10
- > 0.10 to 0.12
- > 0.12 to 0.16
- > 0.16 to 0.18
- > 0.18 to 0.24
- > 0.24 to 0.36
- > 0.36

Based on catalogue of 140 main earthquake events over 1592 to 2003 and attenuation equations from Si & Midorikawa, 2000 .

BIS Seismic Zonation Class as per BIS Code: IS 1893 (Part1) 2002

Source: TARU Analysis, 2004;
TARU Gujarat Earthquake Catalogue, 2004,
USGS, National Earthquake Information Center, 1973-2003;
ANSS Composite Catalogue, 1975-2003;
IRIS Composite Catalogue, 1965-2003;
Earthquake Catalogue, 2002, International Seismological Center, Berkshire, UK; Seimotectonic Atlas of India and its Environs, GSI, 2000, Earthquake in India & Neighborhood, ISET, 1983;
John Douglas, 2004, Ground Motion Estimation Equations, 1964-2003, Imperial College, London; BISAG, GoG.

0 100 km

N

Projection : Lambert Azimuthal Equal Area
Datum : WGS 84

MAP No. : HEQM - 01 OF 01

Date : 21/6/2005

GUJARAT TALUKA EARTHQUAKE HAZARD RISK CLASSIFICATION :
MEAN PGA (in g) BY RETURN PERIOD Table No. HEQT - 01 of 01

GSDMA

Sr. No	District	Taluka	Mean PGA (in g)				Equivalent (IS 1893) Seismic Zones			
			25 year	50 year	100 year	200 year	25 year	50 year	100 year	200 year
1	Ahmadabad	Ahmadabad City	0.03	0.05	0.13	0.17	II	II	IV	IV
2	Ahmadabad	Barwala	0.03	0.09	0.16	0.19	II	III	IV	V
3	Ahmadabad	Bavla	0.03	0.05	0.14	0.19	II	II	IV	V
4	Ahmadabad	Daskroi	0.04	0.06	0.13	0.17	II	II	IV	IV
5	Ahmadabad	Detroj-Rampura	0.03	0.05	0.15	0.20	II	II	IV	V
6	Ahmadabad	Dhandhuka	0.03	0.07	0.14	0.18	II	II	IV	V
7	Ahmadabad	Dholka	0.03	0.06	0.13	0.18	II	II	IV	IV
8	Ahmadabad	Mandal	0.03	0.05	0.16	0.22	II	II	IV	V
9	Ahmadabad	Ranpur	0.04	0.11	0.18	0.20	II	III	V	V
10	Ahmadabad	Sanand	0.03	0.04	0.14	0.19	II	II	IV	V
11	Ahmadabad	Viramgam	0.03	0.05	0.15	0.21	II	II	IV	V
12	Amreli	Amreli	0.03	0.06	0.14	0.19	II	II	IV	V
13	Amreli	Babra	0.03	0.04	0.14	0.19	II	II	IV	V
14	Amreli	Bagasara	0.02	0.06	0.14	0.19	II	II	IV	V
15	Amreli	Dhari	0.03	0.06	0.12	0.16	II	II	IV	IV
16	Amreli	Jafrabad	0.02	0.04	0.10	0.15	II	II	III	IV
17	Amreli	Khambha	0.02	0.04	0.11	0.15	II	II	III	IV
18	Amreli	Kunkavav Vadia	0.03	0.05	0.14	0.20	II	II	IV	V
19	Amreli	Lathi	0.03	0.05	0.13	0.18	II	II	IV	V
20	Amreli	Lilia	0.03	0.05	0.13	0.18	II	II	IV	IV
21	Amreli	Rajula	0.02	0.04	0.10	0.15	II	II	III	IV
22	Amreli	Savar Kundla	0.03	0.04	0.11	0.16	II	II	III	IV
23	Anand	Anand	0.03	0.05	0.10	0.14	II	II	III	IV
24	Anand	Anklav	0.03	0.05	0.11	0.14	II	II	III	IV
25	Anand	Borsad	0.03	0.06	0.13	0.15	II	II	IV	IV
26	Anand	Khambhat	0.03	0.06	0.12	0.16	II	II	IV	IV
27	Anand	Petlad	0.03	0.06	0.12	0.16	II	II	IV	IV
28	Anand	Sojitra	0.03	0.07	0.13	0.16	II	II	IV	IV
29	Anand	Tarapur	0.04	0.06	0.12	0.16	II	II	III	IV
30	Anand	Umreth	0.03	0.04	0.10	0.14	II	II	III	IV
31	Banas Kantha	Amirgadh	0.02	0.06	0.13	0.16	II	II	IV	IV
32	Banas Kantha	Bhabhar	0.03	0.08	0.17	0.24	II	II	IV	V
33	Banas Kantha	Danta	0.01	0.06	0.11	0.13	II	II	III	IV
34	Banas Kantha	Dantiwada	0.02	0.06	0.13	0.16	II	II	IV	IV
35	Banas Kantha	Deesa	0.03	0.07	0.14	0.19	II	II	IV	V
36	Banas Kantha	Deodar	0.03	0.06	0.16	0.22	II	II	IV	V
37	Banas Kantha	Dhanera	0.02	0.06	0.14	0.18	II	II	IV	V
38	Banas Kantha	Kankrej	0.03	0.06	0.16	0.22	II	II	IV	V
39	Banas Kantha	Palanpur	0.02	0.07	0.15	0.18	II	II	IV	IV
40	Banas Kantha	Tharad	0.03	0.06	0.15	0.21	II	II	IV	V
41	Banas Kantha	Vadgam	0.02	0.07	0.14	0.17	II	II	IV	IV
42	Banas Kantha	Vav	0.04	0.08	0.18	0.24	II	II	IV	V
43	Bharuch	Amod	0.03	0.05	0.10	0.13	II	II	III	IV
44	Bharuch	Anklesvar	0.04	0.11	0.14	0.16	II	III	IV	IV
45	Bharuch	Bharuch	0.03	0.08	0.13	0.15	II	III	IV	IV
46	Bharuch	Hansot	0.04	0.07	0.11	0.13	II	II	III	IV
47	Bharuch	Jambusar	0.03	0.05	0.11	0.15	II	II	III	IV
48	Bharuch	Jhagadia	0.03	0.05	0.09	0.11	II	II	III	III
49	Bharuch	Vagra	0.04	0.06	0.11	0.14	II	II	III	IV
50	Bharuch	Valia	0.03	0.06	0.09	0.11	II	II	III	III
51	Bhavnagar	Bhavnagar	0.03	0.07	0.14	0.17	II	II	IV	IV
52	Bhavnagar	Botad	0.04	0.08	0.15	0.18	II	III	IV	IV
53	Bhavnagar	Gadhada	0.03	0.06	0.12	0.17	II	II	IV	IV
54	Bhavnagar	Gariadhar	0.03	0.05	0.12	0.17	II	II	IV	IV
55	Bhavnagar	Ghogha	0.02	0.05	0.10	0.14	II	II	III	IV
56	Bhavnagar	Mahuva	0.02	0.05	0.10	0.14	II	II	III	IV
57	Bhavnagar	Palitana	0.02	0.05	0.11	0.15	II	II	III	IV
58	Bhavnagar	Sihor	0.03	0.06	0.11	0.15	II	II	III	IV
59	Bhavnagar	Talaja	0.02	0.05	0.11	0.15	II	II	III	IV
60	Bhavnagar	Umrala	0.03	0.07	0.14	0.18	II	II	IV	IV
61	Bhavnagar	Vallabhipur	0.03	0.08	0.17	0.19	II	III	IV	V
62	Dohad	Devgadbaria	0.01	0.03	0.06	0.08	II	II	II	III
63	Dohad	Dhanpur	0.01	0.03	0.06	0.08	II	II	II	III
64	Dohad	Dohad	0.01	0.03	0.05	0.08	II	II	II	II
65	Dohad	Fatepura	0.01	0.02	0.06	0.08	II	II	II	III
66	Dohad	Garbada	0.01	0.03	0.06	0.08	II	II	II	II
67	Dohad	Jhalod	0.01	0.03	0.06	0.08	II	II	II	III
68	Dohad	Limkheda	0.01	0.03	0.06	0.08	II	II	II	III
69	Gandhinagar	Dehgam	0.02	0.04	0.10	0.15	II	II	III	IV
70	Gandhinagar	Gandhinagar	0.02	0.04	0.12	0.17	II	II	III	IV
71	Gandhinagar	Kalol	0.02	0.04	0.13	0.18	II	II	IV	IV
72	Gandhinagar	Mansa	0.02	0.05	0.12	0.17	II	II	III	IV
73	Jamnagar	Bhanvad	0.02	0.05	0.15	0.21	II	II	IV	V
74	Jamnagar	Dhrol	0.04	0.09	0.25	0.33	II	III	V	V
75	Jamnagar	Jamjodhpur	0.02	0.05	0.15	0.20	II	II	IV	V
76	Jamnagar	Jamnagar	0.03	0.09	0.23	0.30	II	III	V	V
77	Jamnagar	Jodiya	0.05	0.12	0.29	0.37	II	IV	V	V
78	Jamnagar	Kalavad	0.02	0.06	0.18	0.24	II	II	IV	V
79	Jamnagar	Kalyanpur	0.02	0.06	0.16	0.23	II	II	IV	V
80	Jamnagar	Khambhalia	0.03	0.07	0.18	0.25	II	II	V	V
81	Jamnagar	Lalpur	0.03	0.07	0.18	0.25	II	II	V	V
82	Jamnagar	Okhamandal	0.03	0.06	0.16	0.24	II	II	IV	V
83	Junagadh	Bhesan	0.02	0.04	0.14	0.19	II	II	IV	V
84	Junagadh	Junagadh	0.02	0.04	0.13	0.18	II	II	IV	IV
85	Junagadh	Keshod	0.02	0.04	0.12	0.18	II	II	IV	IV
86	Junagadh	Kodinar	0.02	0.04	0.10	0.15	II	II	III	IV
87	Junagadh	Malia	0.02	0.03	0.11	0.16	II	II	III	IV
88	Junagadh	Manavadar	0.02	0.04	0.14	0.20	II	II	IV	V
89	Junagadh	Mangrol	0.02	0.04	0.12	0.17	II	II	IV	IV
90	Junagadh	Mendarda	0.02	0.04	0.12	0.17	II	II	IV	IV
91	Junagadh	Patan-Veraval	0.02	0.03	0.11	0.16	II	II	III	IV
92	Junagadh	Sutrapada	0.02	0.03	0.10	0.14	II	II	III	IV
93	Junagadh	Talala	0.02	0.04	0.10	0.14	II	II	III	IV
94	Junagadh	Una	0.02	0.05	0.10	0.14	II	II	III	IV
95	Junagadh	Vanthali	0.02	0.04	0.13	0.18	II	II	IV	IV
96	Junagadh	Visavadar	0.02	0.04	0.12	0.17	II	II	III	IV
97	Kachchh	Abdasa	0.05	0.11	0.19	0.30	II	III	V	V
98	Kachchh	Anjar	0.07	0.25	0.41	0.44	II	V	V	V
99	Kachchh	Bhachau	0.09	0.18	0.38	0.50	III	V	V	V
100	Kachchh	Bhuj	0.08	0.19	0.35	0.47	III	V	V	V
101	Kachchh	Gandhidham	0.07	0.26	0.40	0.46	II	V	V	V
102	Kachchh	Lakhpat	0.04	0.13	0.21	0.29	II	IV	V	V
103	Kachchh	Mandvi	0.06	0.11	0.23	0.32	II	III	V	V
104	Kachchh	Mundra	0.05	0.17	0.30	0.37	II	IV	V	V
105	Kachchh	Nakhatrana	0.06	0.13	0.23	0.36	II	IV	V	V
106	Kachchh	Rapar	0.07	0.15	0.29	0.38	II	IV	V	V
107	Kheda	Balasinor	0.02	0.03	0.08	0.11	II	II	II	III
108	Kheda	Kapadvanj	0.02	0.04	0.10	0.14	II	II	III	IV
109	Kheda	Kathlal	0.02	0.04	0.09	0.13	II	II	III	IV
110	Kheda	Kheda	0.03	0.07	0.14	0.17	II	II	IV	IV
111	Kheda	Mahudha	0.02	0.04	0.10	0.14	II	II	III	IV
112	Kheda	Matar	0.03	0.07	0.15	0.17	II	II	IV	IV
113	Kheda	Mehmedabad	0.03	0.06	0.13	0.16	II	II	IV	IV
114	Kheda	Nadiad	0.03	0.06	0.12	0.16	II	II	IV	IV

GUJARAT TALUKA EARTHQUAKE HAZARD RISK CLASSIFICATION :
MEAN PGA (in g) BY RETURN PERIOD Table No. HEQT - 01 of 01

GSDMA

Sr. No	District	Taluka	Mean PGA (in g)				Equivalent (IS 1893) Seismic Zones			
			25 year	50 year	100 year	200 year	25 year	50 year	100 year	200 year
115	Kheda	Thasra	0.02	0.03	0.09	0.12	II	II	III	IV
116	Kheda	Virpur	0.01	0.03	0.08	0.12	II	II	III	III
117	Mahesana	Becharaji	0.03	0.05	0.15	0.21	II	II	IV	V
118	Mahesana	Kadi	0.02	0.04	0.14	0.19	II	II	IV	V
119	Mahesana	Kheralu	0.02	0.06	0.13	0.16	II	II	IV	IV
120	Mahesana	Mahesana	0.02	0.05	0.13	0.19	II	II	IV	V
121	Mahesana	Satlasana	0.02	0.06	0.10	0.12	II	II	III	IV
122	Mahesana	Unjha	0.02	0.06	0.13	0.18	II	II	IV	V
123	Mahesana	Vadnagar	0.02	0.06	0.13	0.17	II	II	IV	IV
124	Mahesana	Vijapur	0.02	0.05	0.12	0.17	II	II	III	IV
125	Mahesana	Visnagar	0.02	0.06	0.13	0.18	II	II	IV	IV
126	Narmada	Dediapada	0.02	0.03	0.06	0.08	II	II	II	III
127	Narmada	Nandod	0.02	0.03	0.07	0.10	II	II	II	III
128	Narmada	Sagbara	0.02	0.03	0.06	0.09	II	II	II	III
129	Narmada	Tilakwada	0.02	0.03	0.08	0.11	II	II	II	III
130	Navsari	Bansda	0.02	0.03	0.06	0.08	II	II	II	III
131	Navsari	Chikhli	0.02	0.04	0.08	0.11	II	II	II	III
132	Navsari	Gandevi	0.02	0.04	0.09	0.11	II	II	III	III
133	Navsari	Jalalpore	0.03	0.05	0.09	0.12	II	II	III	III
134	Navsari	Navsari	0.03	0.04	0.09	0.12	II	II	III	III
135	Panch Mahals	Ghoghamba	0.01	0.03	0.06	0.09	II	II	II	III
136	Panch Mahals	Godhra	0.01	0.03	0.07	0.10	II	II	II	III
137	Panch Mahals	Halol	0.02	0.03	0.07	0.10	II	II	II	III
138	Panch Mahals	Jambughoda	0.01	0.03	0.06	0.09	II	II	II	III
139	Panch Mahals	Kadana	0.01	0.02	0.06	0.09	II	II	II	III
140	Panch Mahals	Kalol	0.02	0.03	0.08	0.11	II	II	II	III
141	Panch Mahals	Khanpur	0.01	0.03	0.07	0.10	II	II	II	III
142	Panch Mahals	Lunawada	0.01	0.03	0.07	0.10	II	II	II	III
143	Panch Mahals	Morwa (Hadaf)	0.01	0.03	0.06	0.09	II	II	II	III
144	Panch Mahals	Santrampur	0.01	0.02	0.06	0.09	II	II	II	III
145	Panch Mahals	Shehera	0.01	0.02	0.07	0.09	II	II	II	III
146	Patan	Chanasma	0.03	0.06	0.15	0.20	II	II	IV	V
147	Patan	Harij	0.03	0.05	0.16	0.22	II	II	IV	V
148	Patan	Patan	0.03	0.06	0.14	0.20	II	II	IV	V
149	Patan	Radhanpur	0.04	0.08	0.19	0.25	II	II	V	V
150	Patan	Sami	0.03	0.06	0.18	0.24	II	II	IV	V
151	Patan	Santalpur	0.04	0.10	0.23	0.29	II	III	V	V
152	Patan	Sidhpur	0.02	0.07	0.14	0.19	II	II	IV	V
153	Patan	Vagdod	0.03	0.07	0.14	0.20	II	II	IV	V
154	Porbandar	Kutiyana	0.02	0.04	0.14	0.19	II	II	IV	V
155	Porbandar	Porbandar	0.02	0.05	0.15	0.21	II	II	IV	V
156	Porbandar	Ranavav	0.02	0.04	0.14	0.19	II	II	IV	V
157	Rajkot	Dhoraji	0.02	0.05	0.15	0.21	II	II	IV	V
158	Rajkot	Gondal	0.02	0.05	0.16	0.22	II	II	IV	V
159	Rajkot	Jamkandorna	0.02	0.05	0.17	0.23	II	II	IV	V
160	Rajkot	Jasdan	0.03	0.06	0.15	0.20	II	II	IV	V
161	Rajkot	Jetpur	0.02	0.04	0.15	0.20	II	II	IV	V
162	Rajkot	Kotda Sangani	0.03	0.06	0.16	0.22	II	II	IV	V
163	Rajkot	Lodhika	0.03	0.06	0.18	0.24	II	II	IV	V
164	Rajkot	Maliya	0.05	0.10	0.28	0.37	II	III	V	V
165	Rajkot	Morvi	0.04	0.08	0.26	0.34	II	III	V	V
166	Rajkot	Paddhari	0.03	0.07	0.21	0.28	II	II	III	IV
167	Rajkot	Rajkot	0.03	0.05	0.17	0.23	II	II	IV	V
168	Rajkot	Tankara	0.03	0.08	0.23	0.30	II	II	V	V
169	Rajkot	Upleta	0.02	0.05	0.15	0.20	II	II	IV	V
170	Rajkot	Wankaner	0.03	0.06	0.20	0.26	II	II	V	V
171	Sabar Kantha	Bayad	0.02	0.04	0.10	0.14	II	II	III	IV
172	Sabar Kantha	Bhiloda	0.02	0.04	0.08	0.11	II	II	II	III
173	Sabar Kantha	Dhansura	0.02	0.04	0.10	0.14	II	II	III	IV
174	Sabar Kantha	Himatnagar	0.02	0.05	0.10	0.14	II	II	III	IV
175	Sabar Kantha	Idar	0.02	0.07	0.12	0.15	II	II	III	IV
176	Sabar Kantha	Khedbrahma	0.01	0.06	0.11	0.12	II	II	III	IV
177	Sabar Kantha	Malpur	0.02	0.03	0.08	0.11	II	II	II	III
178	Sabar Kantha	Meghraj	0.02	0.03	0.08	0.11	II	II	II	III
179	Sabar Kantha	Modasa	0.02	0.04	0.09	0.12	II	II	III	IV
180	Sabar Kantha	Prantij	0.02	0.05	0.10	0.15	II	II	III	IV
181	Sabar Kantha	Talod	0.02	0.04	0.10	0.15	II	II	III	IV
182	Sabar Kantha	Vadali	0.02	0.09	0.14	0.16	II	III	IV	IV
183	Sabar Kantha	Vijaynagar	0.01	0.04	0.07	0.10	II	II	II	III
184	Surat	Bardoli	0.03	0.04	0.08	0.12	II	II	III	III
185	Surat	Chorasi	0.03	0.05	0.10	0.13	II	II	III	IV
186	Surat	Kamrej	0.04	0.05	0.09	0.12	II	II	III	III
187	Surat	Mahuva	0.03	0.04	0.08	0.11	II	II	II	III
188	Surat	Mandvi	0.03	0.03	0.07	0.10	II	II	II	III
189	Surat	Mangrol	0.03	0.06	0.09	0.12	II	II	III	III
190	Surat	Nizar	0.02	0.04	0.07	0.09	II	II	II	III
191	Surat	Olpad	0.03	0.05	0.10	0.13	II	II	III	IV
192	Surat	Palsana	0.03	0.04	0.09	0.12	II	II	III	III
193	Surat	Songadh	0.02	0.03	0.06	0.09	II	II	II	III
194	Surat	Surat City	0.04	0.05	0.10	0.13	II	II	III	IV
195	Surat	Uchchhal	0.02	0.03	0.06	0.09	II	II	II	III
196	Surat	Umarpada	0.02	0.03	0.06	0.08	II	II	II	III
197	Surat	Valod	0.03	0.04	0.08	0.11	II	II	II	III
198	Surat	Vyara	0.02	0.03	0.07	0.10	II	II	II	III
199	Surendranagar	Chotila	0.03	0.05	0.17	0.23	II	II	IV	V
200	Surendranagar	Chuda	0.04	0.10	0.19	0.22	II	III	V	V
201	Surendranagar	Dasada	0.03	0.05	0.17	0.24	II	II	IV	V
202	Surendranagar	Dhrangadhra	0.03	0.05	0.19	0.25	II	II	V	V
203	Surendranagar	Halvad	0.04	0.07	0.23	0.31	II	II	V	V
204	Surendranagar	Lakhtar	0.03	0.06	0.16	0.22	II	II	IV	V
205	Surendranagar	Limbdi	0.03	0.07	0.16	0.20	II	II	IV	V
206	Surendranagar	Muli	0.03	0.06	0.19	0.25	II	II	V	V
207	Surendranagar	Sayla	0.03	0.07	0.17	0.22	II	II	IV	V
208	Surendranagar	Wadhwan	0.03	0.07	0.17	0.23	II	II	IV	V
209	The Dangs	The Dangs	0.02	0.03	0.05	0.07	II	II	II	II
210	Vadodara	Chhota Udaipur	0.01	0.03	0.06	0.08	II	II	II	III
211	Vadodara	Dabhoi	0.02	0.03	0.07	0.10	II	II	II	III
212	Vadodara	Jetpur Pavi	0.01	0.03	0.06	0.09	II	II	II	III
213	Vadodara	Karjan	0.03	0.05	0.09	0.13	II	II	III	IV
214	Vadodara	Kavant	0.02	0.03	0.06	0.08	II	II	II	III
215	Vadodara	Nasvadi	0.02	0.03	0.06	0.09	II	II	II	III
216	Vadodara	Padra	0.03	0.05	0.10	0.13	II	II	III	IV
217	Vadodara	Sankheda	0.02	0.03	0.07	0.10	II	II	II	III
218	Vadodara	Savli	0.02	0.03	0.08	0.11	II	II	II	III
219	Vadodara	Sinor	0.02	0.04	0.08	0.11	II	II	II	III
220	Vadodara	Vadodara	0.03	0.04	0.09	0.12	II	II	III	IV
221	Vadodara	Vaghodia	0.02	0.03	0.07	0.09	II	II	II	III
222	Valsad	Dharampur	0.02	0.03	0.06	0.08	II	II	II	II
223	Valsad	Kaprada	0.02	0.03	0.07	0.08	II	II	II	II
224	Valsad	Pardi	0.02	0.05	0.09	0.11	II	II	III	III
225	Valsad	Umbergaon	0.02	0.05	0.09	0.10	II	II	III	III
226	Valsad	Valsad	0.02	0.05	0.08	0.11	II	II	III	III

CYCLONE HAZARD RISK

CYCLONE & WIND HAZARD ANALYSIS

In India and specifically within Gujarat, peak wind speeds are usually determined by extreme wind events in the form of tropical cyclones. Cyclone and wind hazard risk analysis have utilized parametric models and probabilistic assessment techniques since the 1980s to determine basic and peak design wind speeds at specified sampling and recurrence intervals (Holland, 1980, Jelesniaski, 1984; Georgiou et.al, 1983; 1984; Simiu & Scanlan, 1996; WMO, 2002).

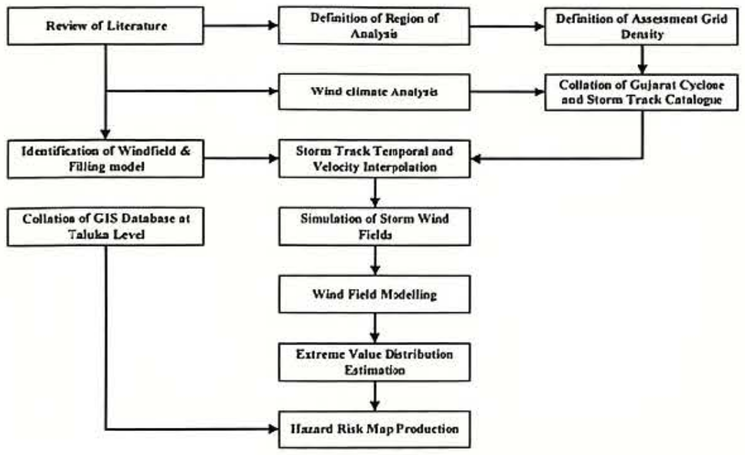
CYCLONE WINDFIELD MODELS

Parametric models of cyclone and storm wind speeds and directions have been fairly accurately estimated for the Pacific and Atlantic basins. Some attempts have been made in this direction for the Bay of Bengal (Basu & Ghosh, 1987, Mandal & Gupta, 1993; Adityam & Sarkar, 1998; Sinha & Mandal, 1999). Similar analysis for the Arabian Sea is limited (Dube. et. al., 1985; Chittibabu, 1999). A minimal set of five storm parameters was used to construct a wind field model for Gujarat:

1. Central pressure difference (Cp)
2. Radial distance to maximum winds (Rmax)
3. Translation velocity (Vt)
4. Approach angle (f)
5. Occurrence rate in time (%)

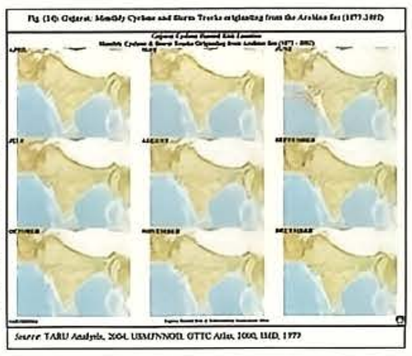
PROBABLISTIC CYCLONE AND WIND HAZARD ASSESSMENT

The analysis followed an eight-step process to produce a Level-1 Probabilistic Wind Hazard Assessment (PWHA), which has been constrained by the frequency and quality of historical data.



GUJARAT WIND CLIMATE

Gujarat has two storm seasons : May and June during the onset of the monsoon and October and November during the retreat of the southwestern monsoon. A classic pattern of storm recurvature away from Gujarat is observed during the month of June, typically just below the Tropic of Cancer. During the months of October and November, recurvature towards the northern Indian plains also take place. A few storms and cyclones occur in the other months but are relatively infrequent. The months of January to March are typically storm-free in this basin.



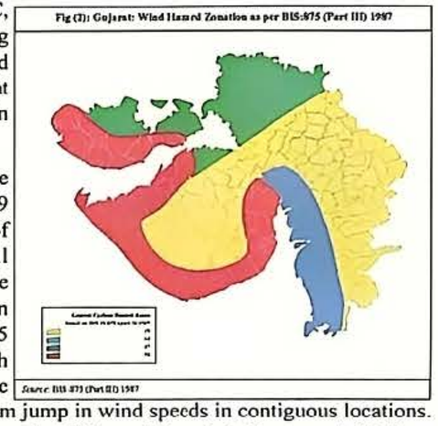
GUJARAT CYCLONE AND STORM TRACK CATALOGUE (1877-2001)

The collation of a comprehensive Cyclone and Storm Track Catalogue for Gujarat, consisting of 210 tracks (after exclusion of repetitions, correction of errors, normalization to common wind speed/pressure units and estimation of critical storm parameters) was undertaken from four major sources:

1. IMD Storm Track Atlases for the 1877-1970 and 1970-1990 periods
2. The US Navy Global Cyclone Climatic Atlas (1842-2002)
3. Satellite based cyclonic storm data from JWCT (1970-2002)
4. Storm windfall data from UNEP-GRID (1998 to 2002)

CHANGES IN BIS ZONATIONS

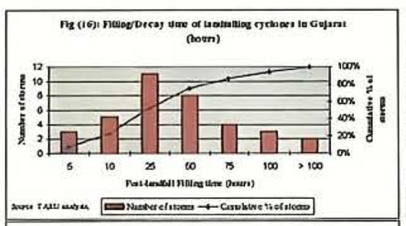
Unlike past analyses (GoG, 1987; BMTPC, 1997), storms terminating or transiting through a region from 65° E to 75° E and 15° N to 25° N were included in the Gujarat catalogue (rather than only those rising in the Arabian Sea)

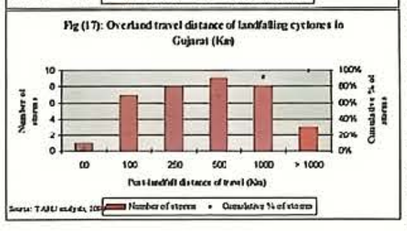


A potential anomaly revolves around three issues % the contiguity of zone 47 and 39 m/sec in central Gujarat, the contiguity of zones 44 and 50 m/sec in coastal Saurashtra and south Gujarat and the discontinuity between the wind speeds in coastal and central Saurashtra between 55 and 39 m/sec. Given the nature of both gradient and surface winds, it would be surprising to find this significant quantum jump in wind speeds in contiguous locations. Hence, a change in the BIS zonation is in order. This analysis adopts the same definitions as IS:875 to classify the basic wind pressure in the area under study.

WIND-FIELD MODEL

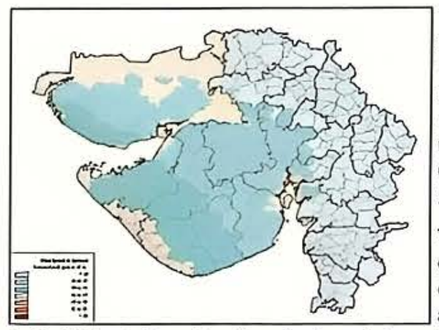
A mix of the standard IMD, Holland and Jelesniask's windfield model and the DeMaria filling model was used based on their robustness in various goodness of fit tests (Houston & Powell, 1990; Houston *et al.*, 1999; Cossette *et al.*, 2002) widely used by NOAA and other cyclone forecasting and warning agencies in the North Atlantic and West North Pacific basins. Appropriate parameterization has been attempted to fit the region under study and broad wind climate using existing regional research studies (Adityam & Sarkar, 1998; Sinha & Mandal, 1999).





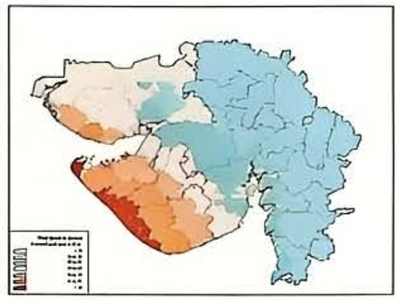
The landfall location of each of the 35 cyclonic storms that crossed the Gujarat coast was determined. This was utilized to determine the mean filling time of cyclones and tropical storms over the landmass of Gujarat.

Unlike the assumption made in IS: 875 (Part III), the mean period of storms filling over the Gujarat landmass was 36 hours. This translated into a mean distance of movement of the storm eye 430 km over land as presented in the figure alongside which is considerably higher than the 60 km assumed in IS Code zonation. This is an important factor in the modification of the current Gujarat wind hazard zonation map for the state.



The estimated mean taluka basic wind speed zonation (in m/sec) for a 50-year return period is presented in the adjoining map. This zonation would typically be used for the design of houses and much of the non-engineered building stock in Gujarat with a mean design service life of 50 years.

This shows a maximum wind speed class of 45 to 47 m/sec along the Saurashtra coast, specifically in Porbandar, Jamnagar and Junagadh districts, which are exposed to the highest intensity of cyclonic and storm impact. The 40 to 44 m/sec class extends further inland into central, north and southern coastal Saurashtra and the southwestern coast of Kachchh. The rest of Kachchh extending into central Saurashtra as far as Ahmedabad and parts of Anand and Bharuch district come under wind speed zones 34 to 39 m/sec.



The estimated mean taluka basic wind speed zonation (in m/sec) for a 100-year return period is presented in the adjoining map. This zonation would typically be used for the design of engineered and critical buildings and infrastructure with a mean design service life of 100 years.

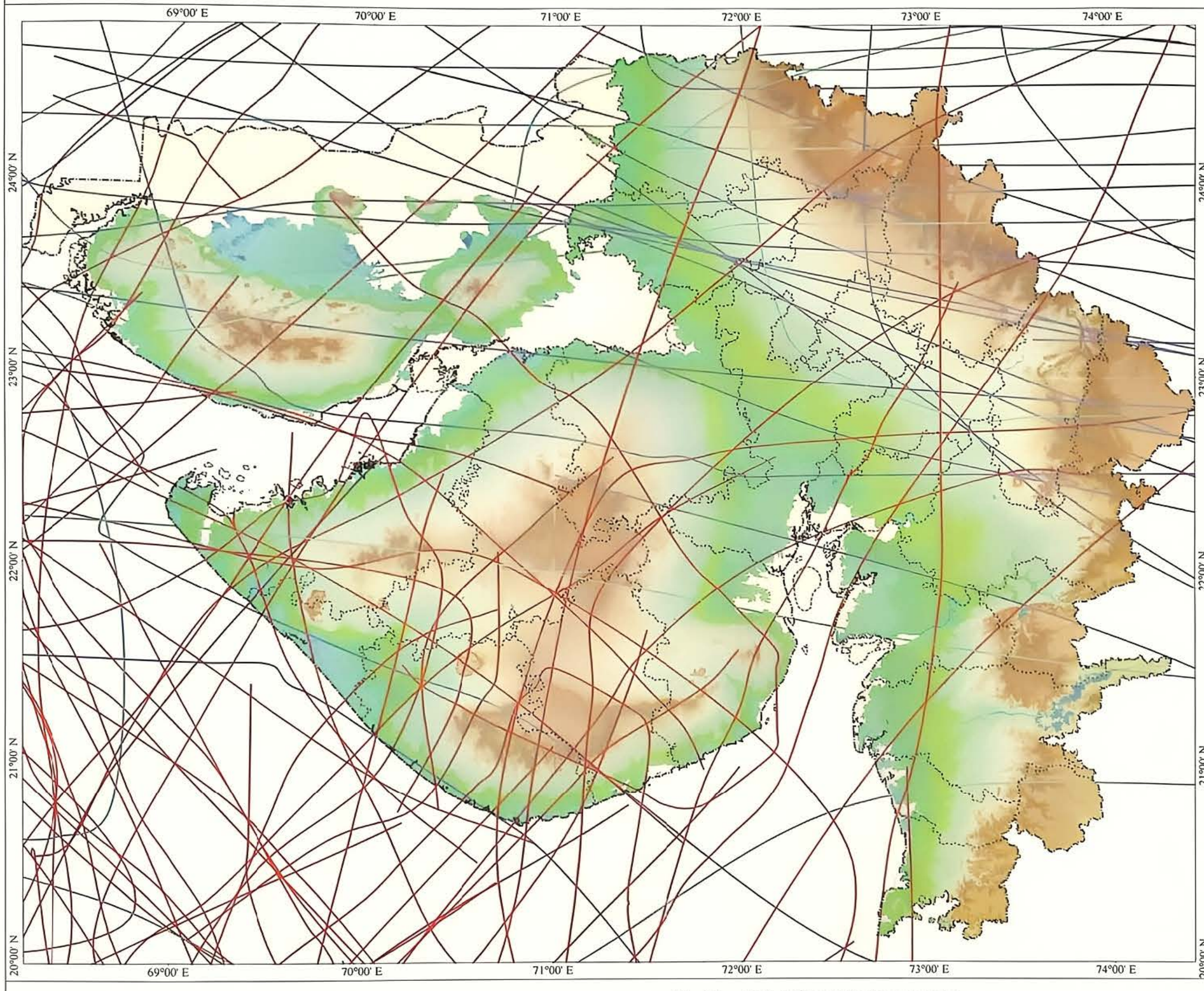
This map shows a maximum wind speed class >55 m/ sec along the Saurashtra coast, specifically in Porbandar, Jamnagar and Junagadh districts, which are exposed to the highest intensity of cyclonic and storm impact. The 51 to 55 m/sec class extends further inland to cover much of Jamnagar, and parts of Rajkot, Junagadh and Kachchh districts. The 48 to 50 m/sec class extends to most of Rajkot, parts of Amreli and Jamnagar districts including Jamnagar, Rajkot cities and parts of Kachchh. The 45 to 47 m/sec class covers much of Saurashtra and all of Kachchh. This is followed by the 40 to 44 m/sec class that gets its swathe from Kachchh through northern Saurashtra all the way to the coast of Gulf of Khambat and south Gujarat. The rest of Gujarat falls into the 34 to 39 m/sec class.

CONCLUSION

This forms part of Level-1 cyclone and hazard risk assessment for Gujarat prepared, in the face of considerable challenges of limited wind field data availability in the pre-remote sensing era and lack of validated wind field and cyclone filling models for the Arabian Sea. The limitation in the available dataset and numerical models for the region under study has constrained the use of more sophisticated modeling methods. The Gujarat cyclone zonation varies considerably from the IS:875 zonation derived from a macro analysis of winds and a much smaller base of cyclone and storm tracks. In addition, the IS: 875 zonation is constrained by the assumption of a 60 km filling range for landfalling storms, which is an over conservative estimate as the data from the Gujarat Catalogue estimates mean travel distance of landfalling cyclones as 430 km, corresponding to a mean 36 hour filling time.

This probabilistic zonation matches much more closely with the Gujarat catalogue of tropical cyclones, storms and depressions and hence with the long-term wind climate of Gujarat. This is evident from the banded zonation across Gujarat, which proceeds deeper inland with an increase in storm recurrence intervals as would be expected given the higher intensity of seaborne cyclones and storms compared to extra tropical storms that influence the wind climate of northern and northeastern Gujarat.

Gujarat Cyclone Hazard Risk Zonation: Cyclone & Storm Tracks Affecting Gujarat (1872-2002)



GSDMA

LEGEND

Cyclone & Storm Tracks by Basin of Origin

- Arabian Sea
- North Bay of Bengal
- South Bay of Bengal
- North Indian Extratropical Storms

Source: US Navy Fleet Numerical Meteorology and Oceanography Detachment, GTTC Atlas, Asheville;
IMD, 1979: Tracks of Storms and Depressions in the Bay of Bengal and the Arabian Sea 1877 to 1990, New Delhi;
GTOPO30, BISAG, GoG.

0 100 km

N

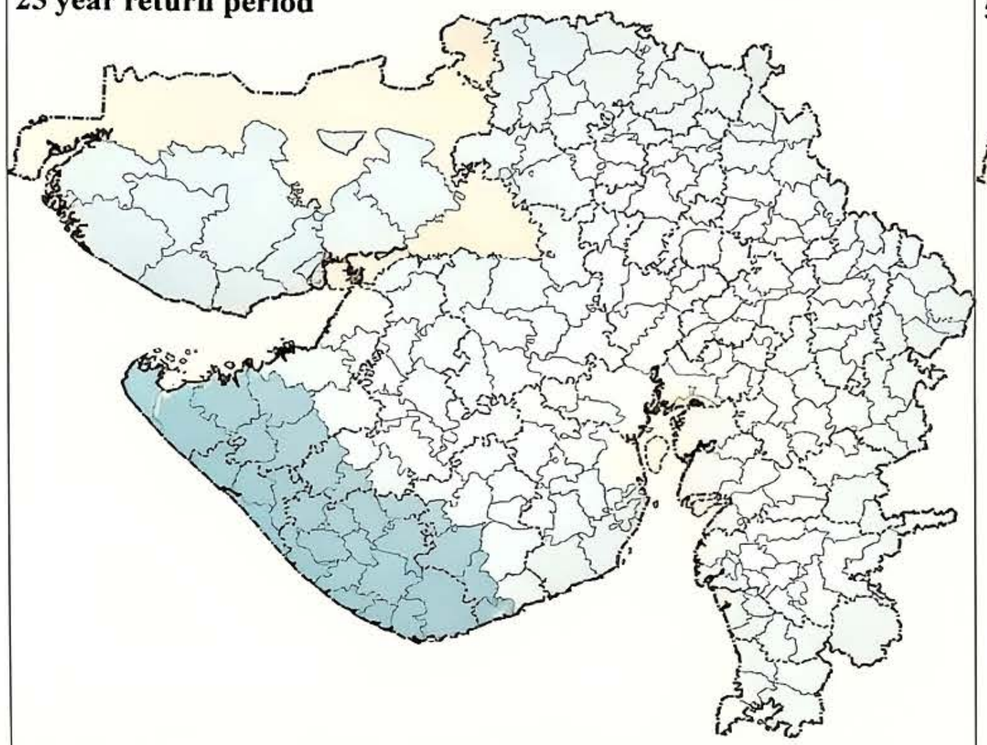
Projection : Lambert Azimuthal Equal Area
Datum : WGS 84

MAP No. : HCTM - 01 OF 01

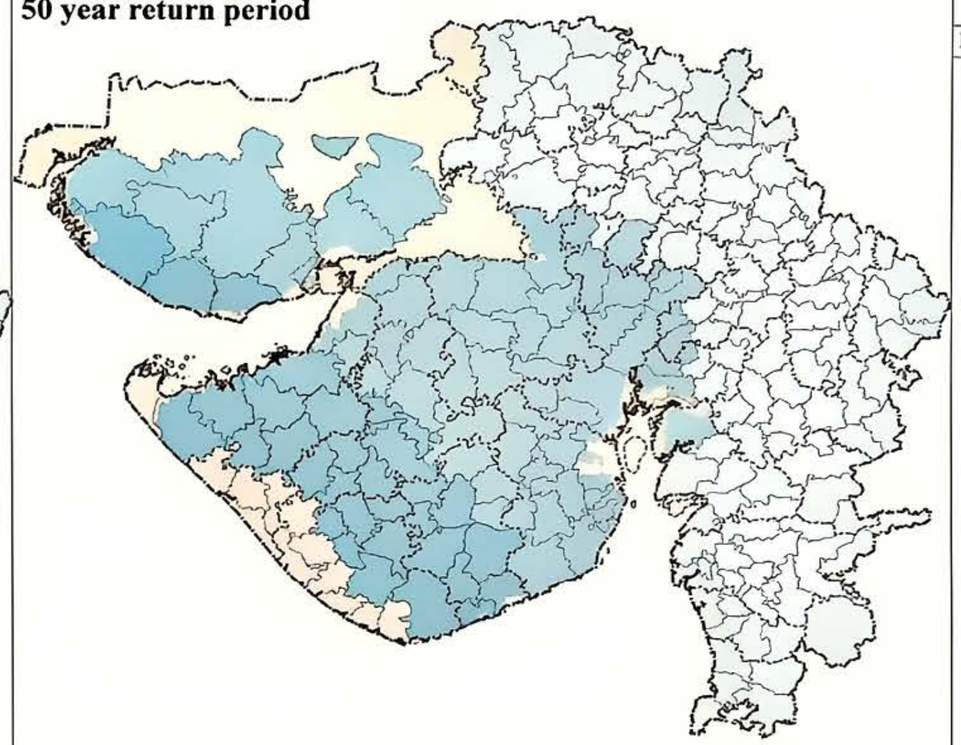
Date : 24/6/2005

Gujarat Cyclone Hazard Risk Zonation: Estimated Mean Taluka Basic (3-second peak gust) Wind Speed Zones (in m/sec)

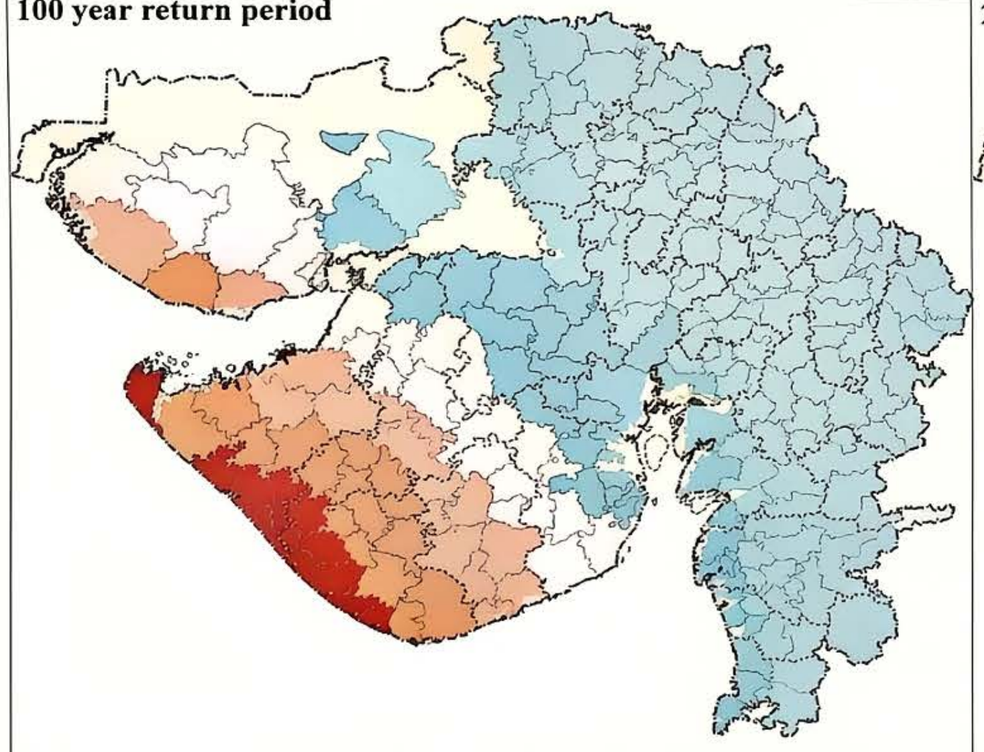
25 year return period



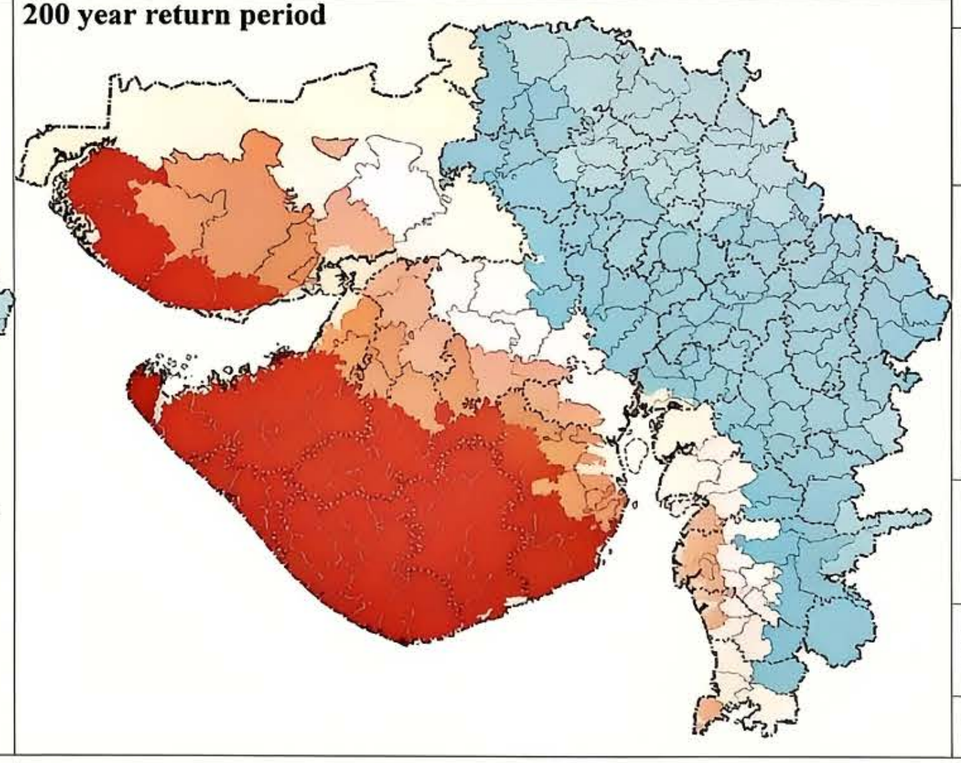
50 year return period



100 year return period



200 year return period



GSDMA

LEGEND

Wind Speed in (m/sec)
3-second peak gust at 10 m

- < 33
- 34 to 39
- 40 to 44
- 45 to 47
- 48 to 50
- 51 to 55
- > 55

Based on a track and intensity database of 207 cyclonic storms & depressions over the 1877 to 2002 period from the Global Tropical Cyclone Climatic Atlas & IMD Trac of Storms & Depressions Atlas interpolated at a 0.1 degree frequency simulated over a 0.1 x 0.1 degree grid covering the landmass of Gujarat using Kaplan, J. & DeMaria, M (1995); Jelesniaski et.al. (1990) & Holland, G.J. et.al. (2000) equatio

Source: IS:875 (Part 3) – 1987, BIS; Georgiou, et al., 1983; "Design Wind Speeds in Regions Dominated by Tropical Cyclones", Journal of Wind Engineering and Industria Aerodynamics; Holland, G.H Ed., 2000, Bureau of Meteorology Research Centre, Melbourne; IMD, 1979; Tracks of Storms and Depressions in the Bay of Bengal and the Arabian Sea 1877 to 1990, New Delhi; Kaplan, J. and DeMaria, M.A., 1995, Journ of Applied Meteorology, 34, 2499-2512; Jayanta Sinha, J. and Mandal, G.S., 1999; National seminar on Wind Engineering-01, IIT, Kharagpur; Jelesniaski, C. P.,2000, In: Holland, G.H Ed. Global Guide to Tropical Cyclone Forecasting, Bureau of Meteorology Research Centre, Melbourne; Johnson, M.E. & Watson, C.C Hurricane Return Period Estimation USAID-OAS; Caribbean Disaster Mitigation Project December 1997; Simiu, E. and Scanlan, R. H., 1996; Wind Effects on Structures New York, Wiley; US Navy Fleet Numerical Meteorology and Oceanography Detachment, GTTC Atlas, Asheville; BISAG, GoG.

0 100 km

N

Projection : Lambert Azimuthal Equal Area
Datum : WGS 84

MAP No. : HCYM - 01 OF 01

Date : 21/6/2005

GUJARAT TALUKA CYCLONE HAZARD RISK CLASSIFICATION :
MEAN BASIC WIND SPEED (3-second peak gust) IN (m/sec) BY RETURN PERIOD Table No. HCYT - 01 of 01

GSDMA

Sr. No	District	Taluka	25 year	50 year	100 year	200 year
1	Ahmadabad	Ahmadabad City	27	33	37	40
2	Ahmadabad	Barwala	28	35	42	49
3	Ahmadabad	Bavla	27	34	38	42
4	Ahmadabad	Daskroi	27	33	37	40
5	Ahmadabad	Detroj-Rampura	27	32	36	40
6	Ahmadabad	Dhandhuka	27	34	41	46
7	Ahmadabad	Dholka	27	34	39	42
8	Ahmadabad	Mandal	27	33	36	40
9	Ahmadabad	Ranpur	28	35	42	49
10	Ahmadabad	Sanand	27	34	37	41
11	Ahmadabad	Viramgam	28	33	38	41
12	Amreli	Amreli	32	40	47	61
13	Amreli	Babra	31	38	46	57
14	Amreli	Bagasara	33	41	49	62
15	Amreli	Dhari	33	41	49	63
16	Amreli	Jafrabad	33	41	49	63
17	Amreli	Khambha	33	41	49	63
18	Amreli	Kunkavav Vadia	32	40	48	60
19	Amreli	Lathi	30	38	45	59
20	Amreli	Lilia	31	38	46	60
21	Amreli	Rajula	32	39	48	62
22	Amreli	Savar Kundla	32	39	47	62
23	Anand	Anand	26	32	37	41
24	Anand	Anklav	25	32	37	41
25	Anand	Borsad	26	32	38	42
26	Anand	Khambhat	26	33	39	43
27	Anand	Petlad	26	32	38	42
28	Anand	Sojitra	26	33	38	41
29	Anand	Tarapur	26	33	38	42
30	Anand	Umreth	25	32	37	41
31	Banas Kantha	Amirgadh	24	29	34	37
32	Banas Kantha	Bhabhar	25	31	36	40
33	Banas Kantha	Danta	24	29	34	37
34	Banas Kantha	Dantiwada	24	29	34	37
35	Banas Kantha	Deesa	24	30	35	38
36	Banas Kantha	Deodar	25	31	36	39
37	Banas Kantha	Dhanera	23	29	34	37
38	Banas Kantha	Kankrej	25	31	36	39
39	Banas Kantha	Palanpur	24	30	35	38
40	Banas Kantha	Tharad	24	29	34	37
41	Banas Kantha	Vadgam	25	30	35	38
42	Banas Kantha	Vav	25	30	35	39
43	Bharuch	Amod	25	32	38	44
44	Bharuch	Anklesvar	25	30	38	45
45	Bharuch	Bharuch	25	31	38	44
46	Bharuch	Hansot	25	31	40	47
47	Bharuch	Jambusar	26	33	39	44
48	Bharuch	Jhagadia	24	30	36	42
49	Bharuch	Vagra	26	32	40	46
50	Bharuch	Valia	24	29	36	42
51	Bhavnagar	Bhavnagar	27	34	42	50
52	Bhavnagar	Botad	29	35	43	51
53	Bhavnagar	Gadhada	29	37	44	55
54	Bhavnagar	Gariadhar	30	37	45	59
55	Bhavnagar	Ghogha	27	35	43	53
56	Bhavnagar	Mahuva	30	37	46	60
57	Bhavnagar	Palitana	29	37	45	57
58	Bhavnagar	Sihor	29	35	43	54
59	Bhavnagar	Talaja	28	35	44	56
60	Bhavnagar	Umrala	29	36	44	55
61	Bhavnagar	Vallabhipur	28	35	43	51
62	Dohad	Devgadbaria	24	30	36	40
63	Dohad	Dhanpur	24	30	35	40
64	Dohad	Dohad	24	29	36	41
65	Dohad	Fatepura	24	30	35	40
66	Dohad	Garbada	24	29	35	40
67	Dohad	Jhalod	24	30	36	40
68	Dohad	Limkheda	24	30	36	41
69	Gandhinagar	Dehgam	26	32	36	40
70	Gandhinagar	Gandhinagar	27	32	37	40
71	Gandhinagar	Kalol	27	32	37	40
72	Gandhinagar	Mansa	26	32	36	38
73	Jamnagar	Bhanvad	34	42	52	64
74	Jamnagar	Dhrol	31	38	46	53
75	Jamnagar	Jamjodhpur	33	42	53	63
76	Jamnagar	Jamnagar	32	40	47	56
77	Jamnagar	Jodiya	30	38	44	51
78	Jamnagar	Kalavad	32	39	49	58
79	Jamnagar	Kalyanpur	34	43	54	67
80	Jamnagar	Khambhalia	33	42	50	63
81	Jamnagar	Lalpur	33	41	49	59
82	Jamnagar	Okhamandal	34	44	56	66
83	Junagadh	Bhesan	33	41	51	62
84	Junagadh	Junagadh	33	42	52	64
85	Junagadh	Keshod	34	44	55	68
86	Junagadh	Kodinar	35	44	54	65
87	Junagadh	Malia	35	45	55	66
88	Junagadh	Manavadar	34	44	55	68
89	Junagadh	Mangrol	35	45	56	68
90	Junagadh	Mendarda	34	43	54	65
91	Junagadh	Patan-Veraval	35	45	56	66
92	Junagadh	Sutrapada	35	45	55	66
93	Junagadh	Talala	34	43	54	66
94	Junagadh	Una	34	42	52	64
95	Junagadh	Vanthali	34	43	54	67
96	Junagadh	Visavadar	33	42	51	64
97	Kachchh	Abdasa	32	40	48	59
98	Kachchh	Anjar	30	37	44	51
99	Kachchh	Bhachau	29	35	40	47
100	Kachchh	Bhuj	30	37	44	50
101	Kachchh	Gandhidham	30	37	44	50
102	Kachchh	Lakhpat	31	38	44	57
103	Kachchh	Mandvi	32	40	50	59
104	Kachchh	Mundra	31	39	48	56
105	Kachchh	Nakhatrana	31	38	46	54
106	Kachchh	Rapar	27	33	38	45
107	Kheda	Balasinor	25	31	36	40
108	Kheda	Kapadvanj	26	32	37	40
109	Kheda	Kathlal	26	32	37	40
110	Kheda	Kheda	27	33	37	41
111	Kheda	Mahudha	26	32	37	40
112	Kheda	Matar	26	33	38	41
113	Kheda	Mehmedabad	26	32	37	41
114	Kheda	Nadiad	26	32	37	41

GUJARAT TALUKA CYCLONE HAZARD RISK CLASSIFICATION :
MEAN BASIC WIND SPEED (3-second peak gust) IN (m/sec) BY RETURN PERIOD Table No. HCYT - 01 of 01

GSDMA

Sr. No	District	Taluka	25 year	50 year	100 year	200 year
115	Kheda	Thasra	25	32	37	41
116	Kheda	Virpur	25	31	36	40
117	Mahesana	Becharaji	27	32	36	39
118	Mahesana	Kadi	27	33	37	40
119	Mahesana	Kheralu	25	30	35	38
120	Mahesana	Mahesana	27	32	36	39
121	Mahesana	Satlasana	25	30	35	37
122	Mahesana	Unjha	26	31	35	38
123	Mahesana	Vadnagar	26	31	35	38
124	Mahesana	Vijapur	26	31	35	38
125	Mahesana	Visnagar	26	31	35	38
126	Narmada	Dediapada	24	29	34	39
127	Narmada	Nandod	24	30	35	40
128	Narmada	Sagbara	23	28	33	38
129	Narmada	Tilakwada	24	30	36	40
130	Navsari	Bansda	24	29	36	42
131	Navsari	Chikhli	25	30	38	44
132	Navsari	Gandevi	25	31	39	46
133	Navsari	Jalalpore	25	31	40	48
134	Navsari	Navsari	25	31	38	46
135	Panch Mahals	Ghoghamba	24	31	36	40
136	Panch Mahals	Godhra	25	31	36	40
137	Panch Mahals	Halol	24	31	37	40
138	Panch Mahals	Jambughoda	24	31	36	40
139	Panch Mahals	Kadana	24	30	36	40
140	Panch Mahals	Kalol	25	31	37	40
141	Panch Mahals	Khanpur	25	30	36	40
142	Panch Mahals	Lunawada	25	31	36	40
143	Panch Mahals	Morwa (Hadaf)	24	30	36	41
144	Panch Mahals	Santrampur	24	30	36	40
145	Panch Mahals	Shehera	25	31	37	41
146	Patan	Chanasma	26	31	35	38
147	Patan	Harij	26	31	36	38
148	Patan	Patan	26	31	35	38
149	Patan	Radhanpur	26	31	36	40
150	Patan	Sami	27	32	36	40
151	Patan	Santalpur	26	32	36	41
152	Patan	Sidhpur	25	31	35	38
153	Patan	Vagdod	25	31	35	38
154	Porbandar	Kutiyana	34	44	55	67
155	Porbandar	Porbandar	35	44	55	68
156	Porbandar	Ranavav	35	44	55	67
157	Rajkot	Dhoraji	33	42	52	65
158	Rajkot	Gondal	32	39	48	59
159	Rajkot	Jamkandorna	32	40	50	62
160	Rajkot	Jasdan	30	37	45	55
161	Rajkot	Jetpur	32	41	50	62
162	Rajkot	Kotda Sangani	31	39	47	58
163	Rajkot	Lodhika	32	39	47	57
164	Rajkot	Maliya	29	35	41	47
165	Rajkot	Morvi	29	36	42	48
166	Rajkot	Paddhari	31	38	46	54
167	Rajkot	Rajkot	31	38	46	54
168	Rajkot	Tankara	30	38	45	51
169	Rajkot	Upleta	33	42	53	65
170	Rajkot	Wankaner	30	37	44	49
171	Sabar Kantha	Bayad	26	31	36	40
172	Sabar Kantha	Bhiloda	25	29	34	38
173	Sabar Kantha	Dhansura	25	31	36	39
174	Sabar Kantha	Himatnagar	26	31	35	38
175	Sabar Kantha	Idar	25	30	34	38
176	Sabar Kantha	Khedbrahma	24	29	34	37
177	Sabar Kantha	Malpur	25	30	36	39
178	Sabar Kantha	Meghraj	25	30	35	39
179	Sabar Kantha	Modasa	25	30	35	38
180	Sabar Kantha	Prantij	26	31	35	38
181	Sabar Kantha	Talod	26	31	36	39
182	Sabar Kantha	Vadali	25	29	34	37
183	Sabar Kantha	Vijaynagar	24	29	34	37
184	Surat	Bardoli	24	30	37	45
185	Surat	Chorasi	25	32	40	48
186	Surat	Kamrej	25	31	38	46
187	Surat	Mahuva	24	30	37	44
188	Surat	Mandvi	24	29	37	43
189	Surat	Mangrol	25	30	37	44
190	Surat	Nizar	23	28	32	36
191	Surat	Olpad	25	32	41	48
192	Surat	Palsana	24	31	38	46
193	Surat	Songadh	23	28	35	40
194	Surat	Surat City	25	32	40	48
195	Surat	Uchchhal	23	28	34	38
196	Surat	Umarpada	24	29	35	41
197	Surat	Valod	24	29	36	44
198	Surat	Vyara	24	29	35	42
199	Surendranagar	Chotila	30	37	44	50
200	Surendranagar	Chuda	28	34	42	47
201	Surendranagar	Dasada	27	33	37	42
202	Surendranagar	Dhrangadhra	28	34	39	44
203	Surendranagar	Halvad	28	35	40	45
204	Surendranagar	Lakhtar	28	34	39	43
205	Surendranagar	Limbdi	27	34	40	45
206	Surendranagar	Muli	28	35	42	46
207	Surendranagar	Sayla	29	36	43	48
208	Surendranagar	Wadhwan	28	34	41	45
209	The Dangs	The Dangs	23	28	34	39
210	Vadodara	Chhota Udaipur	24	30	35	39
211	Vadodara	Dabhoi	24	31	37	41
212	Vadodara	Jetpur Pavi	24	31	36	39
213	Vadodara	Karjan	25	31	37	42
214	Vadodara	Kavant	23	30	35	38
215	Vadodara	Nasvadi	23	30	35	39
216	Vadodara	Padra	25	32	38	42
217	Vadodara	Sankheda	24	31	36	40
218	Vadodara	Savli	25	32	37	41
219	Vadodara	Sinor	24	31	37	41
220	Vadodara	Vadodara	25	32	37	41
221	Vadodara	Vaghodia	24	32	37	41
222	Valsad	Dharampur	24	30	37	42
223	Valsad	Kaprada	25	31	37	44
224	Valsad	Pardi	26	31	39	46
225	Valsad	Umbergaon	26	32	39	49
226	Valsad	Valsad	25	31	39	46

Gujarat Storm Surge Hazard Risk Zonation : Major & Minor Ports & Coastal Features

GSDMA

LEGEND

- Major Ports
- GMB Ports
- Private Sector Ports
- Joint Sector Ports
- Other Ports
- Major Towns
- State Boundary
- District Boundary
- Taluka Boundary
- National Highway
- River
- Drainage
- Mud Flats & Rann

1.4 / -1.3 Pipavav — Mean Highest High Water Level above MSL (in meter) / Mean Lowest Low Water Level above MSL (in meter)

Source : UKHO, 2003; SRTM, 2003; ETOPO, 2003;
Vulnerability Atlas of India, GoI, 1997;
Gujarat Maritime Board, GoG, 2004; BISAG, GoG.

0 — 100 km

N

Projection : Lambert Azimuthal Equal Area
Datum : WGS 84

MAP No. : HSSM - 01 of 05

Date : 2/7/2005

69°00' E 70°00' E 71°00' E 72°00' E 73°00' E 74°00' E

24°00' N 23°00' N 22°00' N 21°00' N 20°00' N

BANAS KANTHA, PATAN, MAHESANA, SABAR KANTHA, GANDHINAGAR, AHMEDABAD, KHEDA, PANCHMAHAL, DAHOD, SURENDRANAGAR, ANAND, VADODARA, BHARUCH, NARMADA, RAJKOT, JAMNAGAR, PORBANDAR, BHAVNAGAR, AMRELI, JUNAGADH, SURAT, NAVSARI, THE DANGS, VALSAD, KACHCHH

Lakhpat, Koteshwar, Jakhau, Bhuj, Anjar, Gandhidham, Kandla, Navlakhi, Mandvi, Mundra, Okhaport, Bedi, Sikka, Rozi, Jamnagar, Salaya, Dwarka, Miyani, Porbandar, Junagadh, Amreli, Rajula, Mahuva, Pipavav, Veraval, Una, Jafrabad, Navabandar, Palanpur, Siddhapur, Mahesana, Himatnagar, Ahmedabad, Surendranagar, Kheda, Godhra, Dahod, Anand, Vadodara, Khambhat, Botad, Bhavnagar, Dahej, Bharuch, Ankleshwar, Ambheta, Mehgam, Piram Island, Mithi Virdi, Alang, Sultanpur, Surat, Suvali, Magdalla, Hajira, Songadh, Navsari, Vansi, Valsad, Vapi, Umbergaon

Banas, Saraswati, Sabarmati, Mahi, Narmada

Porbandar 0.8 / -1.0 · Kandla 2.8 / -3.1 · Mundra 2.8 / -3.2 · Veraval 0.8 / -0.8 · Bhavnagar 4.1 / -4.7 · Dahej 4.7 / -1.7 · Valsad 2.5 / -3.4 · Pipavav 1.4 / -1.3

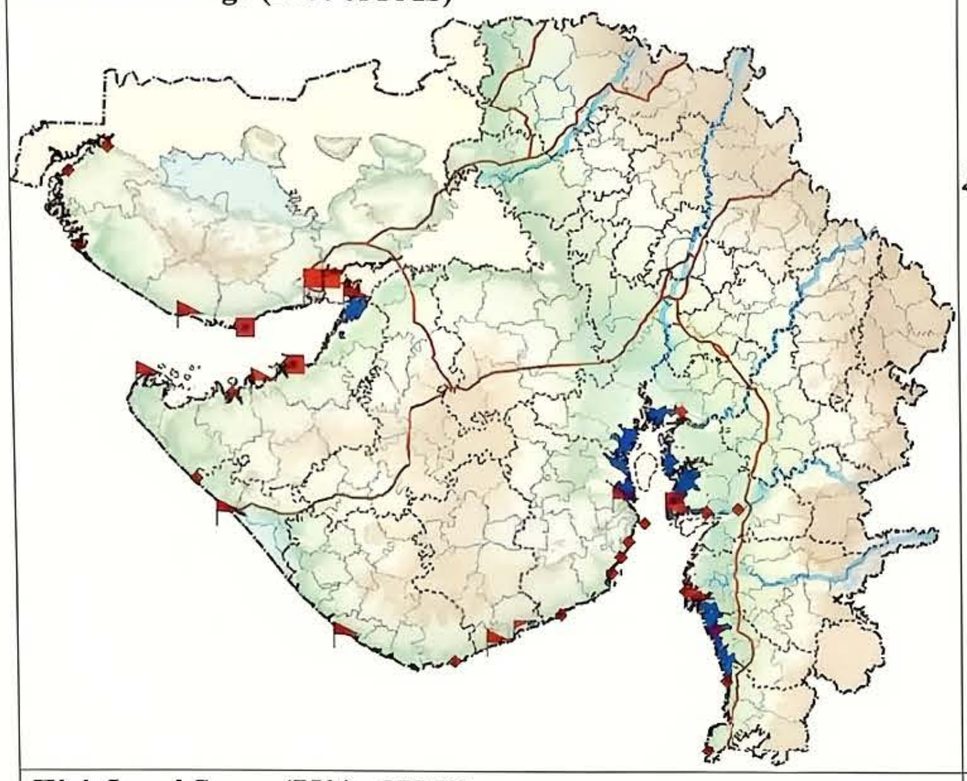
GSDMA/TARU

Gujarat Hazard Risk & Vulnerability Assessment Atlas

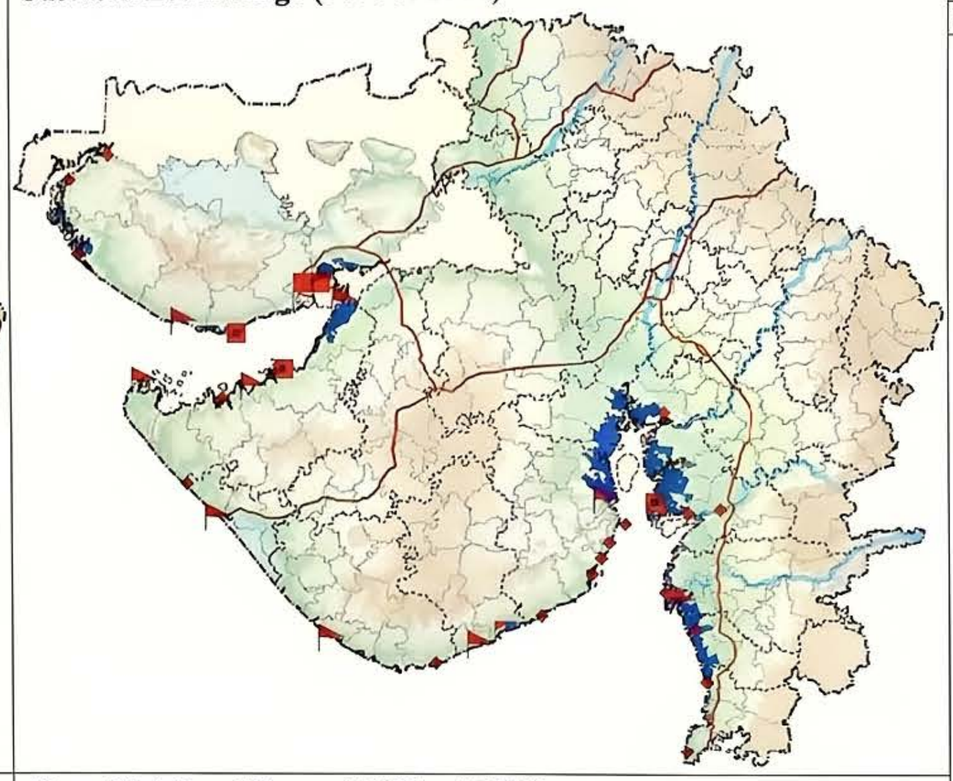
Gujarat Storm Surge Hazard Risk Zonation : Estimated Probable Maximum Surge (PMS) at Mean Sea Level

GSDMA

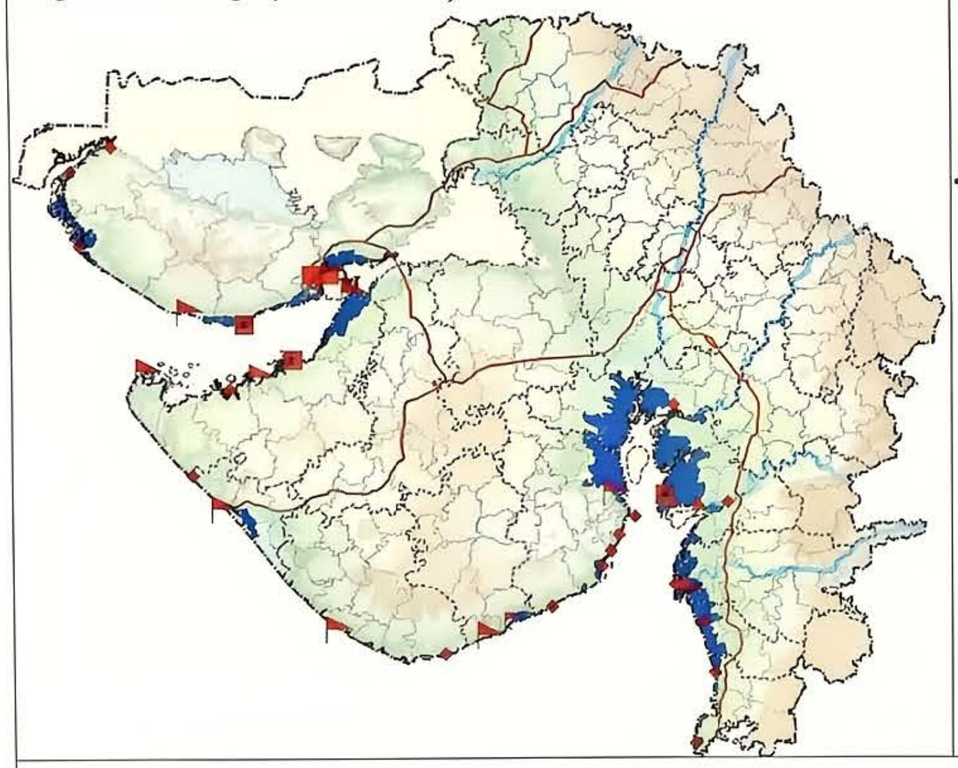
Low Level Surge (25% of PMS)



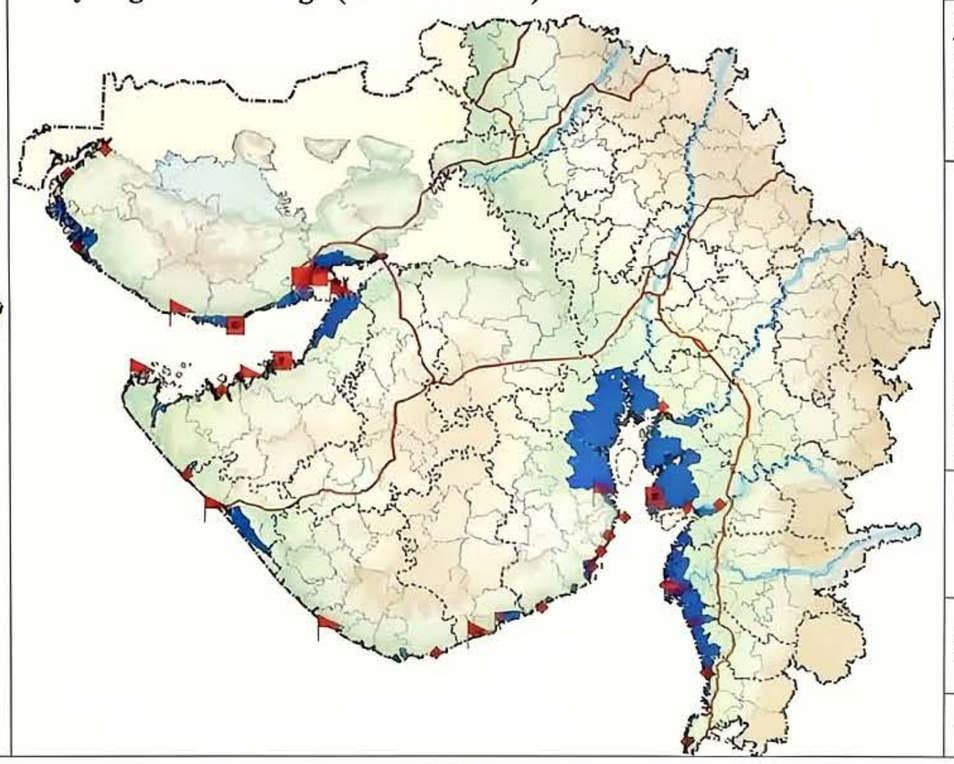
Medium Level Surge (50% of PMS)



High Level Surge (75% of PMS)



Very High Level Surge (100% of PMS)



LEGEND

- Major Ports
- GMB Ports
- Private Sector Ports
- Joint Sector Ports
- Other Ports
- State Boundary
- District Boundary
- Taluka Boundary
- National Highway
- Major Rivers
- Mud Flats & Rann
- Surge Inundation

Based on Probable Maximum Surge Levels as per
The Vulnerability Atlas of India, GoI, 1997.
Ghosh, S. K. Probable Maximum Storm Surge on the Coast of India and Bangladesh, Aspects of Mechanics, 1983.
Chittibabu, P. Development of Storm Surge Prediction Models for the Bay of Bengal and the Arabian Sea, IIT Delhi, 1999.

Source : UKHO, 2003; SRTM, 2003; ETOPO, 2003;
Survey of India, Indian Tide Tables, various years;
Vulnerability Atlas of India, GoI, 1997;
Gujarat Maritime Board, GoG, 2004; BISAG, GoG.

0 100 km

N

Projection : Lambert Azimuthal Equal Area
Datum : WGS 84

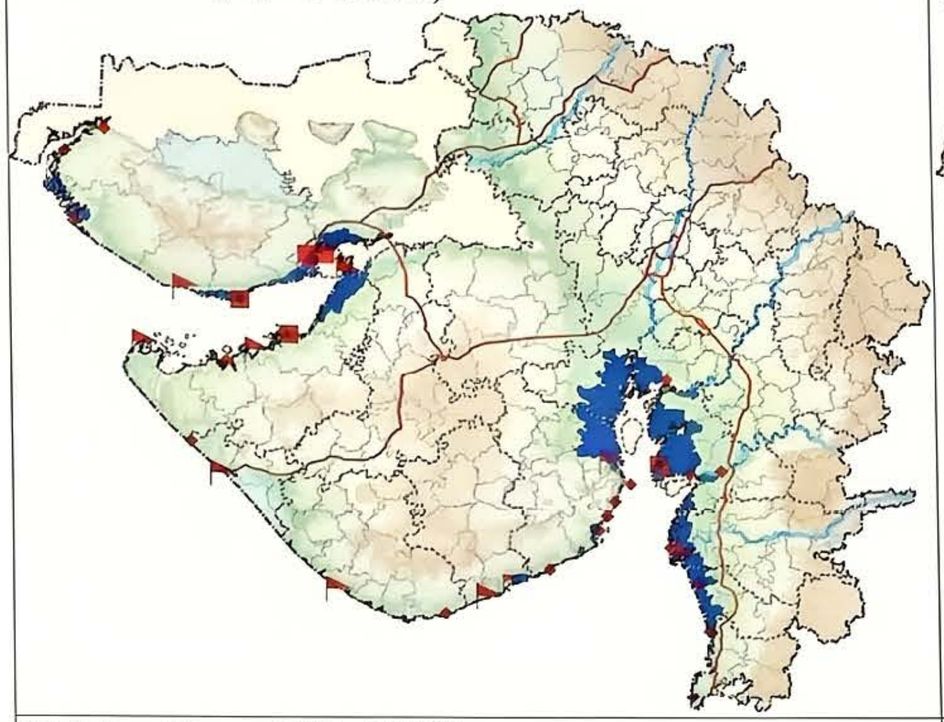
MAP No. : HSSM - 02 of 05

Date : 21/6/2005

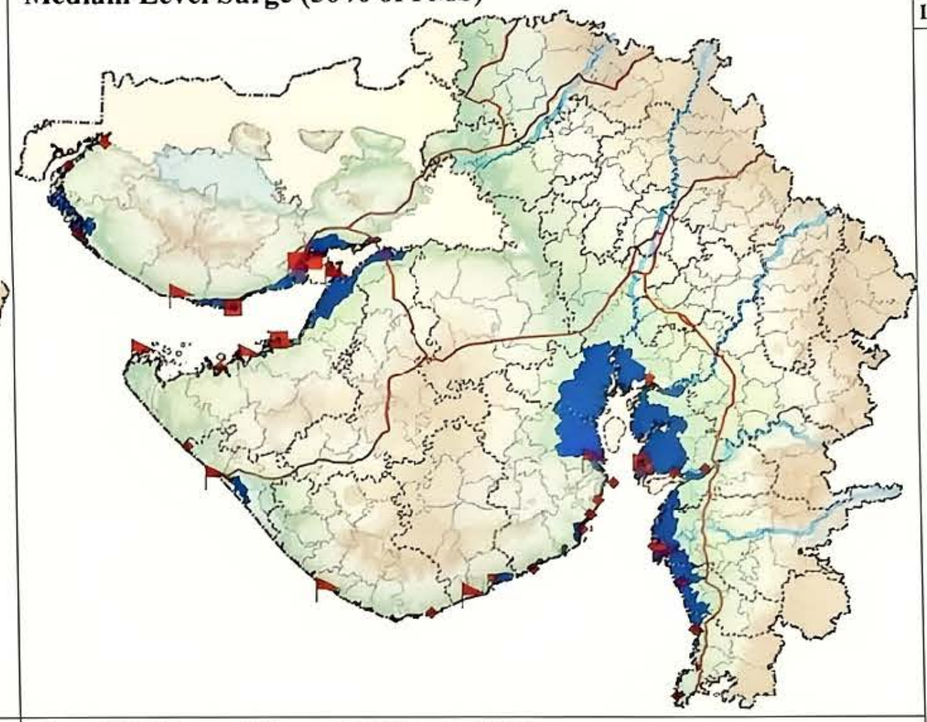
Gujarat Storm Surge Hazard Risk Zonation : Estimated Peak Maximum Surge at Highest High Water Level

GSDMA

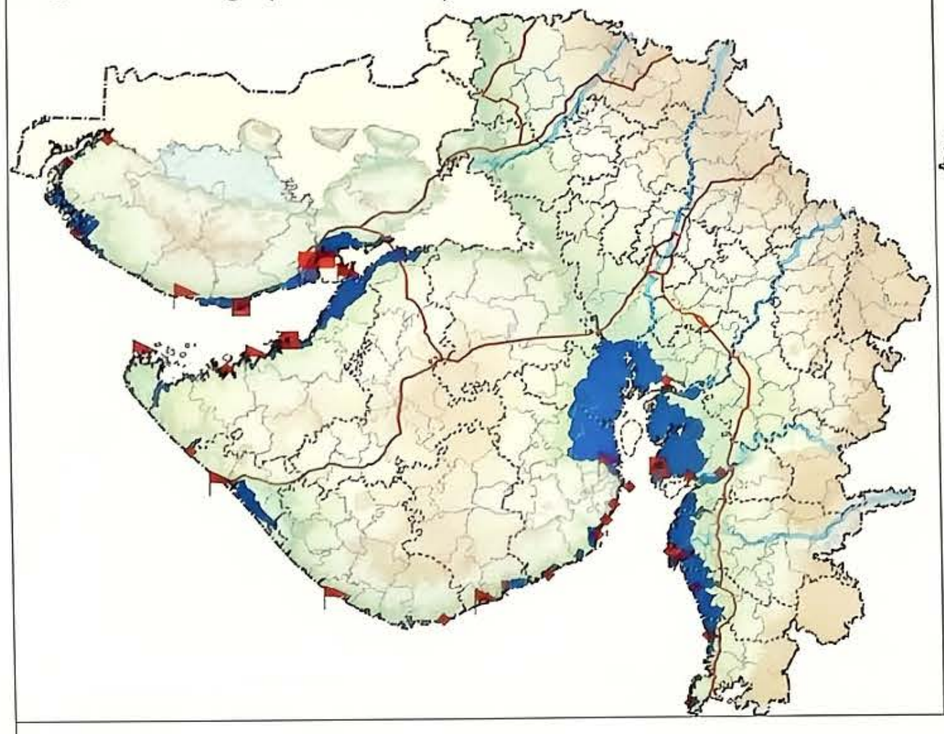
Low Level Surge (25% of PMS)



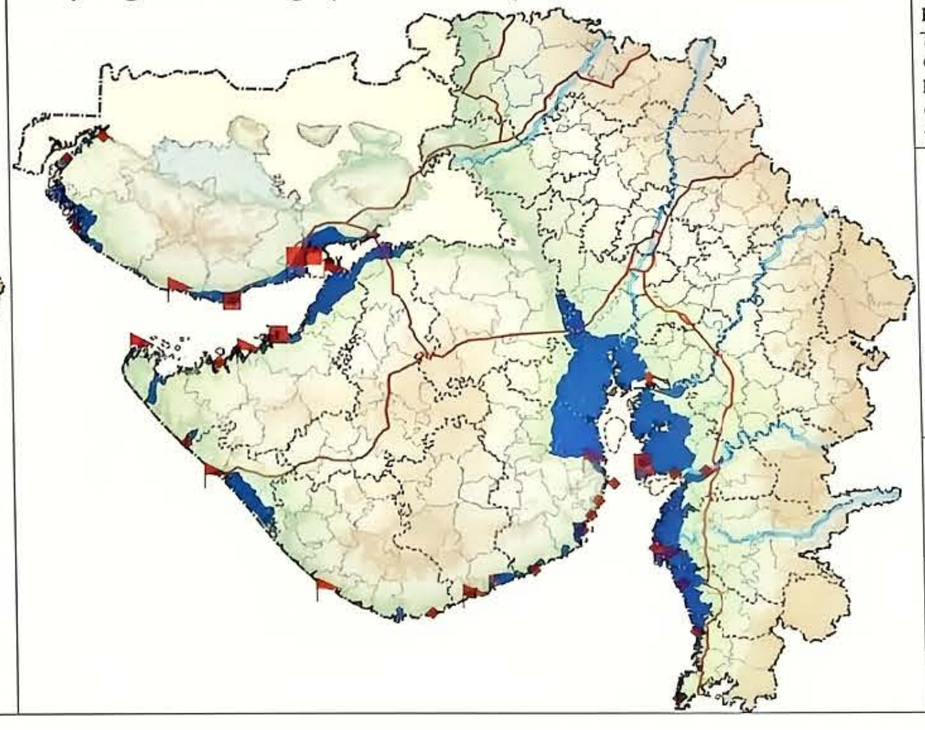
Medium Level Surge (50% of PMS)



High Level Surge (75% of PMS)



Very High Level Surge (100% of PMS)



LEGEND

- Major Ports
- GMB Ports
- Private Sector Ports
- Joint Sector Ports
- Other Ports
- State Boundary
- District Boundary
- Taluka Boundary
- National Highway
- Major Rivers
- Mud Flats and Rann
- Surge Inundation

Based on Probable Maximum Surge Levels as per
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Ghosh, S. K. Probable Maximum Storm Surge on the Coast of India and Bangladesh, Aspects of Mechanics, 1983.
Chittibabu, P. Development of Storm Surge Prediction Models for the Bay of Bengal and the Arabian Sea, IIT Delhi, 1999.

Source : UKHO, 2003; SRTM, 2003; ETOPO, 2003;
Survey of India, Indian Tide Tables, various years;
Vulnerability Atlas of India, GoI, 1997;
Gujarat Maritime Board, GoG, 2004; BISAG, GoG.

0 100 km

N

Projection : Lambert Azimuthal Equal Area
Datum : WGS 84

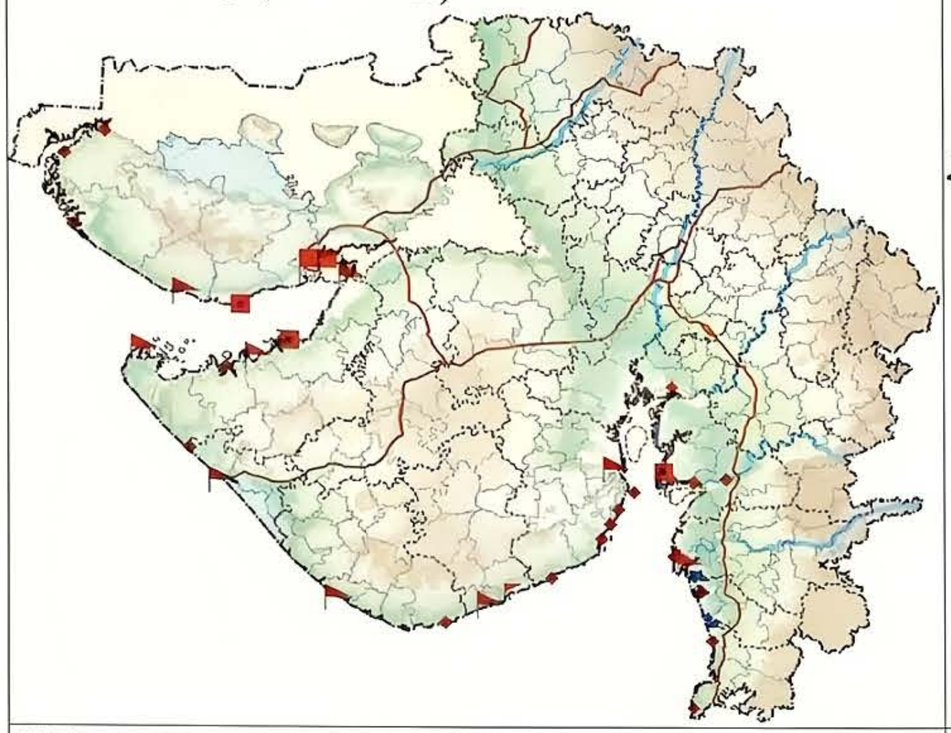
MAP No. : HSSM - 03 of 05

Date : 21/6/2005

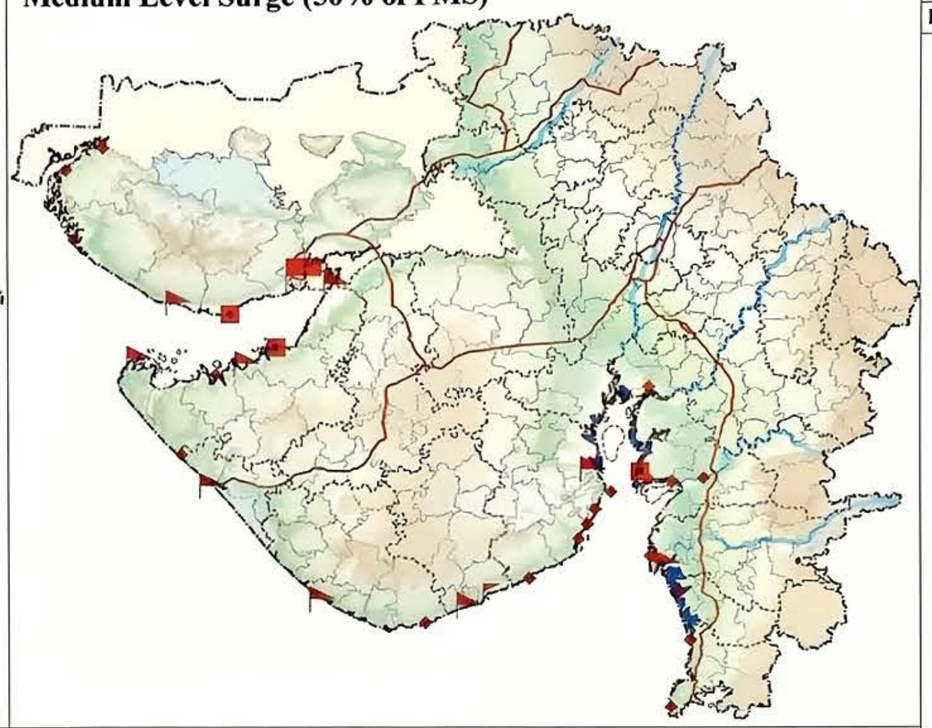
Gujarat Storm Surge Hazard Risk Zonation : Estimated Probable Maximum Surge (PMS) at Lowest Low Water Level

GSDMA

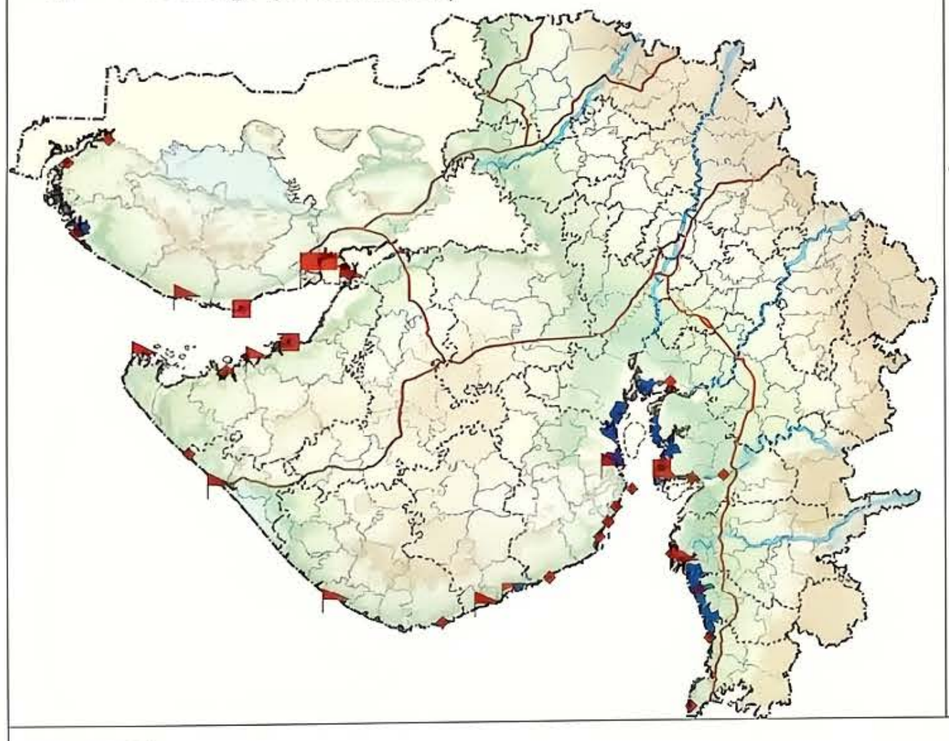
Low Level Surge (25% of PMS)



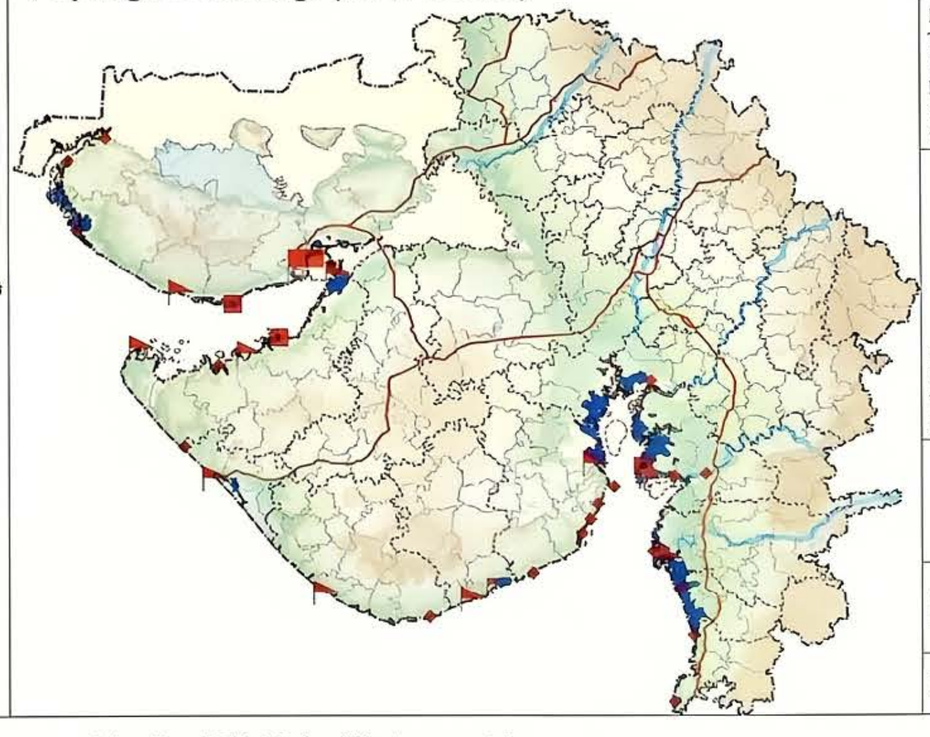
Medium Level Surge (50% of PMS)



High Level Surge (75% of PMS)



Very High Level Surge (100% of PMS)



LEGEND

- Major Ports
- GMB Ports
- Private Sector Ports
- Joint Sector Ports
- Other Ports
- State Boundary
- District Boundary
- Taluka Boundary
- National Highway
- Major Rivers
- Mud Flats & Rann
- Surge Inundation

Based on Probable Maximum Surge Levels as per
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Chittibabu, P. Development of Storm Surge Prediction Models for the Bay of Bengal and the Arabian Sea, IIT Delhi, 1999.

Source : UKHO, 2003; SRTM, 2003; ETOPO, 2003;
Survey of India, Indian Tide Tables, various years;
Vulnerability Atlas of India, GoI, 1997;
Gujarat Maritime Board, GoG, 2004; BISAG, GoG.

0 100 km

N

Projection : Lambert Azimuthal Equal Area
Datum : WGS 84

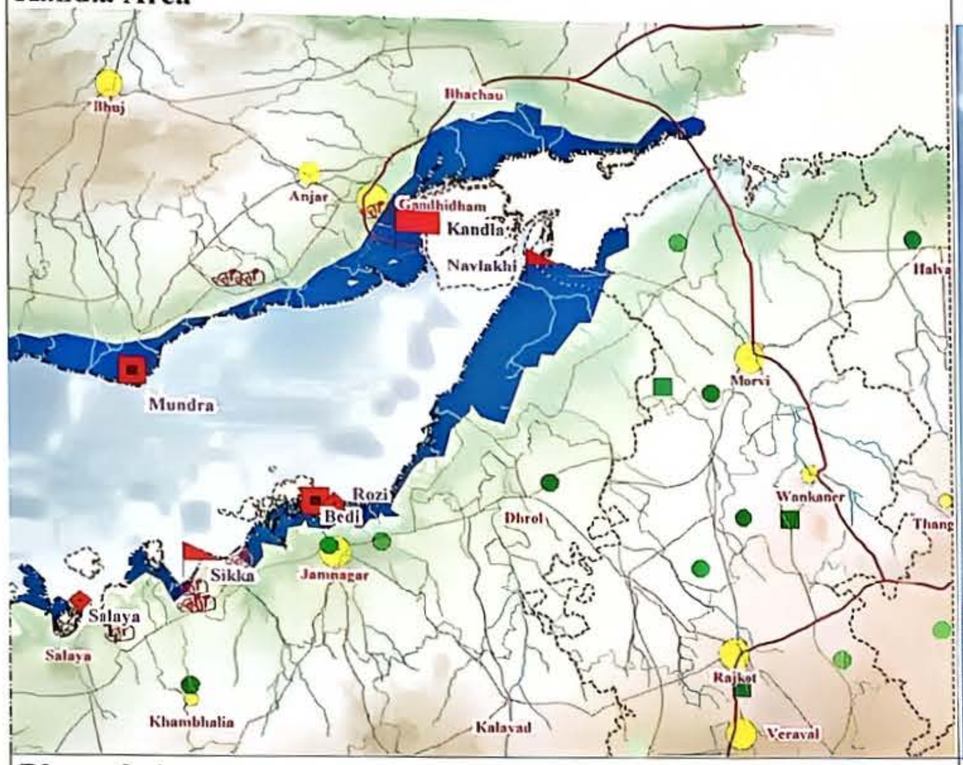
MAP No. : HSSM - 04 of 05

Date : 21/6/2005

Gujarat Storm Surge Hazard Risk Zonation : Estimated Probable Maximum Surge (PMS) at Critical Locations at Mean Sea Level (100% of PMS)

GSDMA

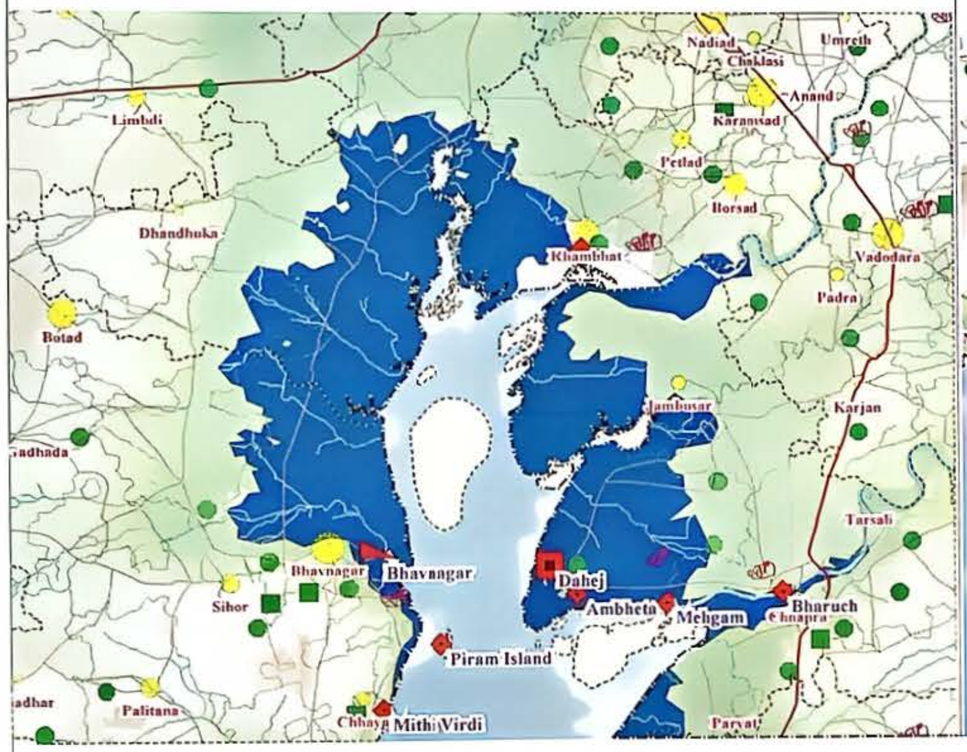
Kandla Area



Porbandar Area



Bharuch Area



Surat Area



LEGEND

- Major Ports
- GMB Ports
- Private Sector Ports
- Joint Sector Ports
- Other Ports
- Ports Label
- Industrial Estates
- Industrial Clusters
- Power Plants
- Towns
- State Boundary
- District Boundary
- Taluka Boundary
- National Highway
- State Highway
- Drainage
- Major Rivers
- Mud Flats & Rann
- Surge Inundation

Based on Probable Maximum Surge Levels as per
The Vulnerability Atlas of India, GoI, 1997.
Ghosh, S. K., Probable Maximum Storm Surge on the Coast of India and Bangladesh, Aspects of Mechanics, 1983.
Chittibabu, P., Development of Storm Surge Prediction Models for the Bay of Bengal and the Arabian Sea, IIT Delhi, 1999.

Source : UKHO, 2003; SRTM, 2003; ETOPO, 2003;
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Vulnerability Atlas of India, GoI, 1997;
Gujarat Maritime Board, GoG, 2004; BISAG, GoG.

0 — 50 km

N

Projection : Lambert Azimuthal Equal Area
Datum : WGS 84

MAP No. : HSSM - 05 of 05

Date : 21/6/2005

GUJARAT CYCLONE & STORM SURGE HAZARD RISK ZONATION : AREA AFFECTED BY PROBABLE MAXIMUM SURGE (PMS) AT MEAN SEA LEVEL (in percent) Table No. HSST - 01 of 01

GSDMA

Sr. No	District	Taluka	25% of PMS	50% of PMS	75% of PMS	100% of PMS
1	Ahmadabad	Ahmadabad City	-	-	-	-
2	Ahmadabad	Barwala	-	1%	21%	37%
3	Ahmadabad	Bavla	-	-	-	-
4	Ahmadabad	Daskroi	-	-	-	-
5	Ahmadabad	Detroj-Rampura	-	-	-	-
6	Ahmadabad	Dhandhuka	14%	34%	48%	59%
7	Ahmadabad	Dholka	-	-	4%	16%
8	Ahmadabad	Mandal	-	-	-	-
9	Ahmadabad	Ranpur	-	-	-	-
10	Ahmadabad	Sanand	-	-	-	-
11	Ahmadabad	Viramgam	-	-	-	-
12	Amreli	Amreli	-	-	-	-
13	Amreli	Babra	-	-	-	-
14	Amreli	Bagasara	-	-	-	-
15	Amreli	Dhari	-	-	-	-
16	Amreli	Jafrabad	-	-	-	-
17	Amreli	Khambha	-	-	-	4%
18	Amreli	Kunkavav Vadia	-	-	-	-
19	Amreli	Lathi	-	-	-	-
20	Amreli	Lilia	-	-	-	-
21	Amreli	Rajula	2%	5%	9%	12%
22	Amreli	Savar Kundla	-	-	-	-
23	Anand	Anand	-	-	-	-
24	Anand	Anklav	-	-	-	-
25	Anand	Borsad	-	-	-	2%
26	Anand	Khambhat	21%	31%	45%	57%
27	Anand	Petlad	-	-	-	-
28	Anand	Sojitra	-	-	-	-
29	Anand	Tarapur	-	-	-	2%
30	Anand	Umreth	-	-	-	-
31	Banas Kantha	Amirgadh	-	-	-	-
32	Banas Kantha	Bhabhar	-	-	-	-
33	Banas Kantha	Danta	-	-	-	-
34	Banas Kantha	Dantiwada	-	-	-	-
35	Banas Kantha	Deesa	-	-	-	-
36	Banas Kantha	Deodar	-	-	-	-
37	Banas Kantha	Dhanera	-	-	-	-
38	Banas Kantha	Kankrej	-	-	-	-
39	Banas Kantha	Palanpur	-	-	-	-
40	Banas Kantha	Tharad	-	-	-	-
41	Banas Kantha	Vadgam	-	-	-	-
42	Banas Kantha	Vav	-	-	-	-
43	Bharuch	Amod	2%	7%	13%	18%
44	Bharuch	Anklesvar	5%	9%	16%	21%
45	Bharuch	Bharuch	3%	4%	8%	12%
46	Bharuch	Hansot	5%	10%	21%	31%
47	Bharuch	Jambusar	20%	33%	51%	58%
48	Bharuch	Jhagadia	1%	1%	1%	2%
49	Bharuch	Vagra	37%	59%	75%	81%
50	Bharuch	Valia	-	-	-	-
51	Bhavnagar	Bhavnagar	21%	33%	52%	67%
52	Bhavnagar	Botad	-	-		-
53	Bhavnagar	Gadhada	-	-	-	-
54	Bhavnagar	Garadhar	-	-		-
55	Bhavnagar	Ghogha	-	-	1%	2%
56	Bhavnagar	Mahuva	1%	1%	1%	3%
57	Bhavnagar	Palitana	-	-		-
58	Bhavnagar	Sihor	-	-	-	1%
59	Bhavnagar	Talaja	5%	5%	8%	9%
60	Bhavnagar	Umrala	-	-	-	-
61	Bhavnagar	Vallabhipur	-	-	-	8%
62	Dohad	Devgadbaria	-	-		-
63	Dohad	Dhanpur	-	-	-	-
64	Dohad	Dohad	-	-		-
65	Dohad	Fatepura	-	-		-
66	Dohad	Garbada	-	-	-	-
67	Dohad	Jhalod	-	-		-
68	Dohad	Limkheda	-	-		-
69	Gandhinagar	Dehgam	-	-	-	-
70	Gandhinagar	Gandhinagar	-	-		-
71	Gandhinagar	Kalol	-	-		-
72	Gandhinagar	Mansa	-	-	-	-
73	Jamnagar	Bhanvad	-	-		-
74	Jamnagar	Dhrol	-	-	-	-
75	Jamnagar	Jamjodhpur	-	-	-	-
76	Jamnagar	Jamnagar	1%	3%	6%	9%
77	Jamnagar	Jodiya	19%	26%	33%	37%
78	Jamnagar	Kalavad	-	-	-	-
79	Jamnagar	Kalyanpur	-	-	1%	6%
80	Jamnagar	Khambhalia	-	-	4%	5%
81	Jamnagar	Lalpur	-	-	-	1%
82	Jamnagar	Okhamandal	-	-	2%	8%
83	Junagadh	Bhesan	-	-	-	-
84	Junagadh	Junagadh	-	-	-	-
85	Junagadh	Keshod	-	-		-
86	Junagadh	Kodinar	-	-	-	3%
87	Junagadh	Malia	-	-	-	-
88	Junagadh	Manavadar			-	-
89	Junagadh	Mangrol	-	-	-	1%
90	Junagadh	Mendarda	-	-	-	-
91	Junagadh	Patan-Veraval	-	-		-
92	Junagadh	Sutrapada	-	-	-	-
93	Junagadh	Talala	-	-	-	-
94	Junagadh	Una	-	-	1%	1%
95	Junagadh	Vanthali	-	-	-	-
96	Junagadh	Visavadar	-	-	-	-
97	Kachchh	Abdasa	1%	5%	9%	13%
98	Kachchh	Anjar	3%	4%	10%	11%
99	Kachchh	Bhachau		7%	13%	15%
100	Kachchh	Bhuj	-	-	-	-
101	Kachchh	Gandhidham	-	-	13%	32%
102	Kachchh	Lakhpat	2%	5%	8%	9%
103	Kachchh	Mandvi	1%	1%	2%	3%
104	Kachchh	Mundra	3%	9%	16%	19%
105	Kachchh	Nakhatrana	-	-	-	-
106	Kachchh	Rapar	-	-	-	-
107	Kheda	Balasinor			-	-
108	Kheda	Kapadvanj	-	-	-	-
109	Kheda	Kathlal	-	-	-	-
110	Kheda	Kheda			-	-
111	Kheda	Mahudha			-	-
112	Kheda	Matar	-	-	-	-
113	Kheda	Mehmedabad	-	-	-	-
114	Kheda	Nadiad			-	-

GUJARAT CYCLONE & STORM SURGE HAZARD RISK ZONATION : AREA AFFECTED BY PROBABLE MAXIMUM SURGE (PMS) AT MEAN SEA LEVEL (in percent) Table No. HSST - 01 of 01

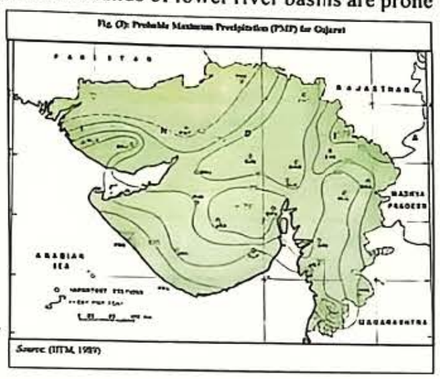
GSDMA

Sr. No	District	Taluka	25% of PMS	50% of PMS	75% of PMS	100% of PMS
115	Kheda	Thasra	-	-	-	-
116	Kheda	Virpur	-	-	-	-
117	Mahesana	Becharaji	-	-	-	-
118	Mahesana	Kadi	-	-	-	-
119	Mahesana	Kheralu	-	-	-	-
120	Mahesana	Mahesana	-	-	-	-
121	Mahesana	Satlasana	-	-	-	-
122	Mahesana	Unjha	-	-	-	-
123	Mahesana	Vadnagar	-	-	-	-
124	Mahesana	Vijapur	-	-	-	-
125	Mahesana	Visnagar	-	-	-	-
126	Narmada	Dediapada	-	-	-	-
127	Narmada	Nandod	-	-	-	-
128	Narmada	Sagbara	-	-	-	-
129	Narmada	Tilakwada	-	-	-	-
130	Navsari	Bansda	-	-	-	-
131	Navsari	Chikhli	-	-	-	-
132	Navsari	Gandevi	27%	29%	32%	35%
133	Navsari	Jalalpore	48%	55%	60%	65%
134	Navsari	Navsari		1%	2%	3%
135	Panch Mahals	Ghoghamba	-	-	-	-
136	Panch Mahals	Godhra	-	-		-
137	Panch Mahals	Halol	-	-	-	-
138	Panch Mahals	Jambughoda	-	-	-	-
139	Panch Mahals	Kadana	-	-		-
140	Panch Mahals	Kalol	-	-	-	-
141	Panch Mahals	Khanpur	-	-		-
142	Panch Mahals	Lunawada	-	-	-	-
143	Panch Mahals	Morwa (Hadaf)	-	-		-
144	Panch Mahals	Santrampur	-	-	-	-
145	Panch Mahals	Shehera	-	-		-
146	Patan	Chanasma	-	-	-	-
147	Patan	Harij	-	-		-
148	Patan	Patan	-	-	-	-
149	Patan	Radhanpur	-	-	-	-
150	Patan	Sami	-	-	-	-
151	Patan	Santalpur	-	-	-	-
152	Patan	Sidhpur	-	-	-	-
153	Patan	Vagdod	-	-	-	-
154	Porbandar	Kutiyana	-	-	-	-
155	Porbandar	Porbandar	-	-	5%	19%
156	Porbandar	Ranavav	-	-	8%	10%
157	Rajkot	Dhoraji	-	-	-	-
158	Rajkot	Gondal	-	-		-
159	Rajkot	Jamkandorna		-		-
160	Rajkot	Jasdan	-	-	-	-
161	Rajkot	Jetpur	-	-	-	-
162	Rajkot	Kotda Sangani	-	-	-	-
163	Rajkot	Lodhika		-	-	-
164	Rajkot	Maliya	3%	4%	7%	9%
165	Rajkot	Morvi	-	-	-	-
166	Rajkot	Paddhari		-	-	-
167	Rajkot	Rajkot		-		-
168	Rajkot	Tankara		-	-	-
169	Rajkot	Upleta		-	-	-
170	Rajkot	Wankaner			-	-
171	Sabar Kantha	Bayad	-			-
172	Sabar Kantha	Bhiloda	-		-	-
173	Sabar Kantha	Dhansura	-	-	-	-
174	Sabar Kantha	Himatnagar	-	-	-	-
175	Sabar Kantha	Idar	-		-	-
176	Sabar Kantha	Khedbrahma	-	-	-	-
177	Sabar Kantha	Malpur	-	-	-	-
178	Sabar Kantha	Meghraj	-			-
179	Sabar Kantha	Modasa				-
180	Sabar Kantha	Prantij	-		-	-
181	Sabar Kantha	Talod				-
182	Sabar Kantha	Vadali	-		-	-
183	Sabar Kantha	Vijaynagar	-			-
184	Surat	Bardoli	-	-	-	-
185	Surat	Chorasi	27%	37%	51%	60%
186	Surat	Kamrej	-	-	-	-
187	Surat	Mahuva	-			-
188	Surat	Mandvi	-			-
189	Surat	Mangrol	-			-
190	Surat	Nizar	-	-		-
191	Surat	Olpad	8%	12%	33%	47%
192	Surat	Palsana	-	-		-
193	Surat	Songadh	-	-		-
194	Surat	Surat City	-	-		4%
195	Surat	Uchchhal	-	-		-
196	Surat	Umarpada	-	-		-
197	Surat	Valod	-	-		-
198	Surat	Vyara	-	-		-
199	Surendranagar	Chotila	-	-		-
200	Surendranagar	Chuda	-	-		-
201	Surendranagar	Dasada	-	-	-	-
202	Surendranagar	Dhrangadhra	-	-		-
203	Surendranagar	Halvad		-		-
204	Surendranagar	Lakhtar	-	-		-
205	Surendranagar	Limbdi	-	-	-	-
206	Surendranagar	Muli	-	-	-	-
207	Surendranagar	Sayla		-		-
208	Surendranagar	Wadhwan	-	-		-
209	The Dangs	The Dangs	-	-	-	-
210	Vadodara	Chhota Udaipur	-	-		-
211	Vadodara	Dabhoi	-	-		-
212	Vadodara	Jetpur Pavi	-	-		-
213	Vadodara	Karjan	-	-	-	-
214	Vadodara	Kavant	-	-		-
215	Vadodara	Nasvadi	-	-	-	-
216	Vadodara	Padra	-	-	2%	4%
217	Vadodara	Sankheda	-	-	-	-
218	Vadodara	Savli	-			-
219	Vadodara	Sinor	-	-		-
220	Vadodara	Vadodara	-	-		-
221	Vadodara	Vaghodia	-	-	-	-
222	Valsad	Dharampur	-	-	-	-
223	Valsad	Kaprada	-	-	-	-
224	Valsad	Pardi	2%	2%	2%	4%
225	Valsad	Umbergaon	11%	13%	15%	17%
226	Valsad	Valsad	16%	18%	19%	22%

FLOOD HAZARD RISK

FLOODS IN GUJARAT

Unlike widely believed, Gujarat has seen many damaging floods. Almost all major rivers in the state pass through a wide stretch of very flat terrain (often more than 50 km) before reaching the sea. These flat lowlands of lower river basins are prone to flooding.



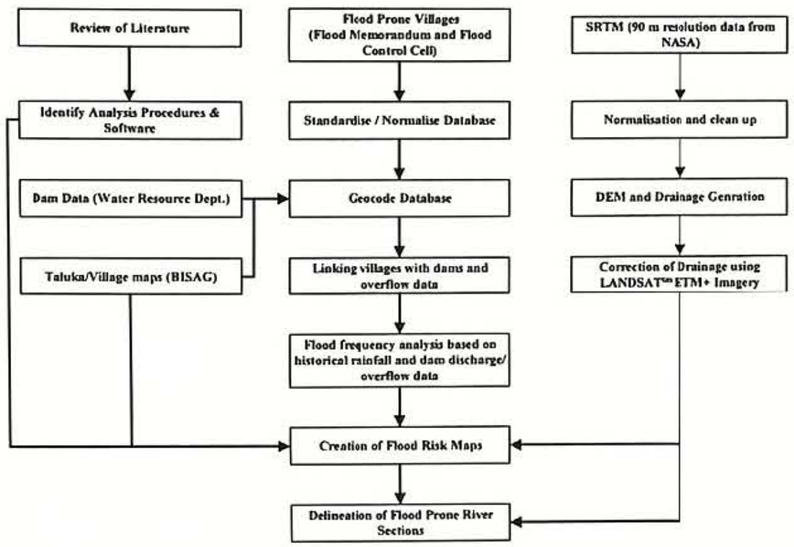
Rainfall in this region mostly occurs in spells associated with depressions originating in the Bay of Bengal, passing across the country and curving over Rajasthan and northern Gujarat (CAZRI, 1983). These downpours can result in severe floods in parts of Rajasthan and Gujarat, the impact of which can extend into the flat alluvial plains of central Gujarat.

Once in a decade the heaviest rainfall can be twice the mean in many talukas of Gujarat. These heavy rainfall years often lead to major floods.

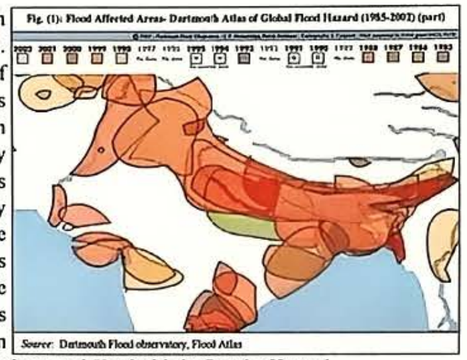
The one-day Probable Maximum Precipitation (PMP) is often higher than the average annual rainfall in most parts of Saurashtra and Kachchh. Occasional cyclones and depressions also cause heavy rainfall in large parts of Saurashtra, Kachchh, central and northern Gujarat. Floods are reported almost every third year in the less developed districts of Gujarat, located in Saurashtra, Kachchh and northern Gujarat. The cities of Ahmedabad, Surat and Bharuch are also located on the flat alluvial plains of large rivers (Bhat, 1999).

FLOOD HAZARD RISK ANALYSIS FOR GUJARAT

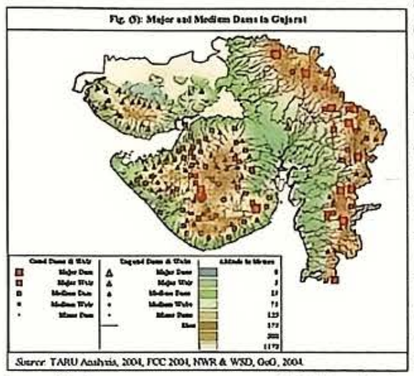
A methodology used for Flood Hazard Risk Analysis is presented below.



The Saurasthra and Kachchh regions are surrounded by the sea. The convective upwelling of humid air over these land masses cools as the air mass rises can result in humid air quickly reaching saturation conditions and resulting in heavy downpours. Favourable conditions for these events happen occasionally during the monsoons. The Dartmouth Atlas of Global Floods shows that, in addition to south Gujarat, Saurashtra and Kachchh is flood affected.



There are only two major dams in Saurashtra. Saurashtra and Kachchh also have many small dams that have large catchments compared to their storage capacity and have to discharge flood waters in case of heavy rainstorms. These dams can overflow at least once every three to four years during heavy rainstorms.



With large dams on the upper catchments of Mahi, Banas and Sabarmati, the situation is similar. Flood discharges are common during heavy rainstorms since extreme rainfall figures are either equal or near the annual mean rainfall values in all these basins. Sudden recurrent releases following heavy rainstorms are often resorted to as rule levels are typically kept high to ensure water availability during normal and drought years.

DATA SOURCES

The primary data sources utilized include:

1. Major, Medium and Minor Projects of Gujarat (1989): salient features of dams
2. Flood Memorandum 2003(FM): flood prone villages, danger levels
3. Flood Control Cell (FCC) data: flood prone villages, reservoir level data,overflows from dams
4. State Water Data Centre data: river gauge data
5. SAGE-Wisconsin database on river discharges: discharges of major rivers
6. Global Runoff Data Centre (GRDC) database: discharges of major rivers
7. Global River Discharge (GRD) database: discharges of major rivers
8. Raw SRTM data: terrain data
9. Dartmouth Flood Observatory: flood atlas

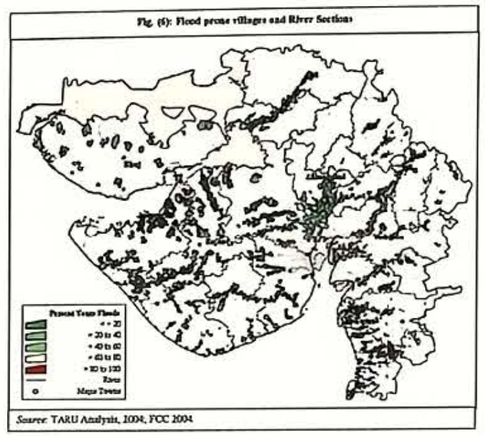
FLOOD MODELLING

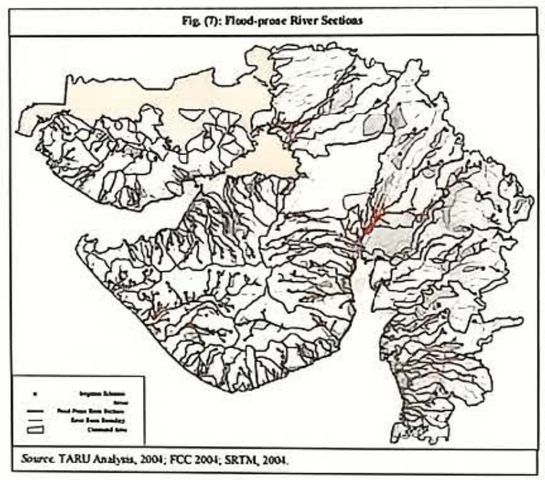
Flood risk is assessed in terms of the potential area that would be affected and the frequency of occurrence of flood events. A simple and robust method of flood mapping of villages, and frequency of reported flood discharges over the last 14 years for which continuous data is available were used to derive settlement level flood risk represented as percentage of years of flooding.

FLOOD RISK ZONATION

The figure shows that almost all parts of Gujarat are flood prone, irrespective of the size of the catchment.

The flood risk in Saurashtra is lower than that of the south Gujarat plains. The relatively flat plains in the lower basin areas with hilly catchments in upper parts of south Gujarat accentuate flood risks. Few villages in the north Gujarat are flood prone.





The flood prone river sections were identified from settlement level analysis. Flood prone river sections in Saurashtra extend to the upper basins due to the presence of dams which have to resort to emergency discharge during heavy rainstorms. Even small valleys in Saurashtra are used for agriculture. Hence, flooding in these zones impacts both residents and settlements.

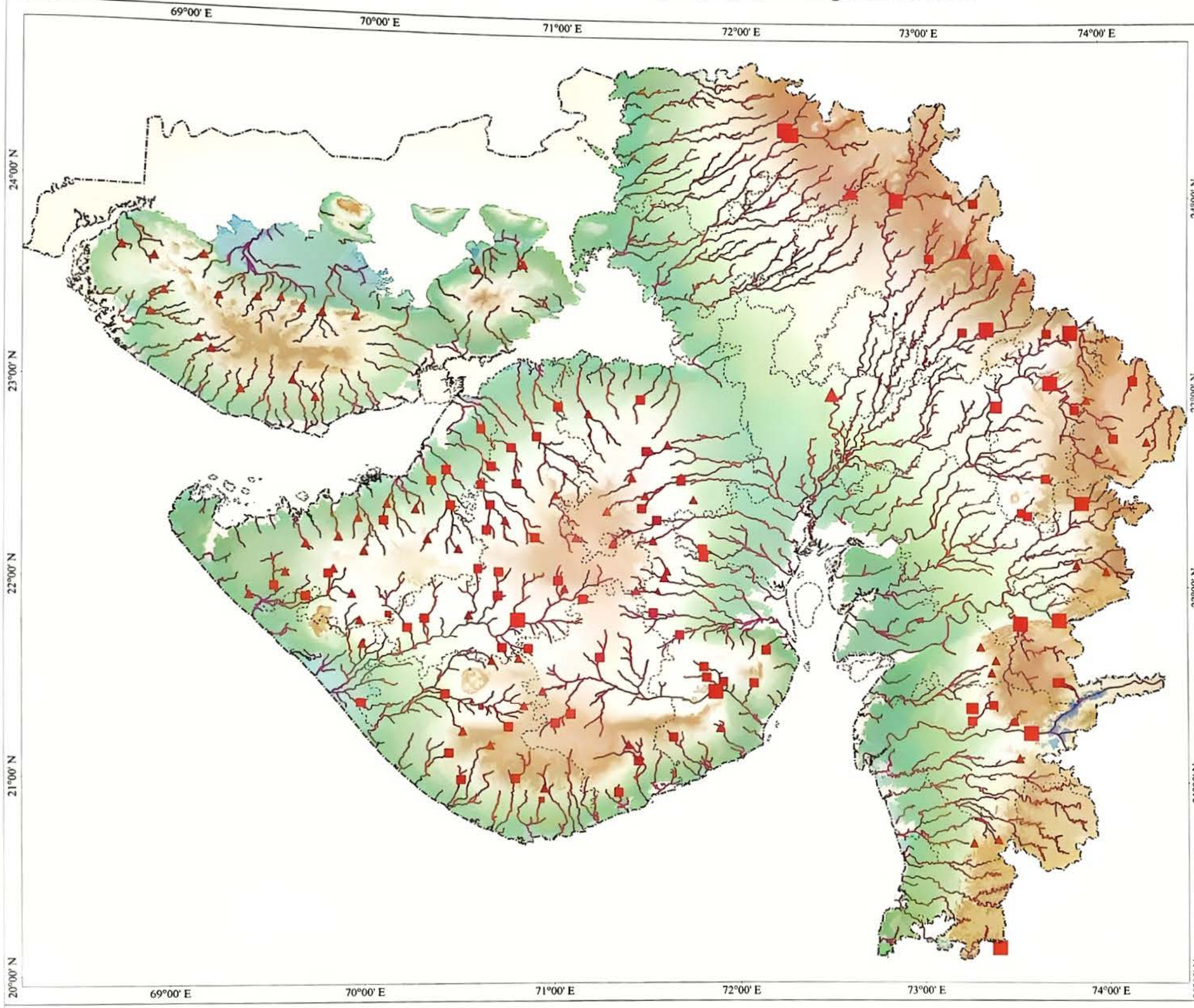
CONCLUSIONS

The Gujarat flood risk zonation identifies settlements in north, central and south Gujarat. In addition, it identifies flood prone areas in Saurashtra and Kachchh regions for the first time. The ratio of the IX decile rainfall across the state indicates that the peak rainfall in Kachchh and Saurashtra can be as high as 1,000 mm or more against an average rainfall of less than 600 mm. While dams are typically designed for 75 percent availability of runoff, these heavy rainstorm events often result in flooding irrespective of the presence or absence of dams in the upper catchments.

The flood risk assessed by this exercise is indicative of the last 14 years of data. These maps need to be updated to reflect the long-term rainfall patterns and man-made modifications to surface hydrology, as and when such datasets are available. With large scale implementation of water conservation works underway, flood risks are likely to change significantly and should be reflected in regularly updated zonation maps.

It must be noted that the new dams and irrigation canals being planned and under construction phase (e.g. the Narmada canal network), are expected to cause significant changes in hydrology. Both canals and the road network can have profound impact on natural drainage - aspects that need to be taken in to consideration. Basin level data is necessary to assess flood risks using computer models. This needs to be done when the implementation of mitigation works is complete and flood data of these regions is available.

Gujarat Flood Hazard Risk Zonation: Physiography & Irrigation Schemes



GSDMA

LEGEND

Gated Dams & Weir
- Major Dam
- Major Weir
- Medium Dam
- Medium Weir
- Minor Dam

Ungated Dams & Weirs
- Major Dams
- Major Weir
- Medium Dams
- Medium Weirs
- Minor Dams
- River

Altitude in Meters
- 0
- 2
- 5
- 10
- 25
- 50
- 75
- 100
- 125
- 150
- 175
- 200
- 225
- 300
- 1170

Source : GSDMA; Flood Control Cell, GoG;
SWDC; Flood Memorandum, 2003, NWRWSD;
Major, Medium & Minor Projects of Gujarat, 1989;
Narmada, Water Resources and Supply Department, GoG;
Dartmouth Flood Observatory, 2004,
(http:\www.dartmouth.edu\~floods\reaches);
Centre for Sustainability and the Global Environment, 2004,
(http:\www.sage.wisc.edu\riverdata\);
Global Runoff Data Centre, 2004,
(http:\www.bafg.de\grdc.htm); BISAG, GoG.

0 100 km

N

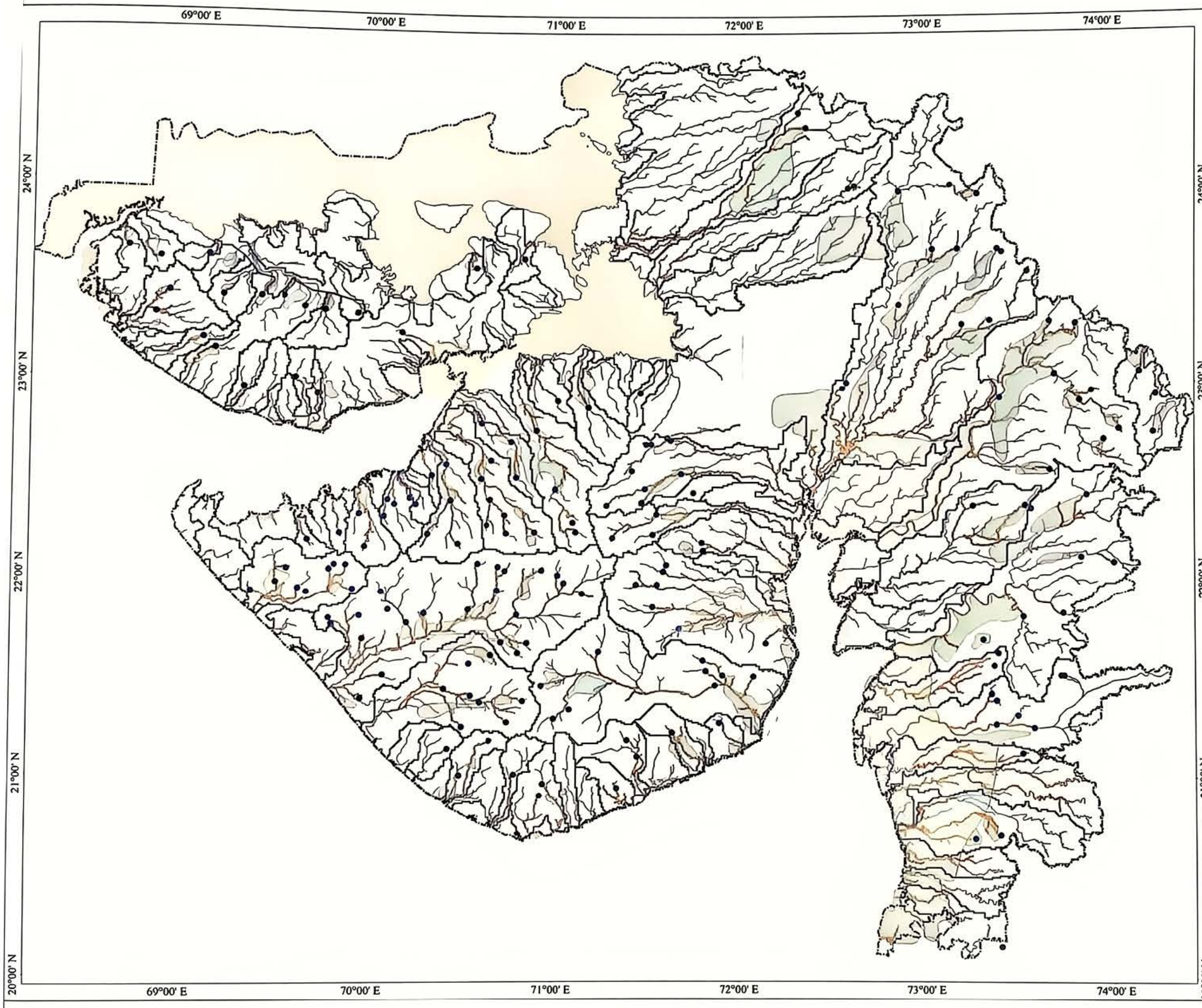
Projection : Lambert Azimuthal Equal Area
Datum : WGS 84

MAP No. : HFLM - 01 OF 03

Date : 25/7/2005

Gujarat Flood Hazard Risk Zonation: Drainage, Irrigation & Flood-Prone River Sections

GSDMA



LEGEND

- Irrigation Schemes
- Rivers
- Flood-Prone River Sections
- River Basin Boundary
- Command Area

Source: GSDMA; Flood Control Cell, GoG;
SWDC; Flood Memorandum, 2003, NWRWSD;
Major, Medium & Minor Projects of Gujarat, 1989;
Narmada, Water Resources and Supply Department, GoG;
Dartmouth Flood Observatory, 2004,
(http:\www.dartmouth.edu\~floods\reaches);
Centre for Sustainability and the Global Environment, 2004,
(http:\www.sage.wisc.edu\riverdata\);
Global Runoff Data Centre, 2004,
(http:\www.bafg.de\grdc.htm); BISAG, GoG.

0 100 km

N

Projection : Lambert Azimuthal Equal Area
Datum WGS 84

MAP No. : HFLM - 02 OF 03

Date : 25/7/2005

Gujarat Flood Hazard Risk Zonation: Settlement-wise Flood Frequency

GSDMA

69°00' E 70°00' E 71°00' E 72°00' E 73°00' E 74°00' E

24°00' N 23°00' N 22°00' N 21°00' N 20°00' N

Bhuj
Jamnagar
Rajkot
Ahmadabad
Vadodara
Surat

LEGEND

Percent Years of Dam Overflow

- < = 20
- > 20 to 40
- > 40 to 60
- > 60 to 80
- > 80 to 100

Flood-Prone River Sections
River
Major Towns
Flood Zone*

*based on BISAG & Vulnerability Atlas of India

Based on 14 years of dam overflow data, Dam-wise flood-prone village database, Global Runoff Data Centre data & SAGE databases.

Source: GSDMA; Flood Control Cell, GoG;
SWDC; Flood Memorandum, 2003, NWRWSD,
Major, Medium & Minor Projects of Gujarat, 1989;
Narmada, Water Resources and Supply Department, GoG;
Dartmouth Flood Observatory, 2004,
(http:\www.dartmouth.edu\~floods\reaches),
Centre for Sustainability and the Global Environment, 2004,
(http:\www.sage.wisc.edu\riverdata\);
Global Runoff Data Centre, 2004,
(http:\www.bafg.de\grdc.htm); BISAG, GoG.

0 100 km

N

Projection : Lambert Azimuthal Equal Area
Datum : WGS 84

MAP No. : HFLM - 03 OF 03

Date : 25/7/2005

CHEMICAL HAZARD RISK

INDUSTRIAL PROFILE

Gujarat is one of the most industrialized states in India. It is known for its large concentration of chemical industries, particularly in the 400 km stretch from Ahmedabad to Vapi known as the 'Golden Corridor'. In Bharuch district, Ankleshwar situated on the Narmada estuary, is Asia's largest chemical zone.

Chemical industry occupies a pre-eminent position in Gujarat's industrial sector, contributing to more than 40 percent of its industrial output. Gujarat contributes more than 20 percent of India's chemical production. Rubber and plastic products, and chemical industries account for more than 70 percent of the state production in medium and large industries followed by food products, basic metals and textiles.

More than 50 percent of the new investments in the state are in the chemical and petrochemical sector. Major hydrocarbon complexes are located in Vadodara, Bharuch, Surat and Jamnagar districts. Petrochemical complexes are located at Vadodara, Dahej, Hazira and Jamnagar. Caustic and chlorine manufacturing plants are located at Mithapur, Veraval, Surendranagar, Vadodara, Dahej, Jhagadia and Atul. Toxic chemicals like cyanides are produced in GACL Baroda, and Cyanides & Chemicals at Surat and Olpad.

There are several port-based installations for petroleum products, gas, petrochemicals products, solvents and other hazardous chemicals at Kandla, Mundra, Vadinar, Porbandar, Dahej, Pipavav and Hazira.

INDUSTRIAL HAZARD CATEGORISATION OF DISTRICTS

TABLE (2): CHEMICAL AND INDUSTRIAL HAZARD

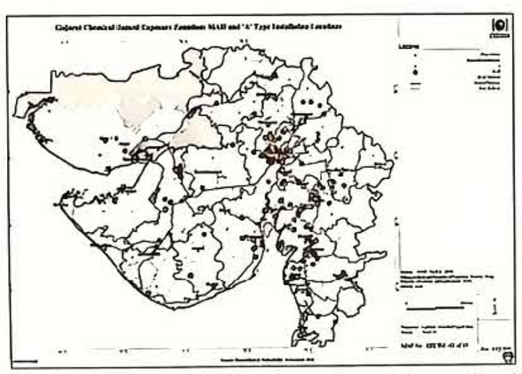
S. No	Category	Districts
1	AA Category (Highly Hazardous)	Bharuch and Vadodara
2	A Category (Hazardous)	Ahmedabad, Jamnagar, Kachchh, Rajkot, Surat, and Valsad.
3	B Category (Less Hazardous)	Anand, Bhavnagar, Gandhinagar, Kheda, Mehsana, Panchmahals and Porbandar.
4	C Category (Much less Hazardous)	Amreli, Banaskantha, Dahod Dangs, Junagadh, Narmada, Navsari, Patan, Sabarkantha and Surendranagar.

Source: GSDMA (2001). State Level Response Plan for Chemical, industrial and Nuclear Hazards Gujarat. High Powered Committee (HPC) GoI.

The Government of Gujarat has categorized districts on the basis of chemical and industrial hazard category as presented in the adjoining table. Bharuch and Vadodra have large volumes of stored toxic gases such as chlorine and ammonia. The quantity of toxic substances being stored and processed within these two districts is far more than the total of other districts.

The concentration of toxic chemicals is higher in these districts as the GIDC encourages installations of chemical units in designated industrial estates. The GIDC maintains fire tenders in the industrial estates to respond to chemical emergencies.

The density of MAH installations suggests that Ahmedabad, Bharuch, Vadodra, Valsad, and Surat have the largest concentration of MAH units. Vadodra, Dahej, Hazira and Jamnagar have major petrochemical complexes.



A large number of medium and small-scale chemical industries are located in the industrial estates of Vapi, Anklesvar, Panoli, Nandesari, Vatva and Naroda, which produce numerous organic chemicals for domestic and international consumption.

CHEMICAL HAZARD CLASSIFICATION

Chemical hazards in India are classified according to their potential impact or consequences, as defined by the provisions of the Manufacture, Storage and Import of Hazardous Chemical Rules, 1989. The UN Classification of Chemicals classifies the consequences of accidental chemical releases as follows:

TOXIC RELEASES

Severe injury or death as a consequence of individual exposure to a toxin at a rate of exposure higher than the body's ability to metabolize it.

FLAMMABLE / EXPLOSIVE RELEASES

The release of clouds of flammable gases or vapours causing one or more of the following outcomes:

- Pool Fire: burning of large puddles of fluid
- Jet Fire: fire from pressurized gas or liquid escaping from a hole
- Boiling Liquid, Expanding Vapour Explosion (BLEVE): explosive release of expanding vapour and boiling liquid following the catastrophic failure of a pressurized vessel holding a liquefied gas, such as propane
- Vapour Cloud Fire: flash fire
- Vapour Cloud Explosion: violent flash fire

CHEMICAL HAZARD EXPOSURE ASSESSMENT

A five-stage method was used to undertake chemical hazard exposure assessment:

- Review of literature and evaluation of multiple consequence models
- Facility identification i.e. collation of Gujarat-wide MAH & A-type industries and hazardous chemical storage, handling and processing types and volumes
- Identification and classification of hazardous chemicals in these facilities
- Scenario definition to estimate metrological stability, definition of the quantity and rate of release of hazardous chemicals and their levels of concern or toxic endpoints consequence analysis
- Risk estimation based on historical event catalogue (not carried out due to inadequate accident catalogue)

CONSEQUENCE MODELS

The Arial Locations of Hazardous Atmospheres (ALOHA™) and Automated Resource for Chemical Hazard Incident Evaluation (ARCHIE) models were found to be most appropriate for this chemical hazard risk assessment. RMP*Comp™ is an automated version of the RMP Offsite Consequence Analysis Guidance, a US EPA handbook describing how to perform RMP consequence analyses.

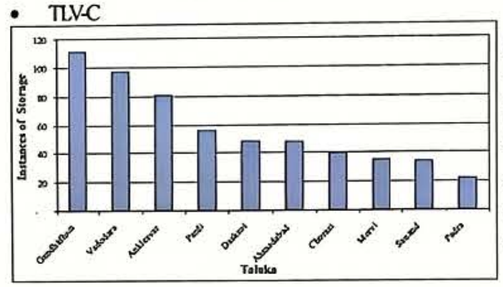
Of the three models, ARCHIE was selected as it provided flexibility in data input and is capable of modelling fire and explosion related hazards. ALOHA, has an artificial distance cut-off of 6 miles (10 km) (i.e. any scenario which would result in an endpoint distance beyond 6 miles is reported as "greater than 6 miles"). ARCHIE on the other hand, can model consequence distance up to 40 km but modelling uncertainties increase as boundary conditions (e.g. atmospheric stability, wind speed, surface roughness) are not likely to remain constant over large distances.

In this assignment, modelling of Oleum / Sulphuric Acid, Chlorine and Ammonia has been undertaken using RMP* Comp™. This software provides more conservative and accurate results as its estimates are based on experimental data from industry specific chemicals. All chemicals have been modelled for atmospheric stability class F and a wind speed of 1.5 m/sec.

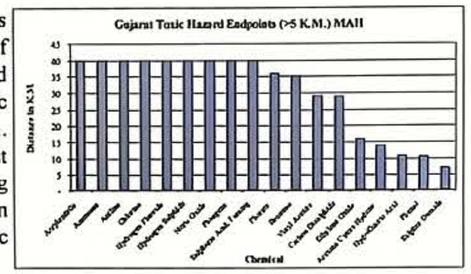
LEVEL OF CONCERN

Pragmatic options (in order of decreasing preference) are as follows:

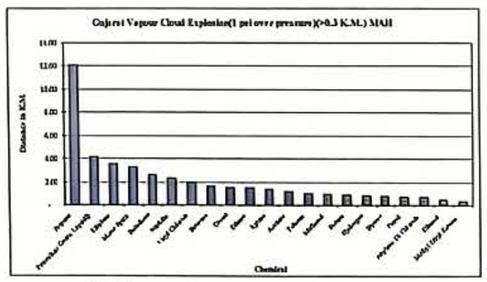
- Use the NAS/NRC SPEGL or the AIHA ERPG-2 value for the material if one has been established.
- Use the highest value among the following:
- IDLH1 value divided by 10 (10 being a safety factor)
- TLV-STEL
- TLV-TWA multiplied by 3 (if a TLV-STEL does not exist)
- TLV-C



Incidence of chemical storage in MAH installations is highest in Gandhidham with its large tank farms. It is closely followed by Vadodara and Ankleshvar. The storage of HAZCHEM in such quantities places these and the surrounding talukas at higher risk.



Toxic endpoints for MAH installations depict the contribution of a group of widely used chemicals that are stored in massive quantities and have toxic endpoints of greater than 40 km. Chlorine and Ammonia are the most important. Other chemicals including Acrylonitrile, Aniline Hydrogen Flouride, Hydrogen Sulphide, Nitric Oxide, Phosgene and Oleum.



Vapour Cloud Explosion hazard (1 psi overpressure) was estimated at maximum endpoint of 12 km in the state due to storage of liquefied propane at natural temperature and pressure. Other chemicals (including liquefied petroleum gas) have endpoints lower than 2.5 km.

Pool Fire radiation hazard has a maximum reach of 2.5 km due to the storage of inflammable chemical motor spirit or petrol, followed by other petrochemical derivatives due to the presence of large processing and storage units within the state.

CONCLUSIONS

Toxic endpoint distances for some installations are capable of travelling more than 40 kms as estimated in these analyses. Although the Pool Fire and Vapour Cloud Explosion hazards may be of a lower order than the toxic hazard risk, they are still a matter of concern.

Gandhidham, Vadodara and Anklesvar could have the highest chemical accident risk exposures owing to a large number of maximum instances of HAZCHEM storage in MAH installations and their resultant endpoints.

There is a need to prepare a detailed historical event catalogue for chemical related accidents in Gujarat and scenarios / causes of releases to undertake hazard risk assessment across the state.

Gujarat Chemical Hazard Exposure Zonation: MAH and 'A' Type Installation Locations

GSDMA

69°00' E 70°00' E 71°00' E 72°00' E 73°00' E 74°00' E

24°00' N 23°00' N 22°00' N 21°00' N 20°00' N

Lakhpat
Jakhau
Bhuj
Anjar
Gandhidham
Jamnagar
Dwarka
Porbandar
Junagadh
Una
Rajula
Amreli
Botad
Bhavnagar
Surendranagar
Palanpur
Siddhapur
Mahesana
Himatnagar
Ahmedabad
Kheda
Anand
Vadodara
Godhra
Dahod
Bharuch
Ankleshwar
Surat
Songadh
Navsari
Valsad
Vapi

LEGEND

- Major Towns
- **Types of Installations**
- 'A' Type
- MAH Type
- **Road Network**
- National Highway

Source: TARU Analysis, 2004;
Office of the Chief Inspector of Factories, Factory Wing, Ministry of Labour and Employment, GoG; BISAG, GoG.

0 100 km

N

Projection : Lambert Azimuthal Equal Area
Datum : WGS 84

MAP No.: HCHM - 01 OF 05

Date 25/7/2005

Gujarat Chemical Hazard Exposure Zonation: MAH Installations (All Chemical Hazards)

GSDMA

69°00' E 70°00' E 71°00' E 72°00' E 73°00' E 74°00' E

24°00' N 23°00' N 22°00' N 21°00' N 20°00' N

LEGEND

Hazard Type

Toxic Release

Pool Fire Radiation

Vapour Cloud Explosion
(1 psi overpressure)

Source : TARU Analysis, 2004;
Office of the Chief Inspector of Factories, Factory Wing, Ministry of Labour and Employment, GoG;
ARCHIE (Automated Resource for Chemical Hazard Incident Evaluation), FEMA, USDOT, and USEPA;
RMP COMP, NOAA and USEPA; BISAG, GoG.

0 100 km

N

Projection : Lambert Azimuthal Equal Area
Datum : WGS 84

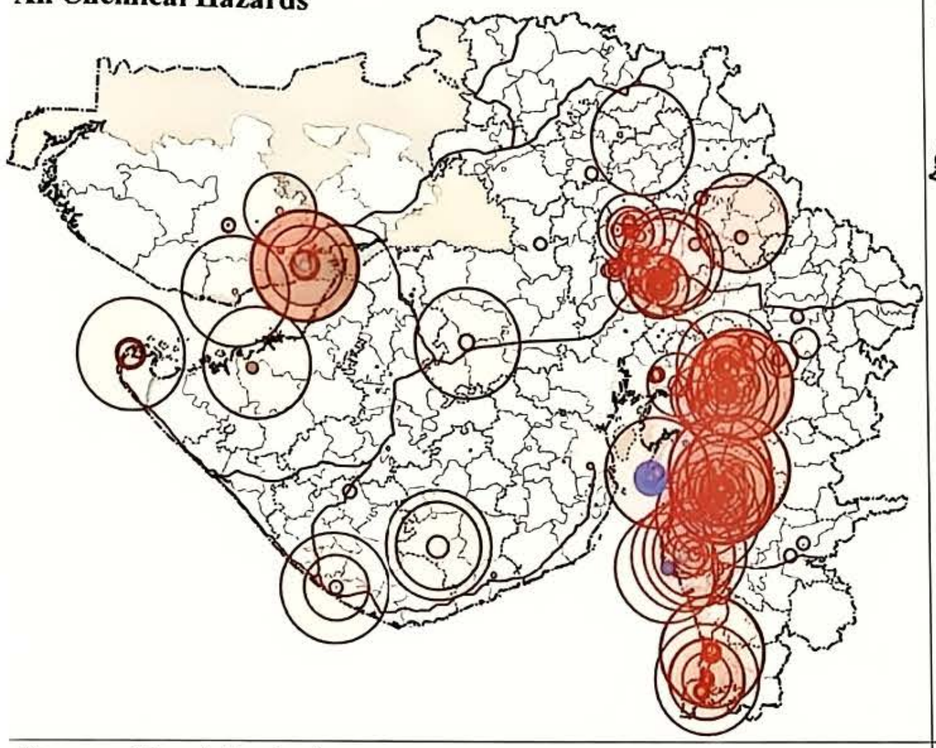
MAP No.: HCHM - 02 OF 05

Date : 13/7/2005

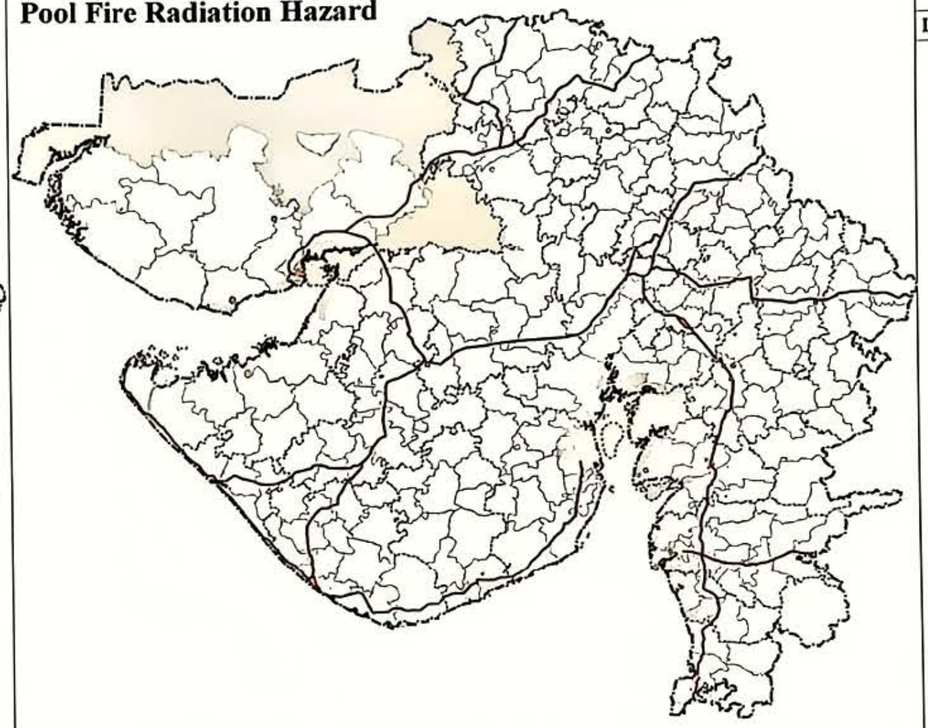
Gujarat Chemical Hazard Exposure Zonation: Toxic,Vapour Cloud & Pool Fire Hazard for MAH Installations

GSDMA

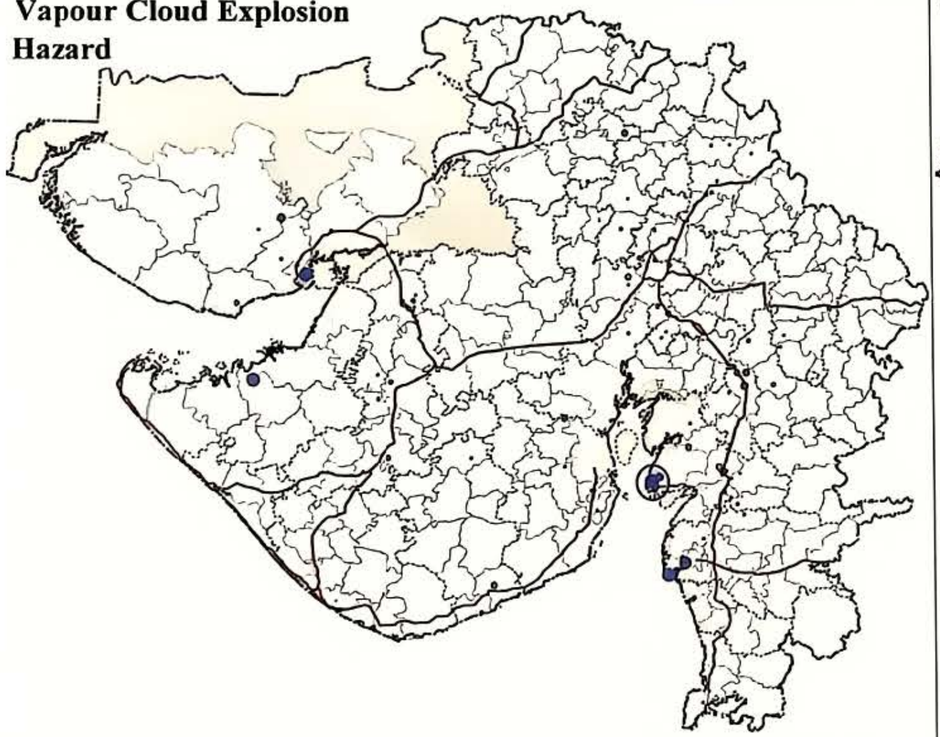
All Chemical Hazards



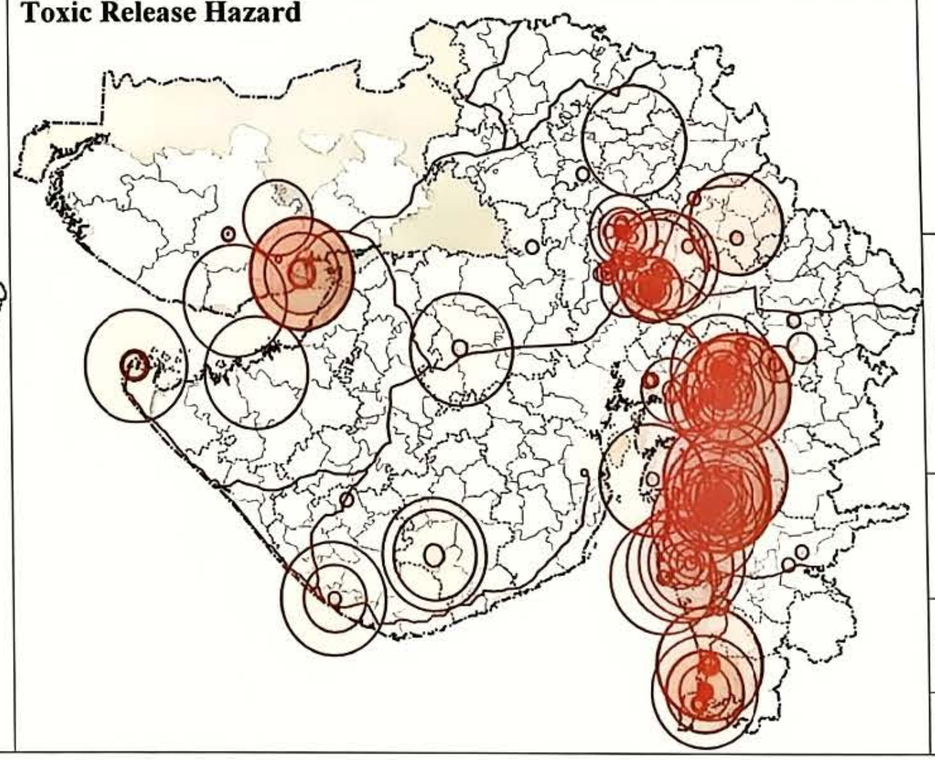
Pool Fire Radiation Hazard



Vapour Cloud Explosion Hazard



Toxic Release Hazard



LEGEND

Hazard Type

- Toxic Release
- Pool Fire Radiation
- Vapour Cloud Explosion (1 psi overpressure)

Source : TARU Analysis, 2004;
Office of the Chief Inspector of Factories, Factory Wing, Ministry of Labour and Employment, GoG;
ARCHIE (Automated Resource for Chemical Hazard Incident Evaluation), FEMA, USDOT, and USEPA;
RMP COMP, NOAA and USEPA; BISAG, GoG.

0 100 km

N

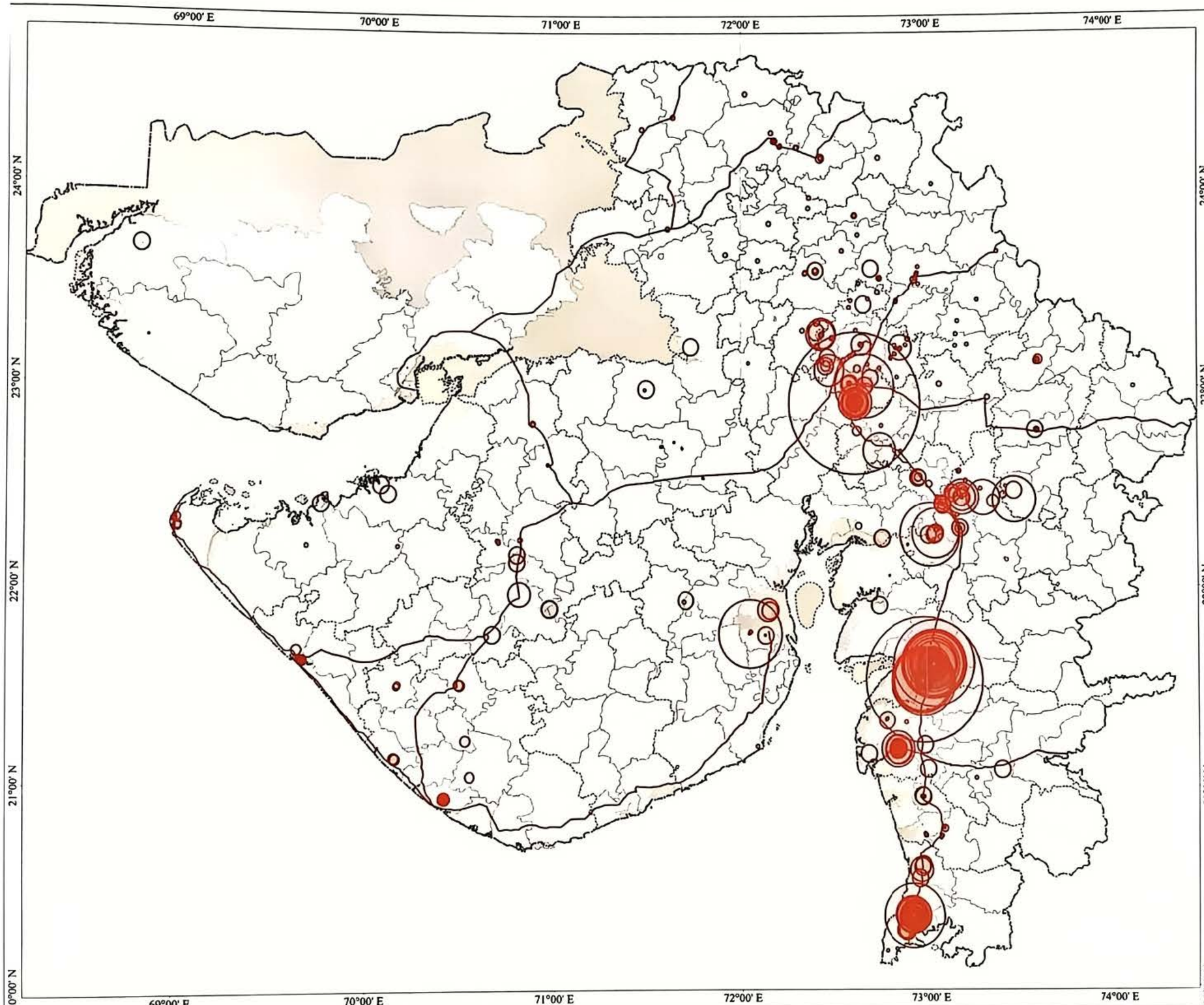
Projection : Lambert Azimuthal Equal Area
Datum : WGS 84

MAP No.: HCHM - 03 OF 05

Date : 13/7/2005

Gujarat Chemical Hazard Exposure Zonation: 'A' Type Installations (All Chemical Hazards)

GSDMA



LEGEND

Hazard Type
Toxic Release
Pool Fire Radiation
Vapour Cloud Explosion
(1 psi overpressure)

Source : TARU Analysis, 2004;
Office of the Chief Inspector of Factories, Factory Wing, Ministry of Labour and Employment, GoG;
ARCHIE (Automated Resource for Chemical Hazard Incident Evaluation), FEMA, USDOT, and USEPA;
RMP COMP, NOAA and USEPA; BISAG, GoG.

0 100 km

N

Projection : Lambert Azimuthal Equal Area
Datum : WGS 84

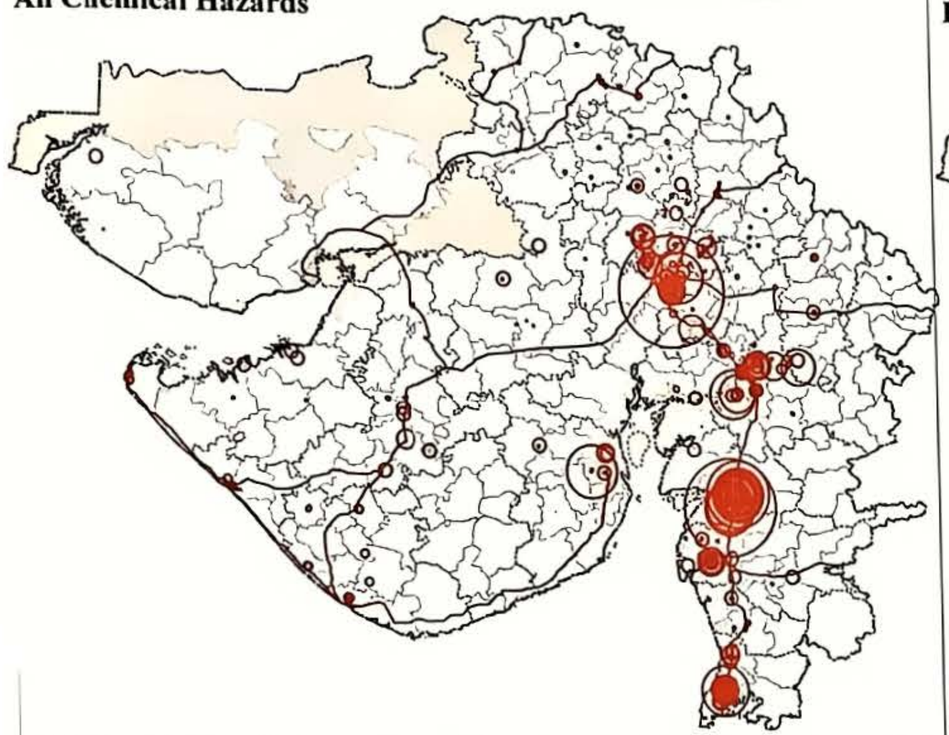
MAP No.: HCHM - 04 OF 05

Date : 13/7/2005

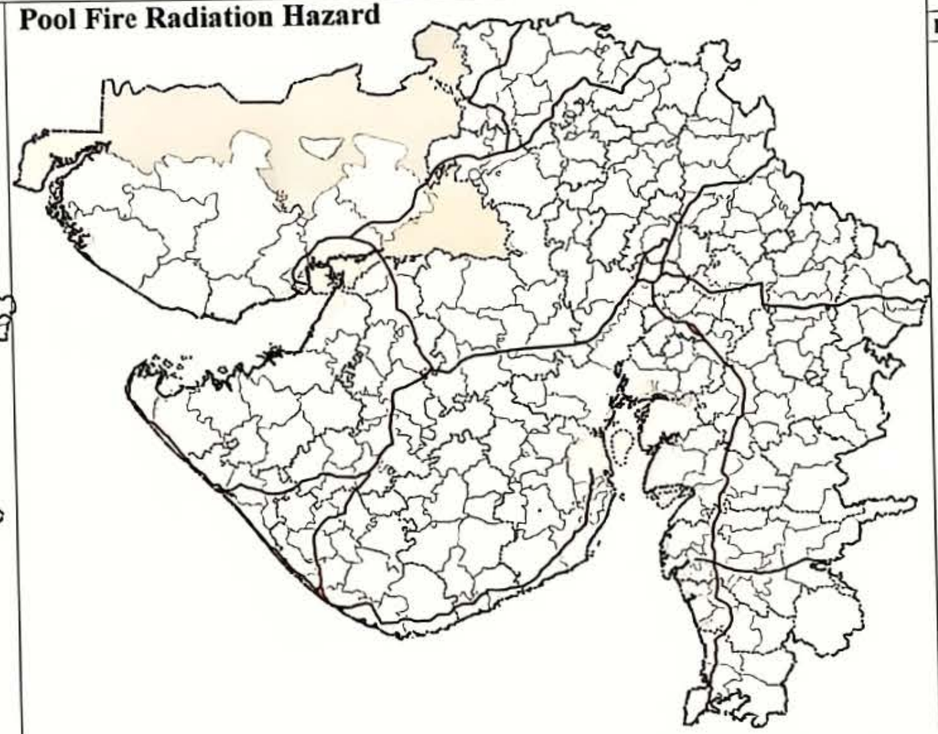
Gujarat Chemical Hazard Exposure Zonation : Toxic, Vapour Cloud & Pool Fire Hazard for 'A' Type Installations

GSDMA

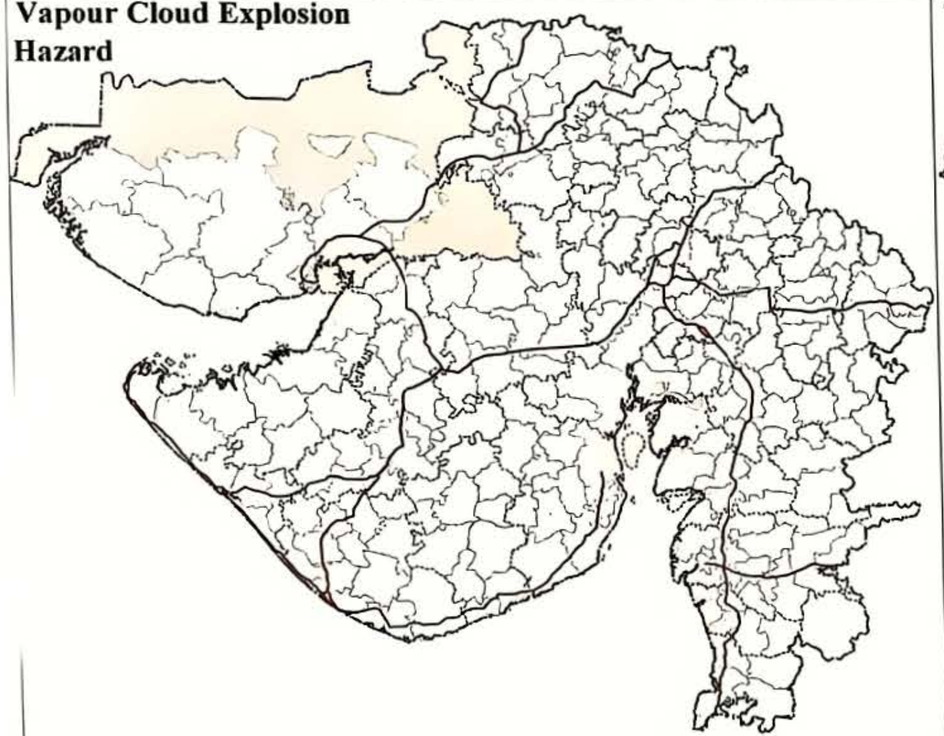
All Chemical Hazards



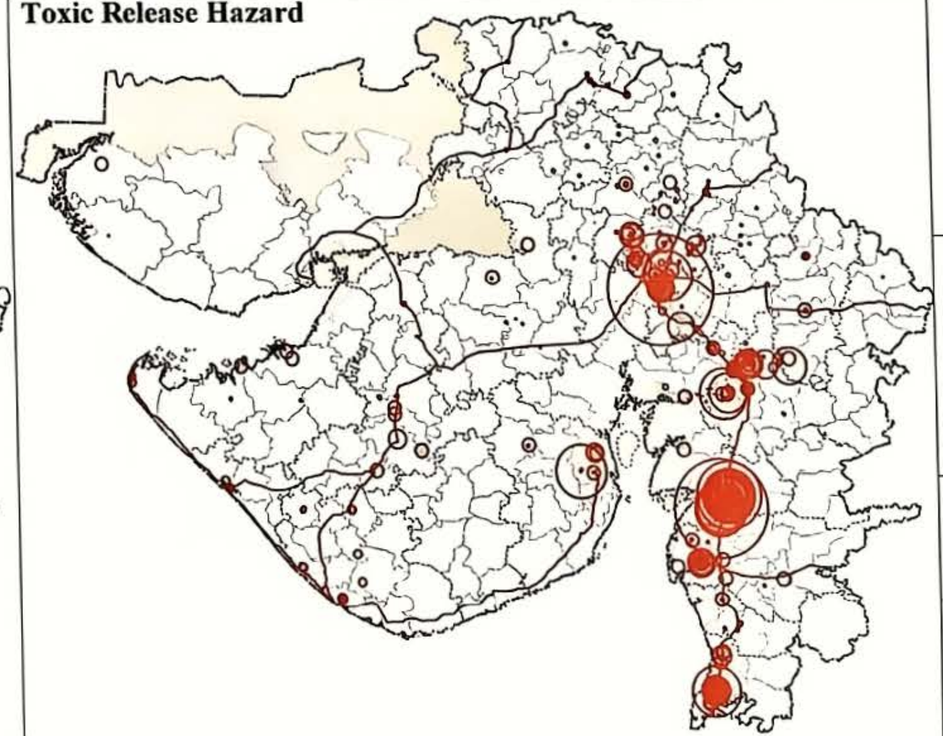
Pool Fire Radiation Hazard



Vapour Cloud Explosion Hazard



Toxic Release Hazard



LEGEND

Hazard Type
Toxic Release
Pool Fire Radiation
Vapour Cloud Explosion
(1 psi overpressure)

Source : TARU Analysis, 2004;
Office of the Chief Inspector of Factories, Factory Wing, Ministry of Labour and Employment, GoG;
ARCHIE (Automated Resource for Chemical Hazard Incident Evaluation), FEMA, USDOT, and USEPA;
RMP COMP, NOAA and USEPA; BISAG, GoG.

0 100 km

N

Projection : Lambert Azimuthal Equal Area
Datum : WGS 84

MAP No.: HCHM - 05 OF 05

Date : 13/7/2005

GUJARAT CHEMICAL HAZARD EXPOSURE ZONATION :TALUKA WISE INCIDENCE OF CHEMICAL STORAGE ACROSS MAH AND "A" TYPE INSTALLATIONS. Table No. HCHT - 01 of 01

GSDMA

Sr. No	District	Taluka	MAH	A Type	Total Instances
115	Kheda	Thasra	-	-	
116	Kheda	Virpur	-		
117	Mahesana	Becharaji	-	-	-
118	Mahesana	Kadi	10	11	21
119	Mahesana	Kheralu	1	3	4
120	Mahesana	Mahesana	1	5	6
121	Mahesana	Satlasana	-	-	-
122	Mahesana	Unjha	-	-	-
123	Mahesana	Vadnagar	-	1	1
124	Mahesana	Vijapur	-	8	8
125	Mahesana	Visnagar	-	1	1
126	Narmada	Dediapada	-	-	-
127	Narmada	Nandod	-	-	-
128	Narmada	Sagbara	-	-	-
129	Narmada	Tilakwada	-	-	-
130	Navsari	Bansda	-	-	-
131	Navsari	Chikhli	-	6	6
132	Navsari	Gandevi	-	3	3
133	Navsari	Jalalpore	-	-	-
134	Navsari	Navsari	3	8	11
135	Panch Mahals	Ghoghamba	1	-	1
136	Panch Mahals	Godhra	1	4	5
137	Panch Mahals	Halol	4	4	8
138	Panch Mahals	Jambughoda	-	-	-
139	Panch Mahals	Kadana	-	-	-
140	Panch Mahals	Kalol	3	1	4
141	Panch Mahals	Khanpur	-	-	-
142	Panch Mahals	Lunavada	-	4	4
143	Panch Mahals	Morwa (Hadaf)	-	-	-
144	Panch Mahals	Santrampur	-	-	-
145	Panch Mahals	Shehera	-	-	-
146	Patan	Chanasma	1	1	2
147	Patan	Harij	-	1	1
148	Patan	Patan	-	1	1
149	Patan	Radhanpur	1	1	2
150	Patan	Sami	-	-	-
151	Patan	Santalpur	-	-	-
152	Patan	Sidhpur	6	1	7
153	Patan	Vagdod	-	-	
154	Porbandar	Kutiyana	-	-	
155	Porbandar	Porbandar	-	21	21
156	Porbandar	Ranavav	-	-	-
157	Rajkot	Dhoraji	-	-	-
158	Rajkot	Gondal	1	2	3
159	Rajkot	Jamkandorna	-	-	-
160	Rajkot	Jasdan	-	2	2
161	Rajkot	Jetpur	1	1	2
162	Rajkot	Kotda Sangani	-	1	1
163	Rajkot	Lodhika	2	5	7
164	Rajkot	Maliya	-	-	-
165	Rajkot	Morvi	35	4	39
166	Rajkot	Paddhari	1	-	1
167	Rajkot	Rajkot	11	1	12
168	Rajkot	Tankara	-	-	-
169	Rajkot	Upleta	-	-	-
170	Rajkot	Wankaner	9	3	12
171	Sabar Kantha	Bayad	1	3	4
172	Sabar Kantha	Bhiloda	2	1	3
173	Sabar Kantha	Dhansura	3	1	4
174	Sabar Kantha	Himatnagar	5	9	14
175	Sabar Kantha	Idar	2	-	2
176	Sabar Kantha	Khedbrahma	-	1	1
177	Sabar Kantha	Malpur	-	-	-
178	Sabar Kantha	Meghraj	-	-	-
179	Sabar Kantha	Modasa	-	1	1
180	Sabar Kantha	Prantij	8	2	10
181	Sabar Kantha	Talod	-	-	-
182	Sabar Kantha	Vadali	-	-	-
183	Sabar Kantha	Vijaynagar	-	-	-
184	Surat	Bardoli	-	-	-
185	Surat	Chorasi	39	1	40
186	Surat	Kamrej	-	2	2
187	Surat	Mahuva	-	-	-
188	Surat	Mandvi	-	-	-
189	Surat	Mangrol	7	1	8
190	Surat	Nizar	-	-	-
191	Surat	Olpad	3	4	7
192	Surat	Palsana	2	1	3
193	Surat	Songadh	2	-	2
194	Surat	Surat City	6	41	47
195	Surat	Uchchhal	-	-	-
196	Surat	Umarpada	-	-	-
197	Surat	Valod	-	1	1
198	Surat	Vyara	-	2	2
199	Surendranagar	Chotila	-	-	-
200	Surendranagar	Chuda	-	-	-
201	Surendranagar	Dasada	1	1	2
202	Surendranagar	Dhrangadhra	-	3	3
203	Surendranagar	Halvad	-	-	-
204	Surendranagar	Lakhtar	-	-	-
205	Surendranagar	Limbdi	-	2	2
206	Surendranagar	Muli	-	1	1
207	Surendranagar	Sayla	2	-	2
208	Surendranagar	Wadhwan	-	5	5
209	The Dangs	The Dangs		-	-
210	Vadodara	Chhota Udaipur	-	-	-
211	Vadodara	Dabhoi	-	4	4
212	Vadodara	Jetpur Pavi		-	-
213	Vadodara	Karjan		-	-
214	Vadodara	Kavant	-	-	
215	Vadodara	Nasvadi	-	-	
216	Vadodara	Padra	22	12	34
217	Vadodara	Sankheda	-	-	-
218	Vadodara	Savli	16	22	38
219	Vadodara	Sinor	-	-	-
220	Vadodara	Vadodara	97	33	130
221	Vadodara	Vaghodia	3	2	5
222	Valsad	Dharampur	2	-	2
223	Valsad	Kaprada	-	-	-
224	Valsad	Pardi	56	91	147
225	Valsad	Umbergaon	11	12	23
226	Valsad	Valsad	10	9	19

Note: A single storage location of a Hazardous Chemical is counted as one incidence within a taluka.

TSUNAMI HAZARD RISK

A Tsunami is a very large ocean wave triggered by underwater earthquakes, volcanic activities or landslides. These waves have unusually long wavelengths (typically in excess of 100 kms.) generated in the open ocean and transformed into a train of catastrophic sea surface oscillations close to coastal zones.

Tsunamis most commonly occur in the Pacific Ocean and, at much lower frequencies, in the seas surrounding the Indian subcontinent. The least frequency in India's littoral waters is on the western coast that includes Gujarat. The Indian coastline is most at risk to catastrophic storm surges (Gujarat, 1998 Orissa, 1999) which can cause significant loss of life and property. These are large perturbations of the sea level caused by cyclonic storms. A tsunami on the other hand, has nothing to do with atmospheric disturbances.

Tsunamis are harmless in the open ocean because of their small wave height (typically 30-60 cms.). Typical speeds in the open ocean are of the order of 600 to 800 km/hr. The tsunami's energy flux, dependent on its wave speed and wave height, remains nearly constant. Hence, as they race into shallow water along continental coasts their speed diminishes. This results in an increase in wave height in order to conserve total energy.

TECTONIC SETUP

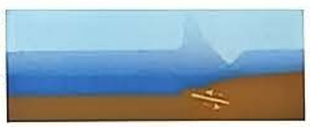
The Earth's outer layer (about 70-100 km. thick) is divided into twelve lithospheric plates (e.g. the North American, South American, African, Indian, Australian plates). These plates are bounded by mid-oceanic ridges, subduction zones and transform faults where most of the major earthquake activity in the world is concentrated.

The Indian plate is bounded by the Sunda Trench (subduction zone) on the east and the Central Indian and Carlsberg ridges on the west. The Andaman-Nicobar-Nias (off Sumatra) Sedimentary Arc in the northeast of the Indian Ocean defines a nearly 2,200 km. long trench slope break and an outer arc ridge between the Indian plate and the SE Asia-Burma plate. The entire 3,500 km. long Burmese- Andaman arc constitutes an important transitional link between the Himalaya and the Western Pacific arc system characterized by varying degree of seismic activity and volcanism.

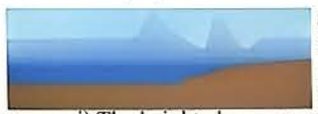
Tsunamis are most often generated by undersea shallow inter-plate earthquake events. Deep-focus earthquakes usually occur in subduction zones, while they occur at relatively shallow depths in mid-ocean ridges.

TSUNAMI BUILDUP

There are four identified stages of tsunami buildup.



INITIATION: Near the source of large magnitude submarine earthquake, the seafloor is uplifted and down-dropped, pushing the entire water column up and down. The potential energy that results from is then transferred to horizontal propagation of a tsunami wave.

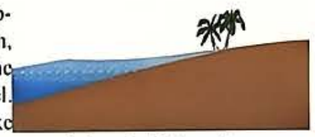


SPLIT : Within several minutes of the earthquake, the initial tsunami is split into a tsunami that travels out to the deep ocean (distant tsunami) and another that travels towards the nearby coast (local tsunami).The height above mean sea level of the two tsunamis travelling in opposite directions is approximately half that of the original tsunami. The speed at which both tsunamis travel varies depending on the square root of the water depth. Therefore, the deep-ocean tsunami travels faster than the local tsunami and can reach velocities of 800 km. per hour.



AMPLIFICATION: Several things happen as the local tsunami travels over the continental slope the obvious effect of which is that wave amplitude increases. In addition, the wavelength decreases. This results in steepening of the leading wave. Deep ocean tsunamis travel much farther than local tsunamis, yet amplification and wave shortening occurs, just as with the local tsunami.

RUNUP: As the tsunami wave travels from the deep-water continental slope region to the near-shore region, tsunami runup occurs. Runup is a measurement of the height of the water onshore above a reference sea level. Most tsunamis do not result in giant breaking waves (like normal surf waves at the beach that curl over as they approach shore). Rather, they come in much like very strong and fast tides (i.e. a rapid, local rise in sea level). Therefore, tsunamis will often travel much farther inland than normal waves. The small number of tsunamis that do break often form vertical walls of turbulent water called bores. After runup, part of the tsunami energy is reflected back to the open ocean. In addition, a tsunami can generate edge waves that travel back-and-forth, parallel to the shore. These effects result in many arrivals of the tsunami at a particular point on the coast rather than a single wave. Because of the complicated behaviour of tsunami waves near the coast, the first runup is often not the largest.



TSUNAMI HAZARD RISK

The tsunami risk within the Indian Ocean is quite low as compared to storm surge owing to very long return periods and the lower level of inter-plate events. The adjoining table presents estimated return periods and event frequencies of tsunamis in various global basins. It should also be noted that not all tsunami events are destructive and hence may go unnoticed.

Region	No. of Years of Data	No. of Tsunami Events	Percentage Probability per Year	Return Period in Years	Reference
Alaska	177	79	44.6	2.24	Lander and Lockridge, 1989
American Samoa	150	69	46	2.17	Lander and Lockridge, 1989
Australia	127	16	12.6	7.94	Davidsen and Ryno, 1998
Caribbean	500	100	20	5	Lander and O'Laughlin 2000
East Coast of USA	209	11	5.3	19	Lander and Lockridge, 1989
Hawaii	175	138	78.9	1.27	Lander and Lockridge, 1989
India	2,300	25	1.09	92	Murty and Bapat, 1999
Puerto Rico and Virgin Islands	228	12	5.3	19	Lander and Lockridge, 1989
Turkey	3,300	100	3.03	33	Altinok and Ersoy, 1995
U.S. Possessions in the Pacific	167	37	22.2	4.51	Lander and Lockridge, 1989
West Coast of USA	176	100	58.5	1.71	Lander and Lockridge, 1989

Source : Murty T. S. et. al. Return Periods of Tsunamis in Chile. Comparison with other Regions of the Globe

Due to the lower tsunami hazard risk as compared to storm surge in the north Indian Ocean basin, mitigative measures for protection against sea inundation due to storm surge, if suitably enhanced, could provide the most cost-effective risk mitigation measures for the region.

REPORTED TSUNAMIS IN THE NORTH INDIAN OCEAN BASIN	
Date	**References**
326 B.C.	Alexander the Great
Between 1st April and 9th May 1008	Tsunami on the Iranian coast from a local earthquake
August 27th 1883	Krakatoa volcanic eruption 1.5 m ysunami at Madras, 0.6 m at Nagapattainam, 0.2 m at Arden
1884	Earthquake in western Bay of Bengal tsunami at Port Blair. Doublet (mouth of Hoogly River)
26th June 1941	M 8 1 quake in the Andaman Sea at 12.9°N, 92.5° E Tsunamis on the east coast of India with amplitudes from 0.75 to 1.25 m. Some damage reported on India's east coast.
27th November 1945	Makran Earthquake (Magnitude 8 2 at 24.5° N, 63.0° E) Tsunami reached a reported height of 13 m in some Makran ports (no instrumental data available). Tide guage measurement of 2 m at Karachi with no damage either to port or boats, 2 m at Mumbai with 15 recorded deaths. Tsunami induced tidal surge also reported from Karwar and 1m surge in the Seychelles .
26th December 2004	Earthquake of M 9.1 off north Sumatra coast generated devastating tsunami waves affecting several countries In South East Asia. In India Andaman & Nicobar Island, Tamil Nadu, Pondichery, Andhra Pradesh, Kerala and Lakshdweep casualitiesabout 9,700 people about 6,000 more reported missing
* The tsunami was reported by one source (Murty et al., 1999, Pendse, 1945) at 11 0-11.5* meters in Kachchh, Gujarat but no damage reports are available or independent cross-verification of run-up exists. There is considerable variation in the tidal amplitudes and concentrations at the mouth and head of the Gulf of Kachchh (Shetye S. R., Tides in the Gulf of Kutch, India, NIO, Goa, 1999) The projected tsunami run-up height would also vary accordingly. The reported run up height does not correlate with the parameters reported above. Since instrumental data for adjoining regions (Karachi & Mumbai) show much lower run-up, the location of Kachchh run-up is unknown and no major loss has been reported it seems unlikely that the whole Gulf would have a run-up height as mentioned. In absence of instrumental or historical records the authenticity of this report cannot be established	
Source : Murty, T. S., Bapat, A. (1999). Tsunamis on the Coastline of India. Science of Tsunami Hazards Vol 17. No. 3, NDMD. Prevention/Protection and Mitigation from Risk of Tsunami Disasters -A Concept Note. Ministry of home Affairs. GoI	

HISTORICAL EVENTS

A list of historical tsunamis that affected the Indian coast is presented in the adjoining table, based on various uncorroborated sources.

CONSTRAINTS

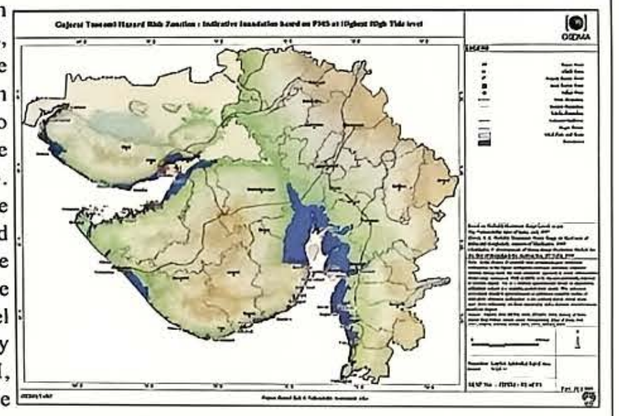
Since tsunamis are a very low risk within the Gujarat regional context, no scientific studies have been carried out estimating tsunami risk in the region. The earthquake hazard risk analysis presented in this Atlas takes into account all submarine intra-plate earthquakes in the Gujarat and environs (that includes parts of Pakistan, the west coast of India and other Indian states). No tsunamigenic submarine earthquakes are found in this 500-year record.

The primary risk to the Gujarat region of tsunamigenic events would emanate from plate boundary events. There is limited research in this area that would need to be addressed. Since much of the tsunami threat to India comes from the seismically active regions of Indian Ocean % the Andaman-Java-Sumatra and Makran subduction zone % it is necessary to map the stress field of these active regions to estimate the potential for future strong earthquakes.

Scientific tsunami runup modelling for Gujarat would only be possible after the risk of tsunamigenic inter-plate earthquakes off India's western coast is established. In addition, the following data (which is currently unavailable will be required):

- Identification of tide-gauge records for previous tsunamis and developing the ability to simulate runup, using model-based scenarios for the northern India Ocean.
- High-resolution geomorphic, near-shore bathymetry, near-coastal topography databases is essential for simulating and mapping tsunami runup and coastal inundation.
- In the case of a warning system, however, a more promising approach would be to estimate Green's function for shallow-water equations for the northern Indian Ocean basin.

In the absence of region specific runup models, the most conservative approach that is used in this Atlas was to estimate the worst case inundation scenario. The maximum possible inundation established is for Probable Maximum Surge at the highest high tide level as per the Vulnerability Atlas of India (GoI, 1997). This may be used for initial planning purposes as the area at risk to a potential tsunami in the region. Given the high uncertainty and long return periods of tsunamis in the region, this is only an interim estimate till a rigorous tsunami model is constructed for the region.



CONCLUSION

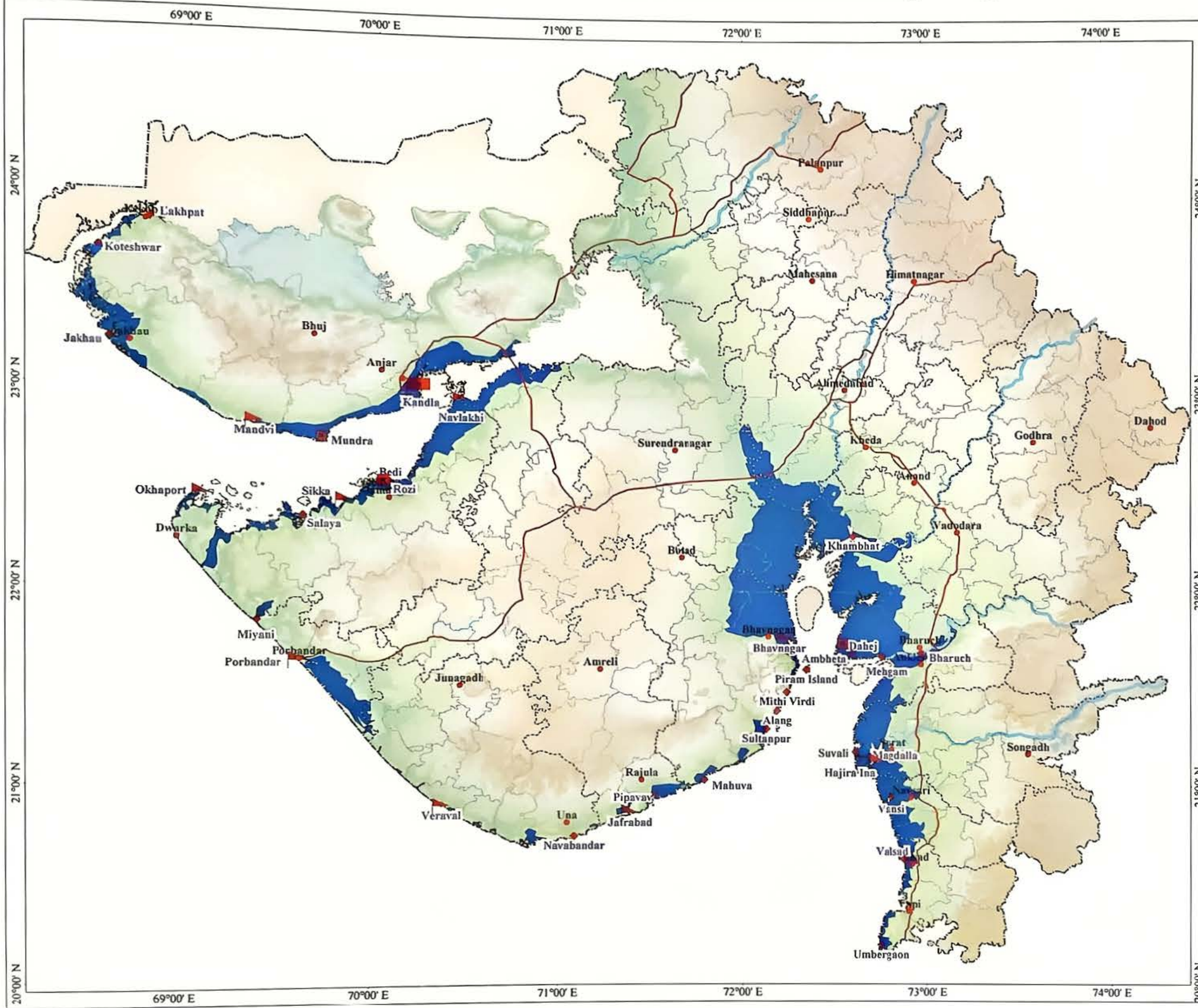
Tsunamis are extremely rare (over 250-year return period) events in Gujarat. No instrumental records or damage records are available for tsunami impact in the region. Nevertheless, tsunami impact in the Gujarat region is expected to be similar to that of the worst storm surge – which occurs at a much higher frequency.

Hence, in the absence of data, it is estimated that appropriate structural mitigation measures for storm surge linked to an appropriate tsunami warning system could address much of the risk associated with tsunami impact to residential populations.

Government agencies should also formulate and implement appropriate land-use regulations for coastal areas at risk, particularly if such an area is known to have sustained damage by storm surge in the past. An appropriate tsunami model and warning system may need to be developed for the region based on risk perceptions of the Government of India, Gujarat and experts.

Gujarat Tsunami Hazard Risk Zonation : Indicative Inundation based on PMS at Highest High Tide level

GSDMA



LEGEND

- Major Ports
- GMB Ports
- Private Sector Ports
- Joint Sector Ports
- Other Ports
- State Boundary
- District Boundary
- Taluka Boundary
- National Highway
- Major Rivers
- Mud Flats and Rann
- Inundation

Based on Probable Maximum Surge Levels as per
The Vulnerability Atlas of India, GoI, 1997.
Ghosh, S. K. Probable Maximum Storm Surge on the Coast of India and Bangladesh, Aspects of Mechanics, 1983.
Chittibabu, P. Development of Storm Surge Prediction Models for the Bay of Bengal and the Arabian Sea, IIT Delhi, 1999.

Note : In the absence of scientific data on tsunami-genic submarine earthquakes in the Gujarat earthquake catalogue and hence a rigorous tsunami run-up model, the most pragmatic approach to assist administrative action and mitigation planning is to take the worst case Storm surge scenario i.e. PMS at HHTL to be the area potentially exposed to tsunami impact. This is a working approximation based on engineering judgement and not on a scientific probabilistic model. This indicative assessment should be updated based on additional scientific studies of inter-plate submarine earthquakes in the northern Indian Ocean basin, near shore bathymetry, on-shore topography and a rigorous tsunami run-up model for Gujarat.
Source : UKHO, 2003; SRTM, 2003, ETOPO, 2003; Survey of India, Indian Tide Tables, various years; Vulnerability Atlas of India, GoI, 1997, Gujarat Maritime Board, GoG, 2004; BISAG, GoG.

0 — 100 km

N

Projection : Lambert Azimuthal Equal Area
Datum : WGS 84

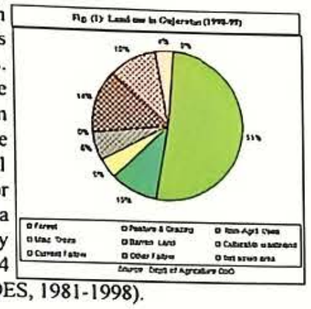
MAP No. : HTSM - 01 of 01

Date : 24/6/2005

DROUGHT VULNERABILITY AND RISK

AGRICULTURE IN GUJARAT

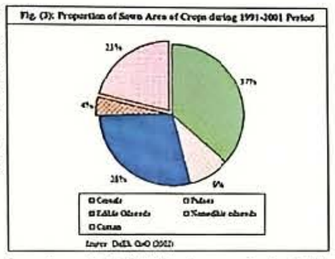
Gujarat is situated in an arid to sub-humid region with large diversity in terrain, edaphic and climatic conditions and is subdivided in to eight agro-ecological zones. Inhabited by both caste and tribal populations, this state offers a variety of agricultural practices ranging from intensive irrigated agriculture to tribal subsistence agriculture. The geographical area of Gujarat is 19.61 million hectare (mha), of which land use is reported for 18.81 mha. The cultivable land is about 9.5 mha with a net irrigated area of about 3.8 mha. The cropping intensity is 113 percent and irrigation intensity varies between 114 percent and 126 percent over the 1981-1998 periods (DES, 1981-1998).





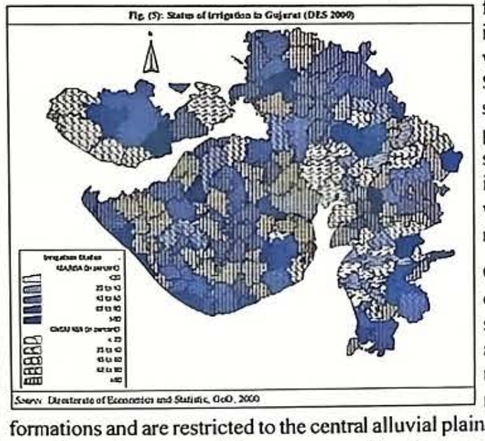
Gujarat lies in the arid to sub-humid zones and therefore experiences extremes of rainfall and temperature. The arid zone of Kachchh gets an annual rainfall of about 250 mm where as the southern hills get more than 2000 mm with low variation across years. While the arid zone shows a high coefficient of variability, the sub-humid zones experience very low variability. The I Decile rainfall in the sub-humid zone is sufficient to grow rain-fed rice while the I Decile in the arid zone is insufficient to grow any food crops.

The adjoining figure indicates that food grains are most important crops in this state. Edible and non-edible oilseeds stand next in the order. Cotton is a significant crop in this state, which accounts for about 1.5 to 2 million ha. Cotton is mostly grown under irrigated conditions and is therefore not vulnerable to drought. Over the last decade, there has not been a major crop shift away from food to cash crops in Gujarat.



IRRIGATION IN GUJARAT

The ultimate irrigation potential through surface water is estimated at 3.94 mha, against which maximum utilization in 2003 was 1.48 mha (Socio-Economic Review 2003). The adjoining figure indicates that the proportion of irrigated to net sown area has high variability with large parts of Saurashtra and some parts of southwest Gujarat having a low percentage of net irrigated area to net sown area. The share of ground water in irrigated areas is also highly variable with highest proportion found in the northern Gujarat and Saurashtra.



Groundwater resources are also distributed unevenly in unconsolidated sedimentary formations covering about 40 percent of the state. About two-thirds of the ground water resources are in unconsolidated formations and are restricted to the central alluvial plains (Khambhat basin) of Gujarat. In the remaining 45 percent of the area, comprising both consolidated and unconsolidated rocks, groundwater occurs under phreatic conditions with limited yield. About 80 percent of irrigation in the state is dependent on groundwater.

DATA SOURCES

Twenty-year data on taluka-wise cropping pattern, irrigation and crop yield was used from three main sources:

- District Statistical Handbooks (1981-2003)
- Data from Agricultural Department
  - Crop statistics
  - Crop insurance data
  - Irrigation and crop data
  - Rainfall data
- Soil data from BISAG
- Rainfall data from Gujarat Agricultural University, Anand

CROP LOSS MODEL

The CROPWAT model developed by FAO was utilised for estimating losses at taluka level to individual crops for different deciles of rainfall (http://www.fao.org/landandwater/aglw/cropwat.stm). The main crops that are grown in Gujarat include bajra, jowar, maize, oilseeds, cotton, rice, pulses and wheat were analysed. Crop yield estimates in irrigated and rainfed conditions were analysed separately. The Decile Method was used to assess drought risks. The value of production of eight most important crops was estimated at 2002 along with the value of standard loss by rainfall decile. The total value of output and loss were used to map agricultural vulnerability across talukas.

VALUE OF AGRICULTURAL PRODUCTION LOSSES

The adjoining figure shows that only three agro-ecological zones have lower than Gujarat's average loss while the remaining five agro-ecological zones experience higher losses. The maximum loss is experienced in the arid Rann and Banni zone, closely followed by the arid Kachchh zone. The lowest losses are experienced in the sub-humid Sahyadri zone.

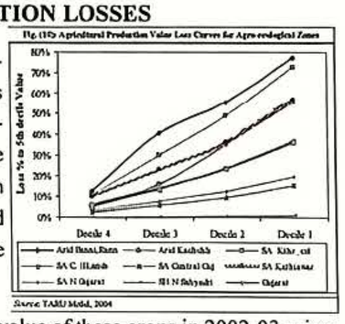


TABLE (9): GUJARAT- VALUE OF CROPS UNDER VARIOUS DECILES OF RAINFALLS (2002-03 PRICES Rs. million)

Crop	First decile	Second Decile	Third decile	Fourth decile	Fifth Decile
Bajra	2,658	3,724	4,576	5,252	5,759
Jowar	1,512	1,690	1,827	1,929	1,992
Maize	738	1,360	1,831	2,312	2,672
Rice	10,611	10,649	10,673	10,697	10,716
Wheat	10,148	11,420	12,141	12,758	13,195
Pulses	5,824	7,432	8,573	9,600	10,336
Oil seeds	13,899	20,482	25,549	30,210	33,125
Cotton	7,820	9,665	10,765	11,809	12,646
Total	53,210	66,422	75,934	84,567	90,441

Source: TARU Study, 2004

The total value of these crops in 2002-03 prices at the median V Decile rainfall in the state was found to be Rs. 90,441 million. Field data indicates that food grain and oilseeds are the most important crops in the state and oilseeds suffer most during the droughts.

The maximum proportional of loss is estimated for maize followed by oilseed crops. In the I Decile rainfall most crops are highly vulnerable, indicating that once in ten years, major crop can be expected to suffer severe loss, except for rice which is least vulnerable owing to its production under irrigated conditions.

The percentage loss of all crops is estimated at 41 percent for the I Decile. I Decile rainfall across the state can cause severe distress to farming households and can adversely affect other sectors like animal husbandry and agro industries.

TABLE (6): GUJARAT- PERCENTAGE LOSS (Rs.) OF CROPS UNDER VARIOUS DECILES OF RAINFALLS (2002-03 Prices)

Crop	First Decile	Second Decile	Third Decile	Fourth Decile	Normal Value Rs. million
Bajra	54%	35%	21%	9%	5,759
Cotton	38%	24%	15%	7%	12,646
Oilseeds	58%	38%	23%	9%	33,125
Jowar	24%	15%	8%	3%	1,992
Maize	72%	49%	31%	13%	2,672
Pulses	44%	28%	17%	7%	10,336
Rice	1%	1%	0%	0%	10,716
Wheat	23%	13%	8%	3%	13,195
Total	41%	27%	16%	6%	90,441

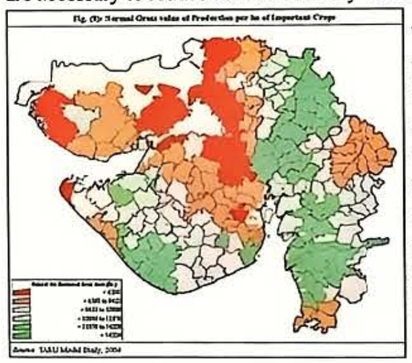
Source: TARU Study, 2004

The percentage loss was calculated in relation to V Decile rainfall over a 10-year cycle. The adjoining table indicates that a mean value of vulnerability is nine percent over a 10-year period. Maize has highest percentage loss for any single crop, but most of the maize area is concentrated in hilly areas. The losses to oilseeds are the largest in magnitude followed by food grains. The loss of Rs. 42,360 million in oilseeds indicates that major interventions are necessary to reduce the vulnerability of these crops.

TABLE (8): ESTIMATED DROUGHT INDUCED LOSSES IN GUJARAT OVER A TEN YEAR CYCLE (value in Rs. Million)

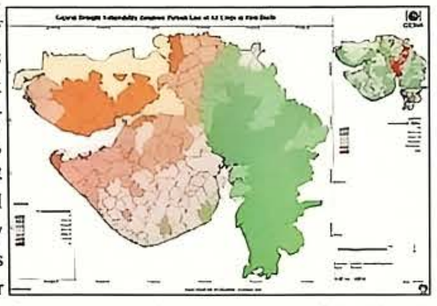
Crop	Loss amount (first to fourth decile)	Estimated 10 year production value based on Fifth decile	Percentage loss
Bajra	6,824	57,583	12%
Jowar	1,011	19,923	5%
Maize	4,446	26,716	17%
Rice	234	107,158	0%
Wheat	6,314	131,952	5%
Pulses	9,917	103,364	10%
Oilseeds	42,360	331,250	13%
Cotton	10,524	126,457	8%
Total	81,630	904,406	9%

Source TARU Study, 2004



The adjoining figure indicates that the production value per ha of net sown area is highest in irrigated mainland Gujarat and parts of Saurashtra. The area west of the Khambhat basin comprising parts of Saurashtra and most of Kachchh, and hilly regions show the lowest value of production per ha. Parts of the southern sub-humid region also show low values, which is largely due to large areas being under cash crops like sugarcane and fruit.

The loss is found to be highest in parts of Kachchh and north-western parts of the mainland Gujarat. The I Decile losses are estimated to be about 37 percent which can impact the agricultural sector considerably. Among eight crops studied, oilseeds were found to be most vulnerable (52 percent of losses at I Decile rainfall). The high vulnerability of oilseeds is partially due to the areas where these crops are grown as a major crop. Similarly, vulnerability of cotton is about 10 percent loss at I Decile rainfall. Oilseeds and cotton losses alone account for nearly two-thirds of the total losses at I decile rainfall.



CONCLUSIONS

A model was developed to assess drought risks in Gujarat. It incorporates the impact of reduction in sown area, irrigated area and yield. This model is based on taluka level statistics and rainfall deciles at taluka level.

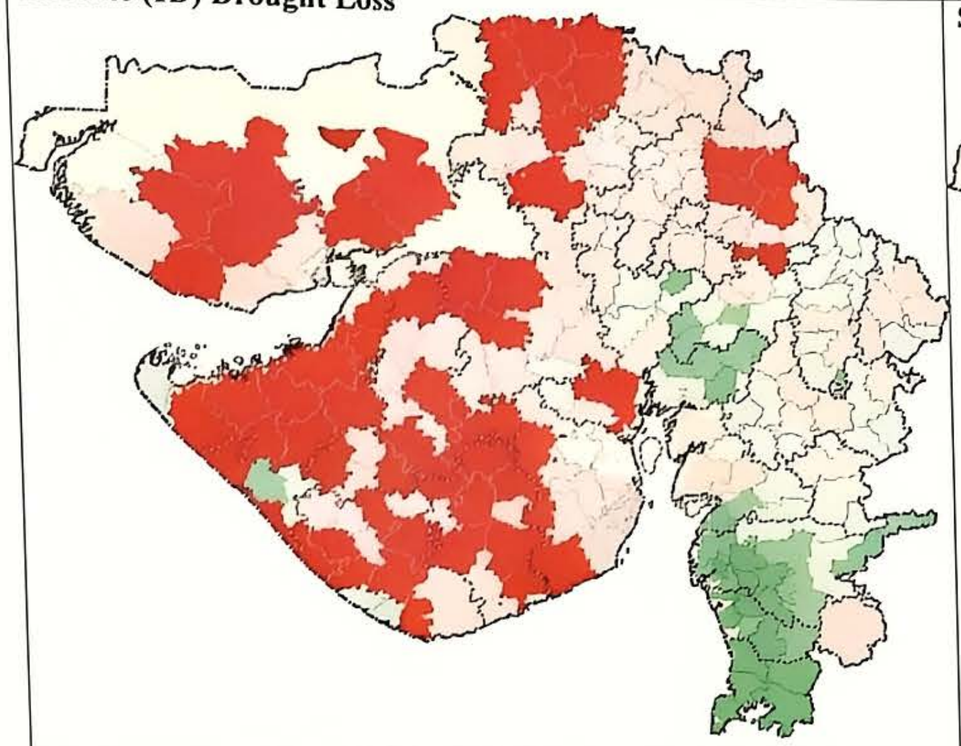
The agricultural risk assessment indicates that Gujarat's agriculture sector is prone to drought impact. While the total loss in a 10-year cycle is up to 9 percent of the total value of production, major crops suffer differentially due to droughts under normal rainfall conditions.

Oilseeds are more prone to drought risks and the 10-year loss can reach up to 13 percent. Cotton is the close second in terms of losses with about 10 percent loss compared to the normal production. Reducing the vulnerability of oilseeds and cotton can significantly reduce the losses during worst droughts.

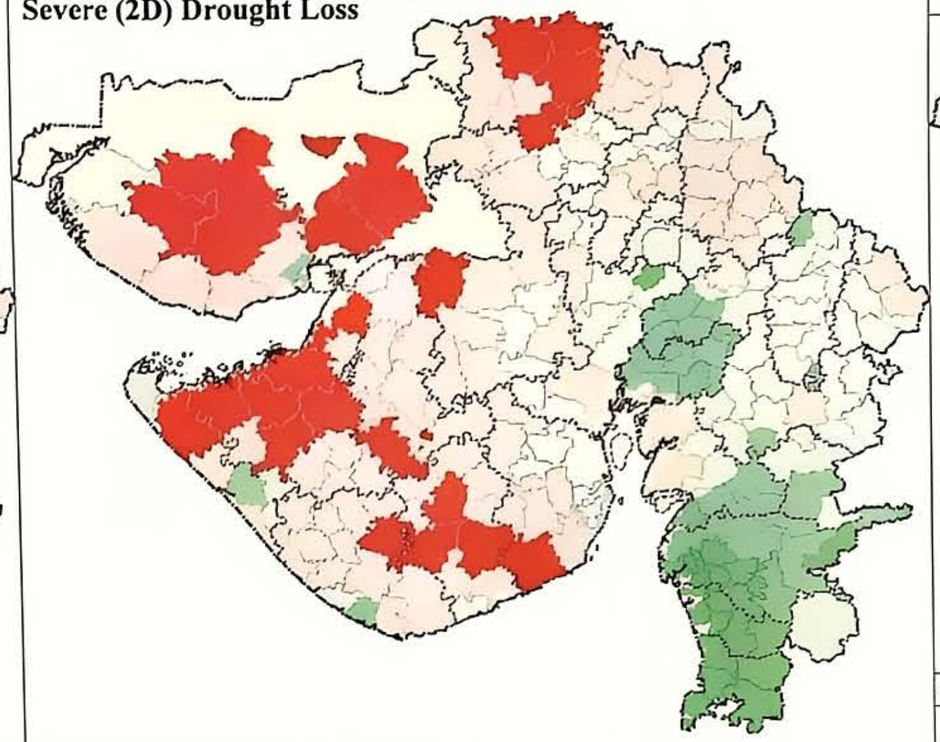
Gujarat Drought Vulnerability Zonation : Value of Loss of All Crops
(Rs. Million 2002-2003 Prices)

GSDMA

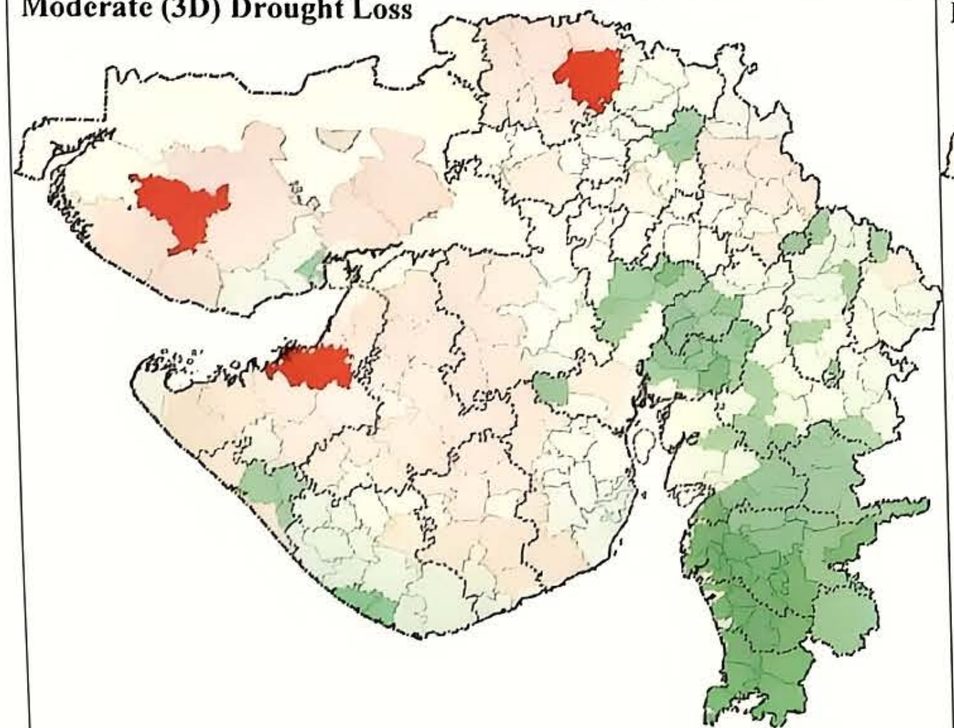
Extreme (1D) Drought Loss



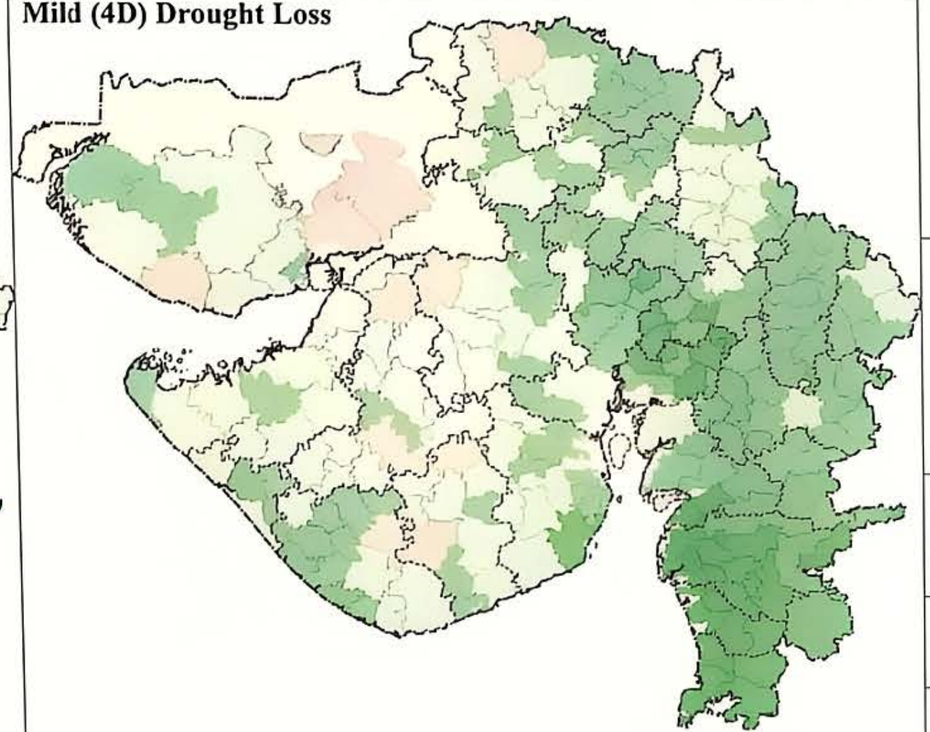
Severe (2D) Drought Loss

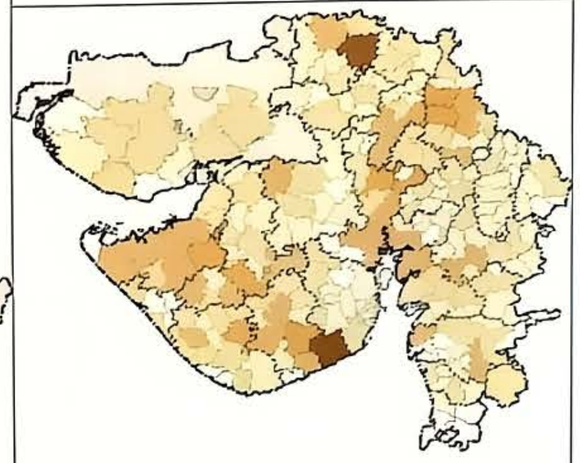


Moderate (3D) Drought Loss



Mild (4D) Drought Loss





Normal (5D) Crop Value (Rs. Million)

- < 200
- > 200 to 400
- > 400 to 600
- > 600 to 800
- > 800 to 1000
- > 1000

LEGEND

Crop Loss Value (Rs. Million)

- < 2
- > 2 to 8
- > 8 to 27
- > 27 to 86
- > 86 to 263
- > 263

Source: TARU Analysis, 2004; Department of Economics & Statistics, GoG; Department of Agriculture, GoG; FAO/ICRISAT; GAU, Anand; BISAG, GoG.

0 100 km

N

Projection : Lambert Azimuthal Equal Area
Datum : WGS 84

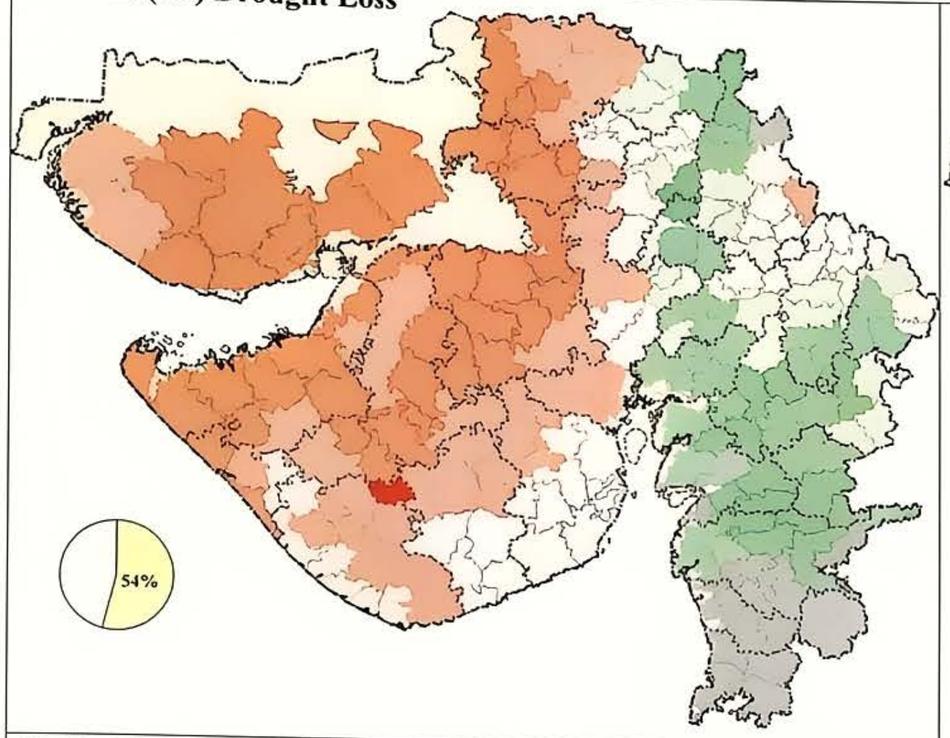
MAP No. : VADM - 01 OF 09

Date : 22/6/2005

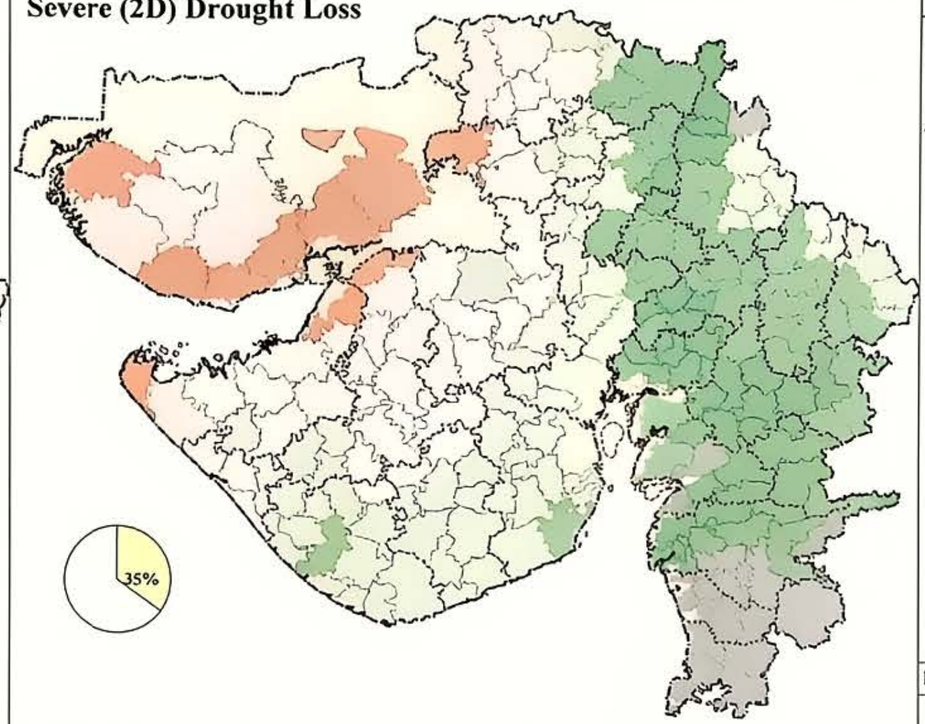
Gujarat Drought Vulnerability Zonation : Bajra Crop Loss (First to Fourth Decile Rainfall)

GSDMA

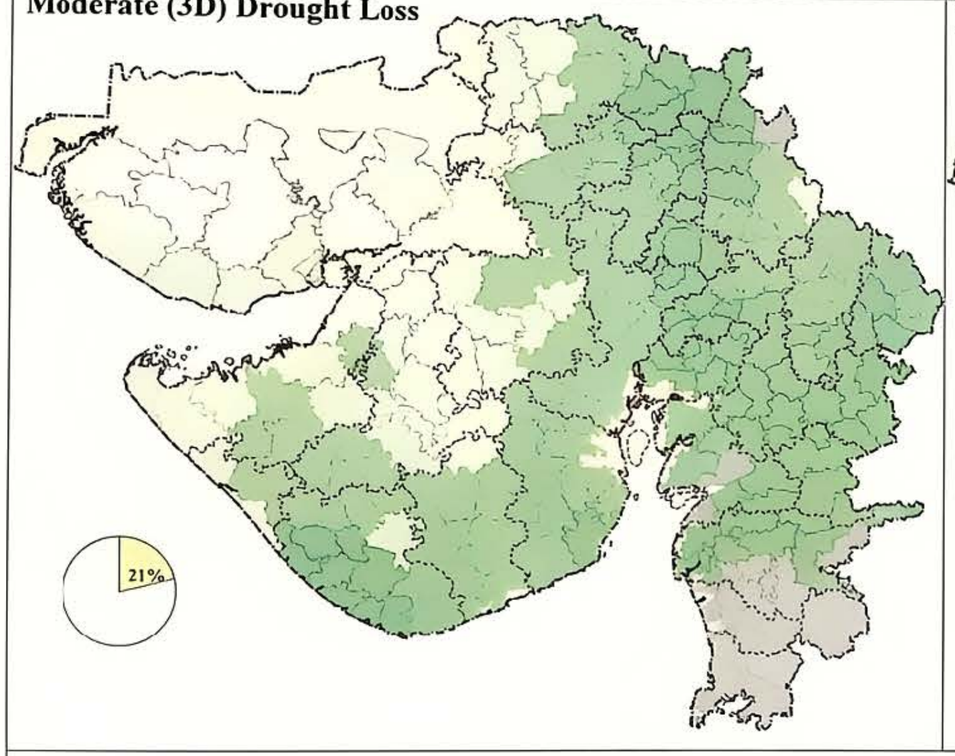
Extreme (1D) Drought Loss



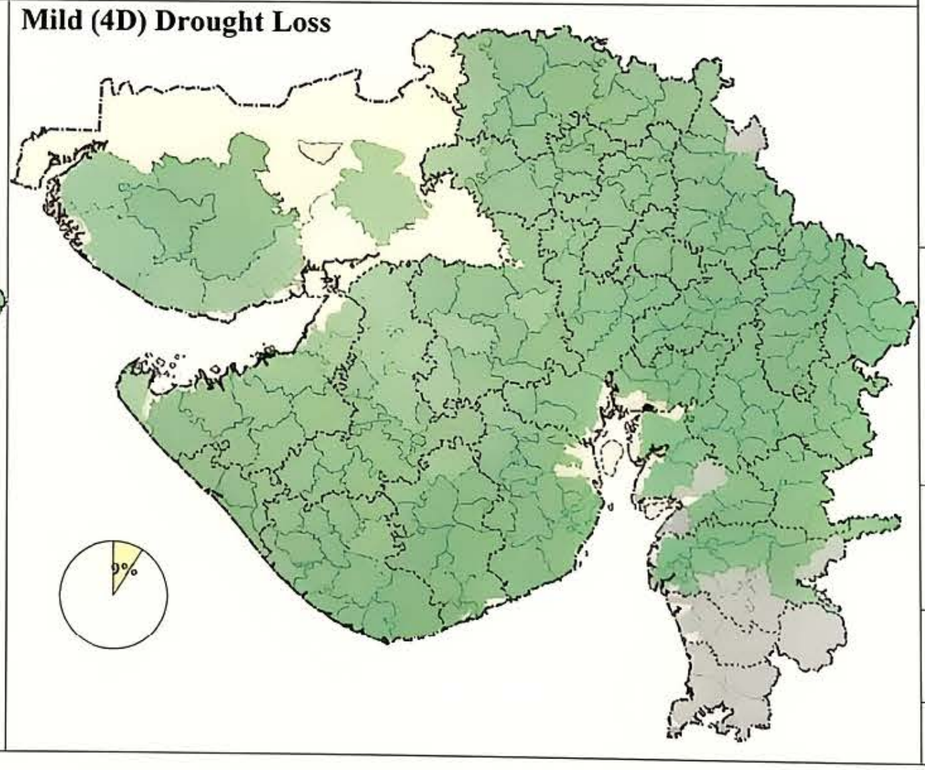
Severe (2D) Drought Loss

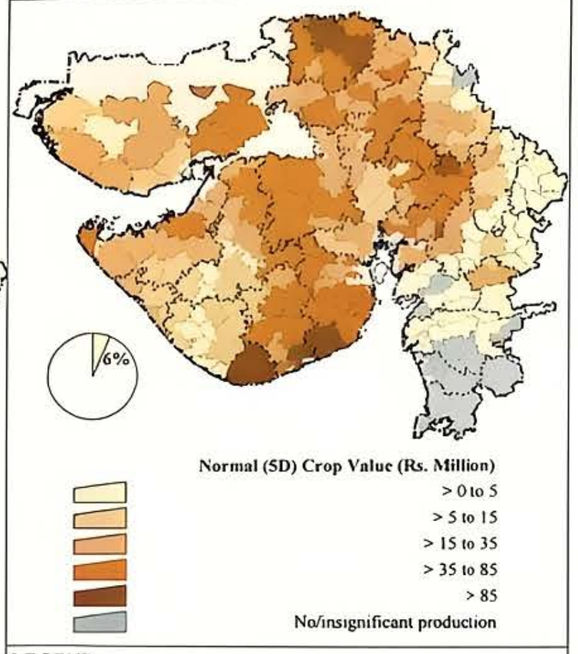


Moderate (3D) Drought Loss



Mild (4D) Drought Loss





LEGEND

% Crop Loss
- < 15
- > 15 to 30
- > 30 to 45
- > 45 to 60
- > 60 to 75
- > 75 to 90
- > 90
- No/insignificant production

Inset map pie chart shows the proportion of Bajra crop production to total crop production.
Main map pie charts show the proportion of Bajra crop loss to total crop loss for the respective decile.

Source: TARU Analysis, 2004; Department of Economics & Statistics, GoG; Department of Agriculture, GoG; FAO/ICRISAT; GAU, Anand; BISAG, GoG.

0 100 km

N

Projection : Lambert Azimuthal Equal Area
Datum : WGS 84

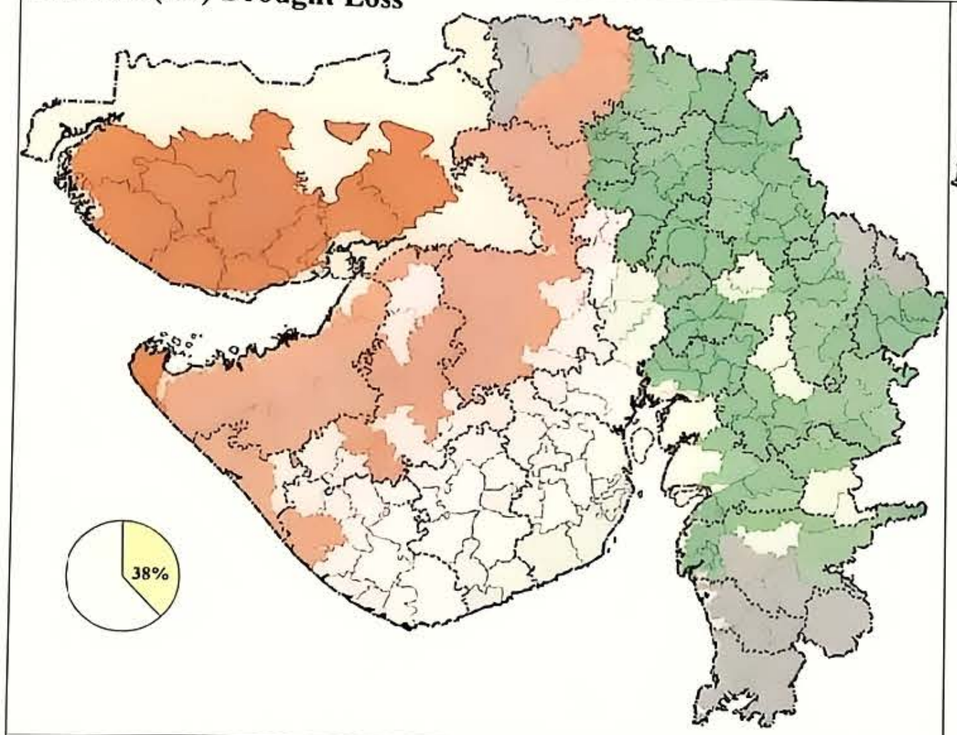
MAP No. : VADM - 02 OF 09

Date : 22/6/2005

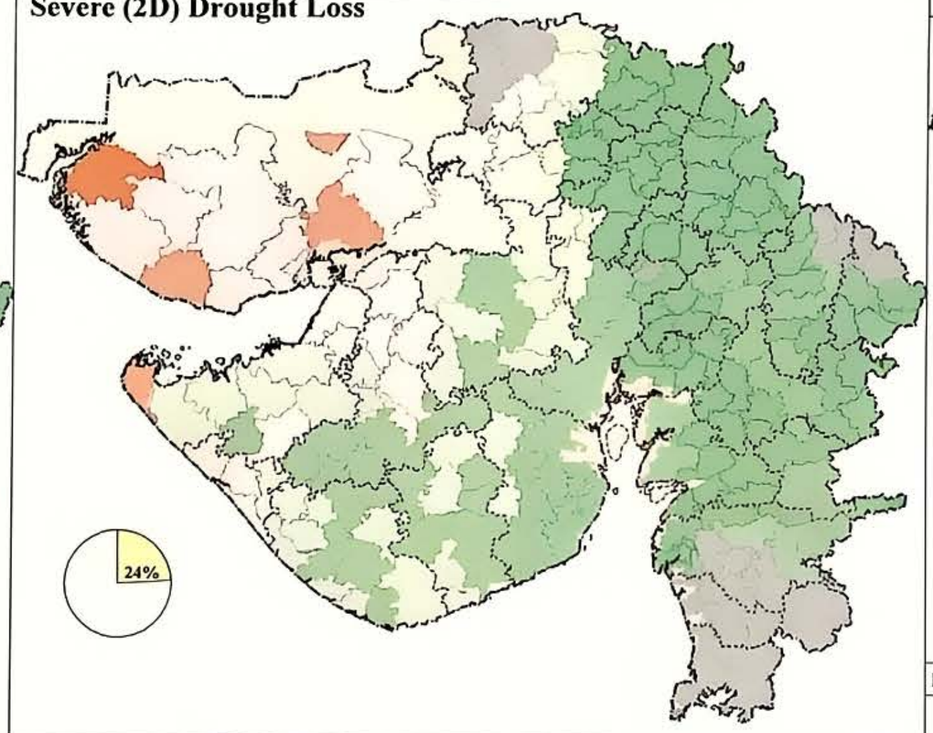
Gujarat Drought Vulnerability Zonation : Cotton Crop Loss (First to Fourth Decile Rainfall)

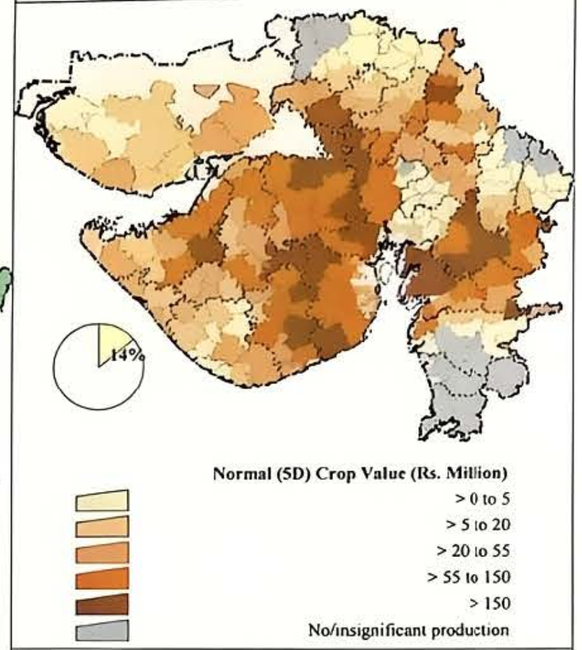
GSDMA

Extreme (1D) Drought Loss

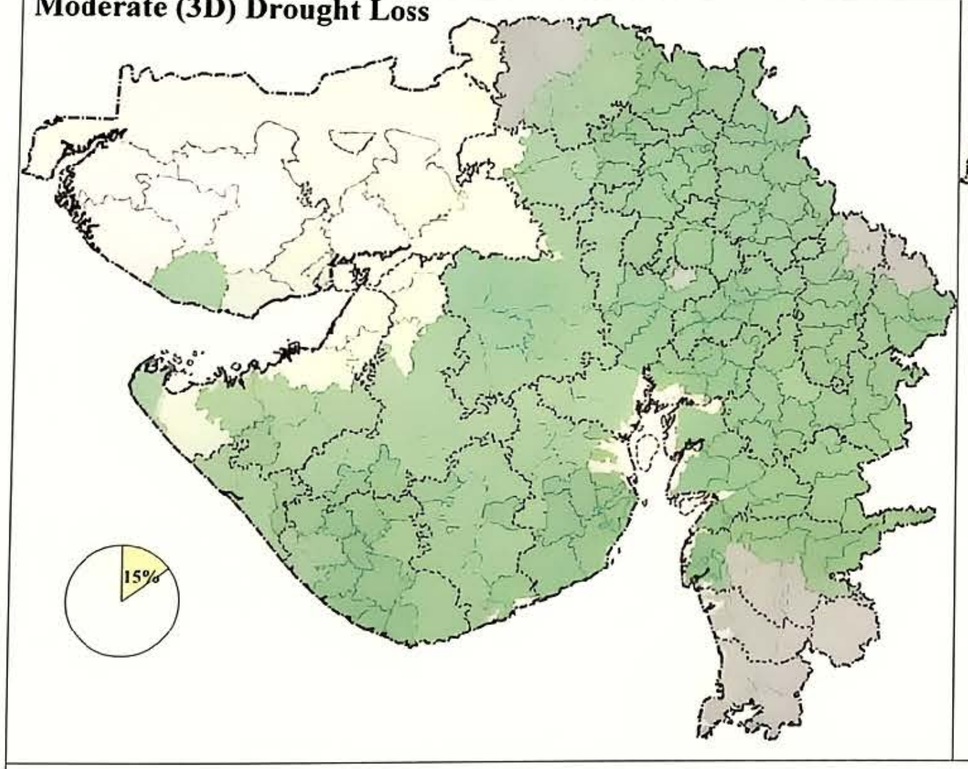


Severe (2D) Drought Loss

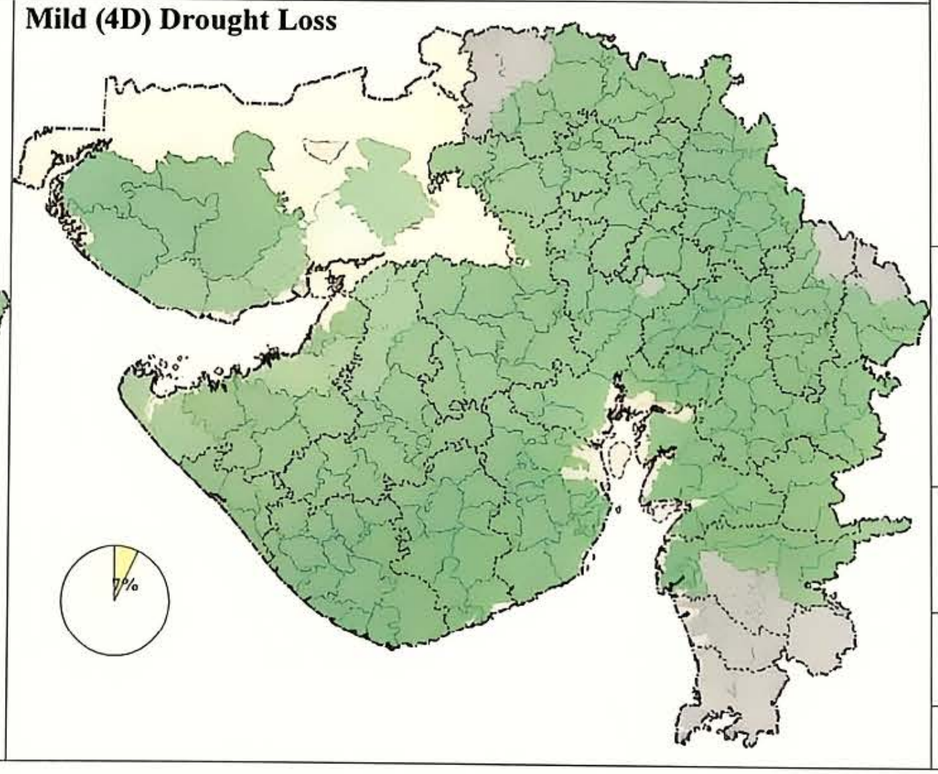




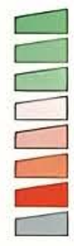
Moderate (3D) Drought Loss



Mild (4D) Drought Loss



LEGEND



Inset map pie chart shows the proportion of Cotton crop production to total crop production.
Main map pie charts show the proportion of Cotton crop loss to total crop loss for the respective decile.

Source: TARU Analysis, 2004; Department of Economics & Statistics, GoG; Department of Agriculture, GoG; FAO/ICRISAT; GAU, Anand; BISAG, GoG.



N

Projection : Lambert Azimuthal Equal Area
Datum : WGS 84

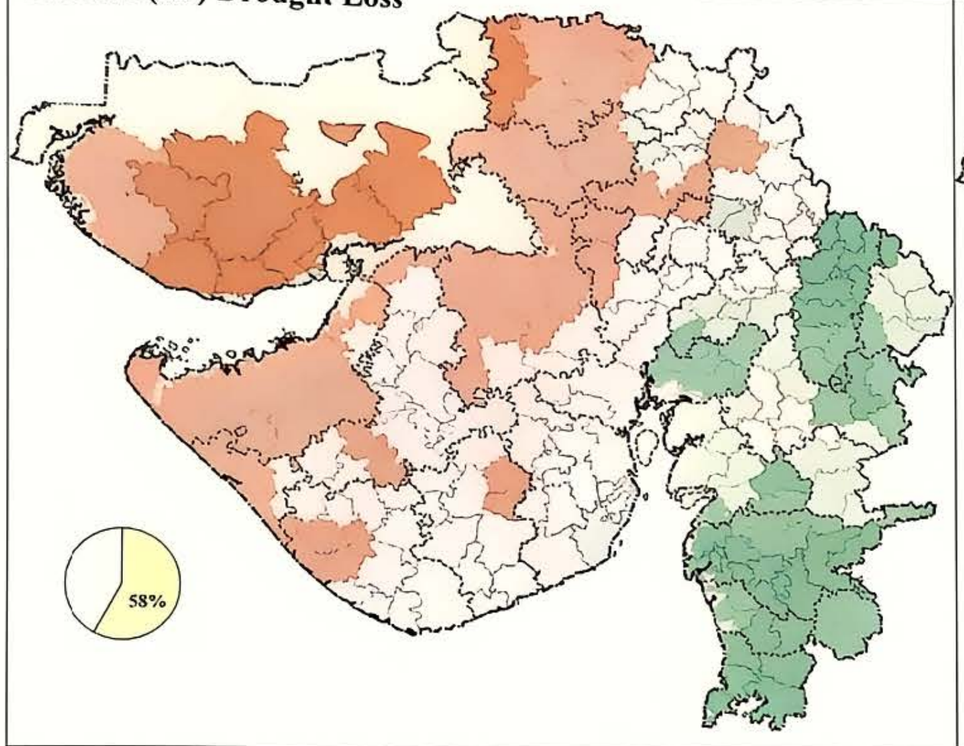
MAP No. : VADM - 03 of 09

Date : 22/6/2005

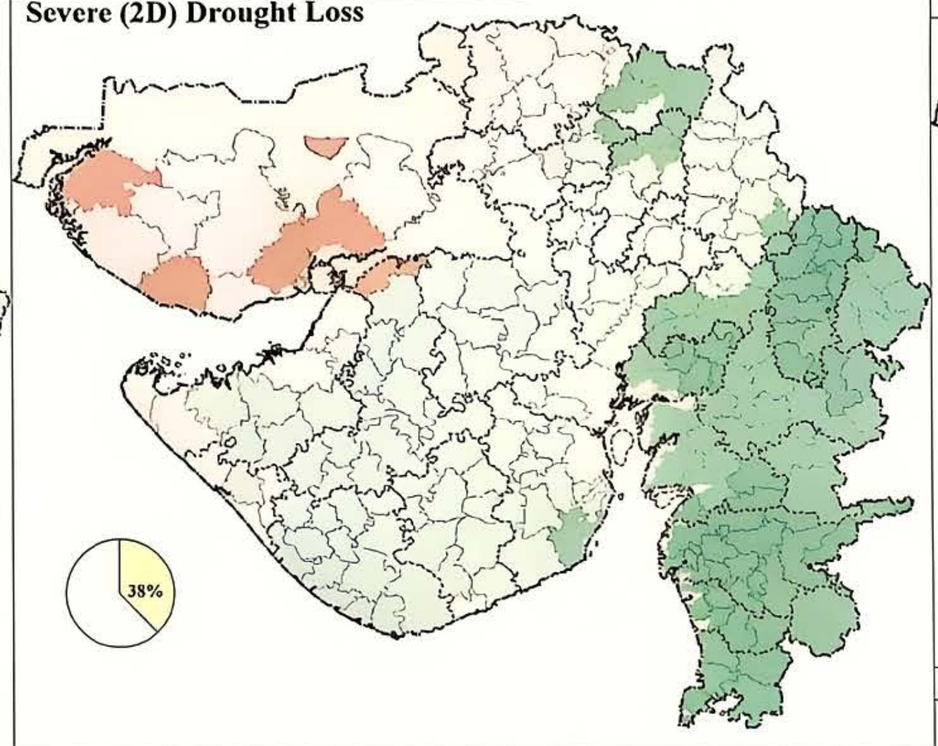
Gujarat Drought Vulnerability Zonation : Oilseed Crop Loss (First to Fourth Decile Rainfall)

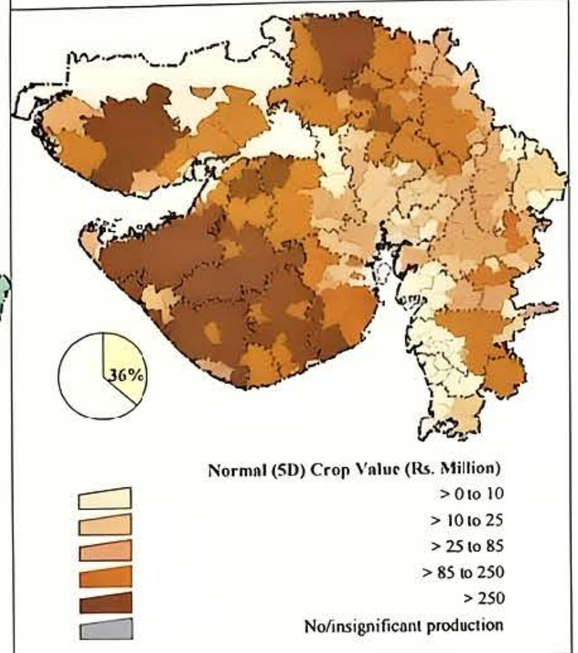
GSDMA

Extreme (1D) Drought Loss

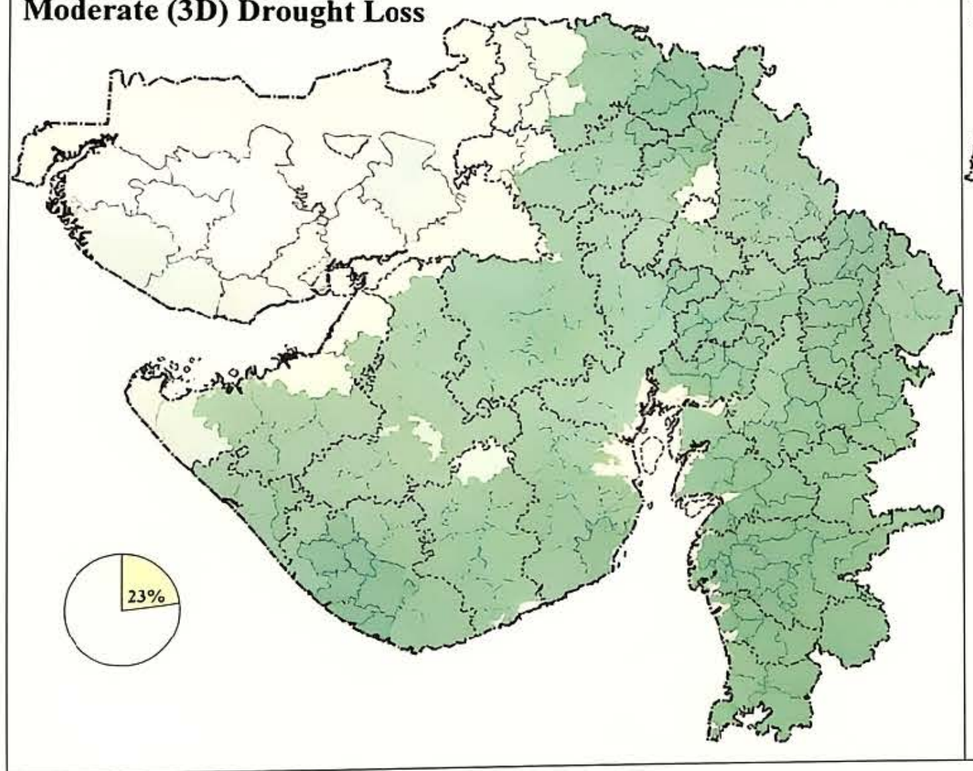


Severe (2D) Drought Loss

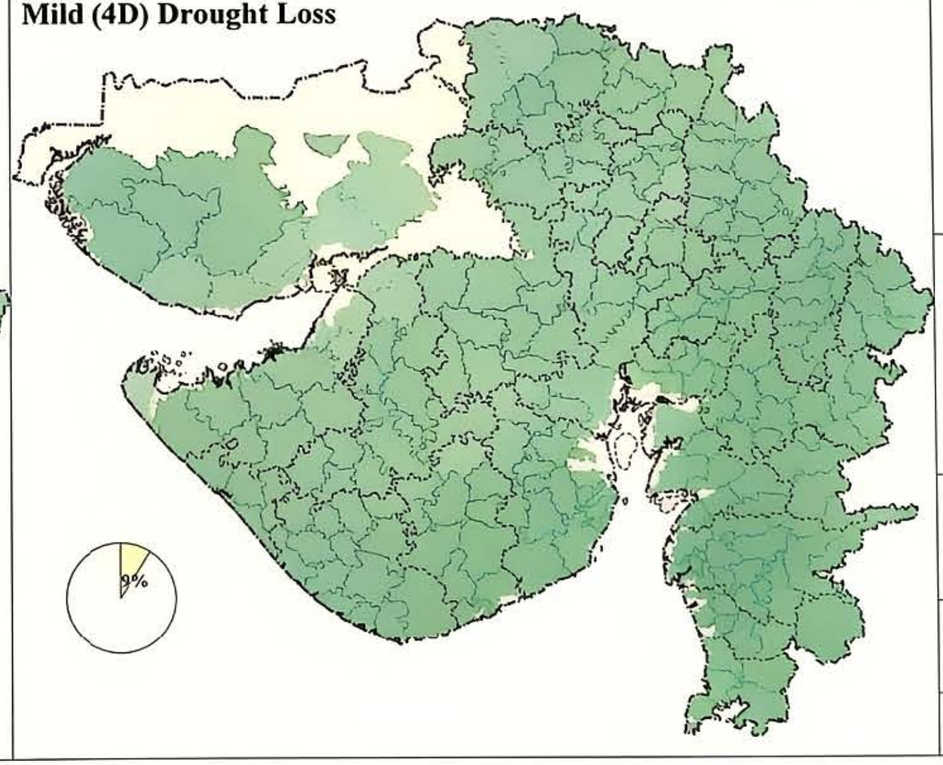




Moderate (3D) Drought Loss



Mild (4D) Drought Loss



LEGEND

% Crop Loss
< 15
> 15 to 30
> 30 to 45
> 45 to 60
> 60 to 75
> 75 to 90
> 90
No/insignificant production

Inset map pie chart shows the proportion of Oilseed crop production to total crop production.
Main map pie charts show the proportion of Oilseed crop loss to total crop loss for the respective decile.

Source: TARU Analysis, 2004; Department of Economics & Statistics, GoG; Department of Agriculture, GoG; FAO/ICRISAT; GAU, Anand; BISAG, GoG.

0 100 km

N

Projection : Lambert Azimuthal Equal Area
Datum : WGS 84

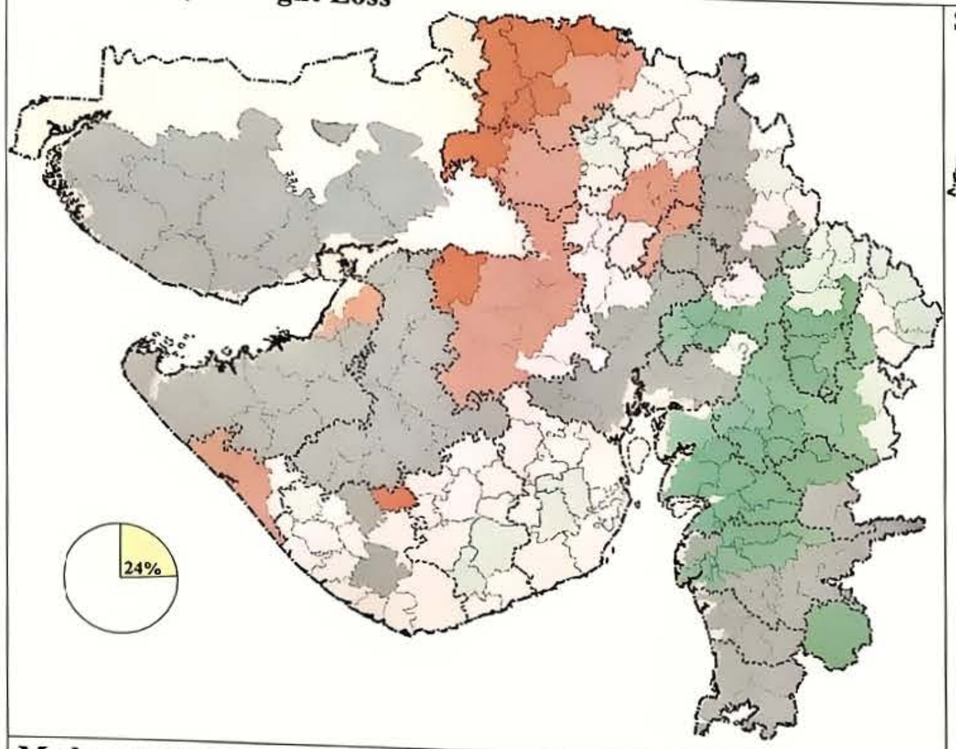
MAP No. : VADM - 04 of 09

Date : 22/6/2005

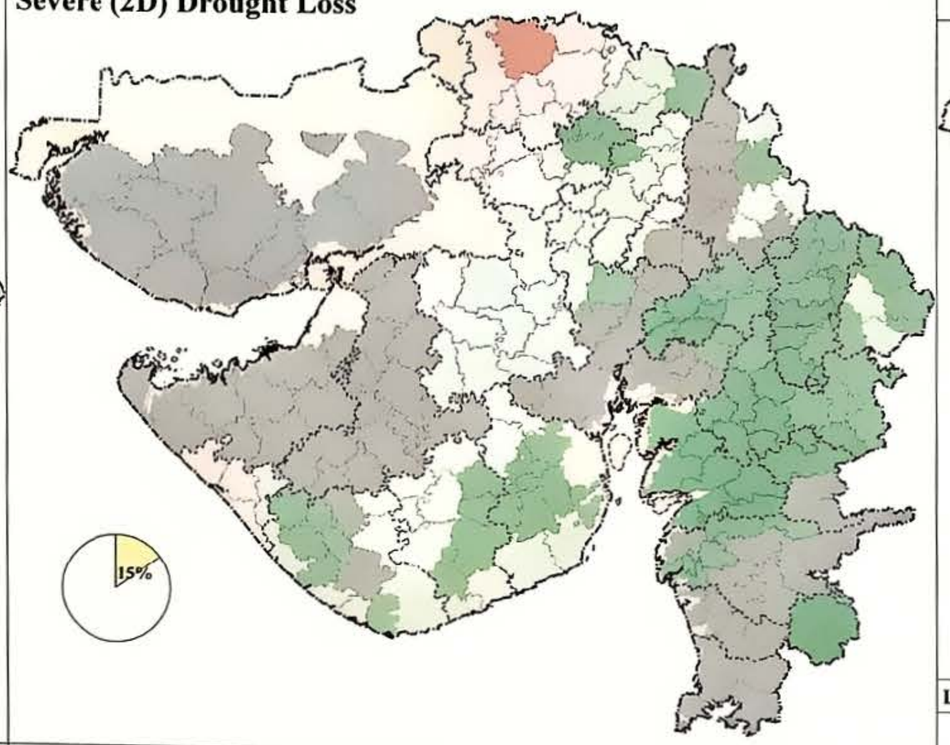
Gujarat Drought Vulnerability Zonation : Jowar Crop Loss (First to Fourth Decile Rainfall)

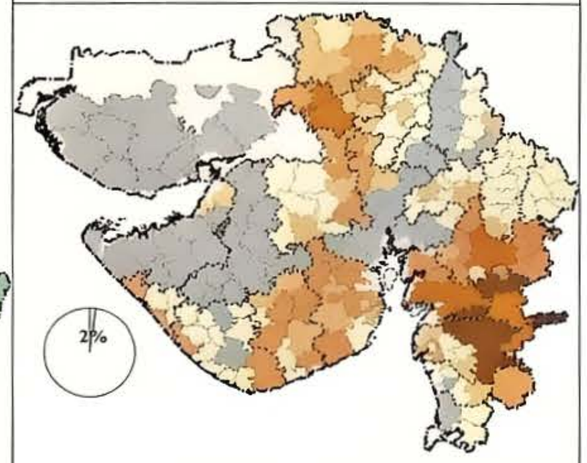
GSDMA

Extreme (1D) Drought Loss

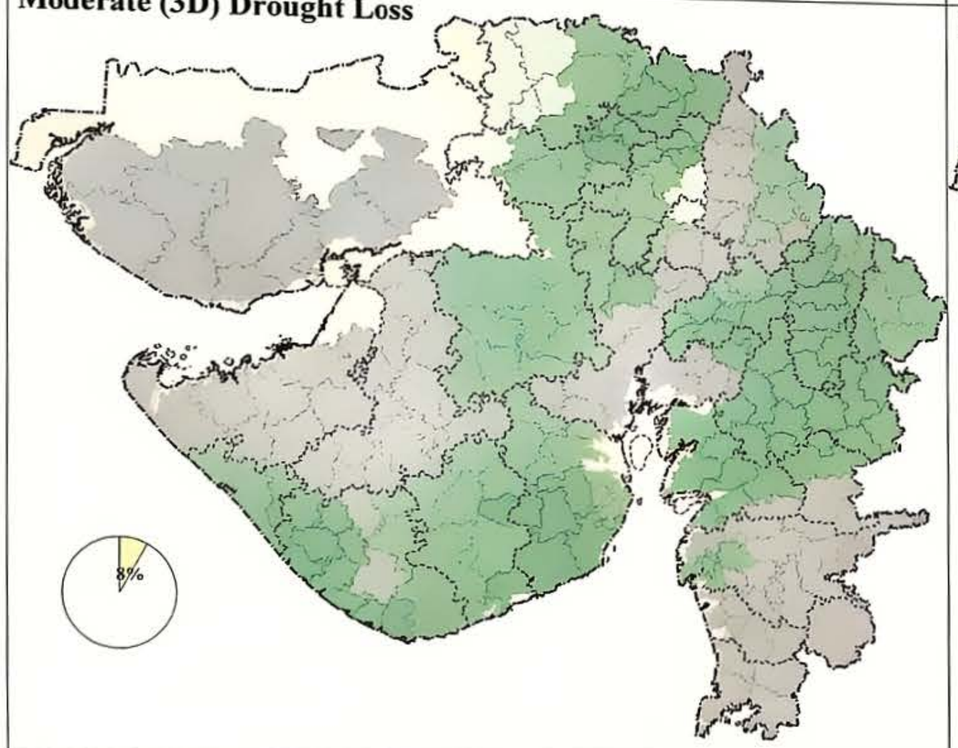


Severe (2D) Drought Loss

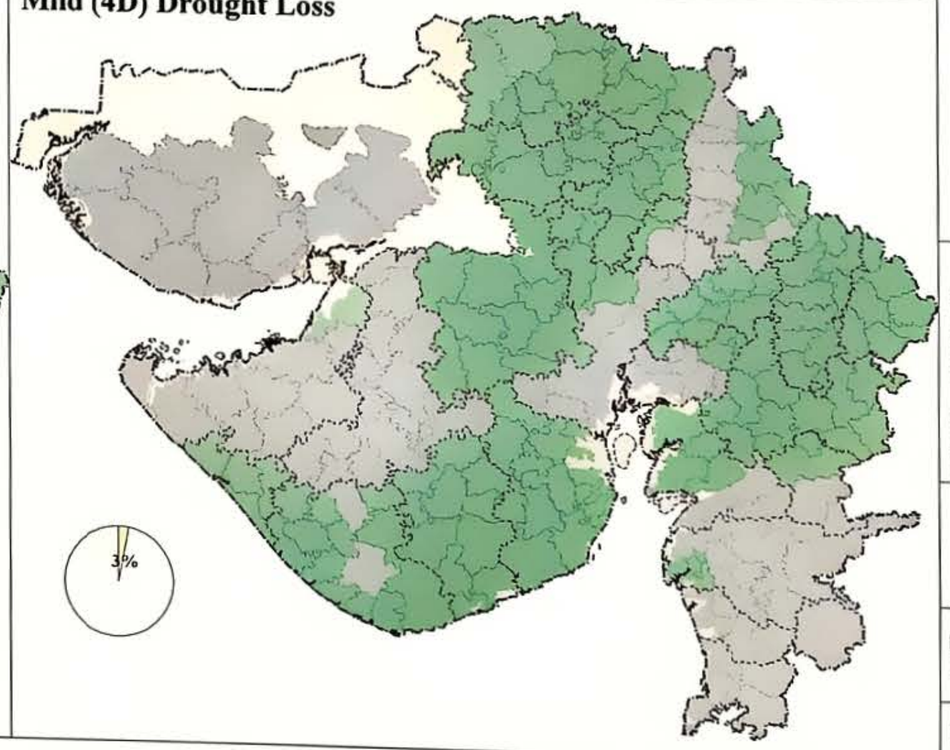




Moderate (3D) Drought Loss



Mild (4D) Drought Loss



LEGEND

% Crop Loss
< 15
> 15 to 30
> 30 to 45
> 45 to 60
> 60 to 75
> 75 to 90
> 90
No/insignificant production

Inset map pie chart shows the proportion of Jowar crop production to total crop production.
Main map pie charts show the proportion of Jowar crop loss to total crop loss for the respective decile.

Source: TARU Analysis, 2004; Department of Economics & Statistics, GoG; Department of Agriculture, GoG; FAO/ICRISAT; GAU, Anand; BISAG, GoG.

0 100 km

N

Projection : Lambert Azimuthal Equal Area
Datum : WGS 84

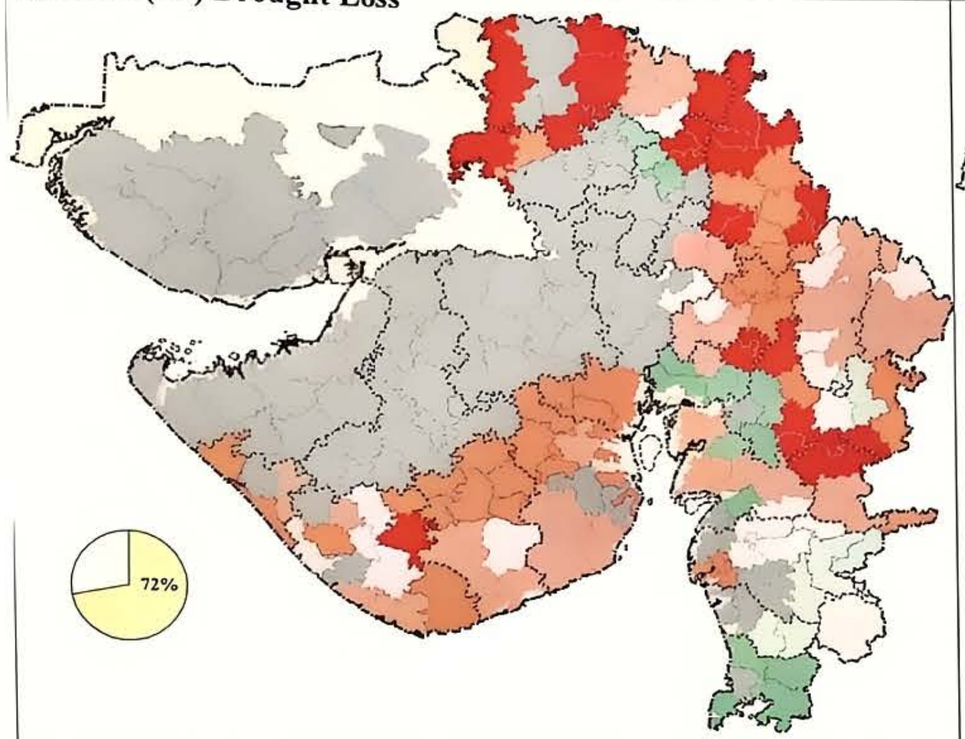
MAP No. : VADM - 05 OF 09

Date : 22/6/2005

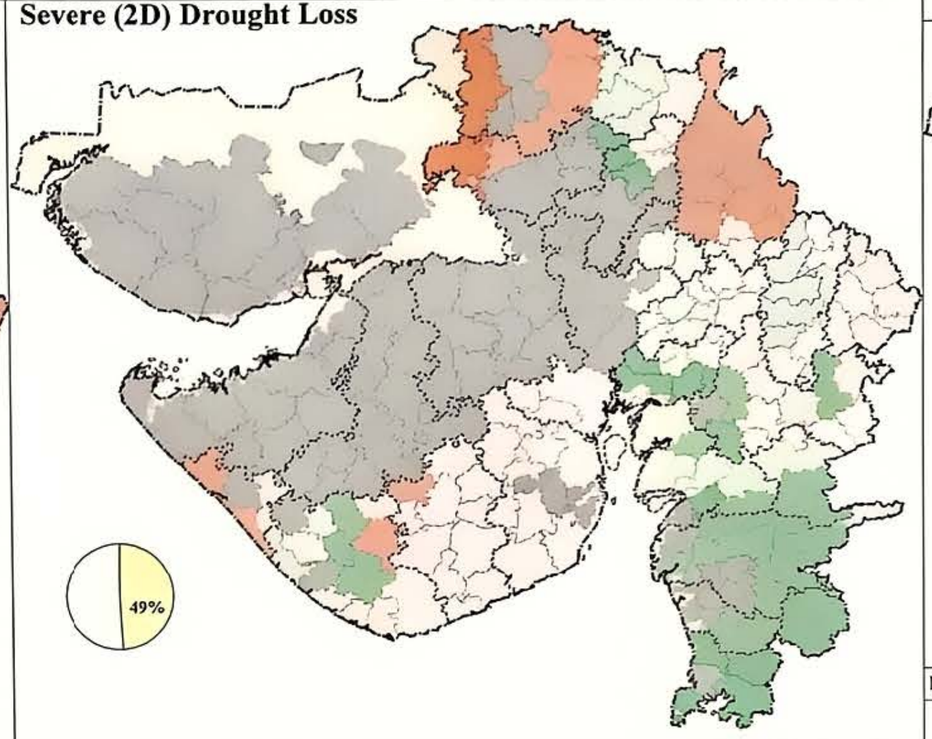
Gujarat Drought Vulnerability Zonation : Maize Crop Loss (First to Fourth Decile Rainfall)

GSDMA

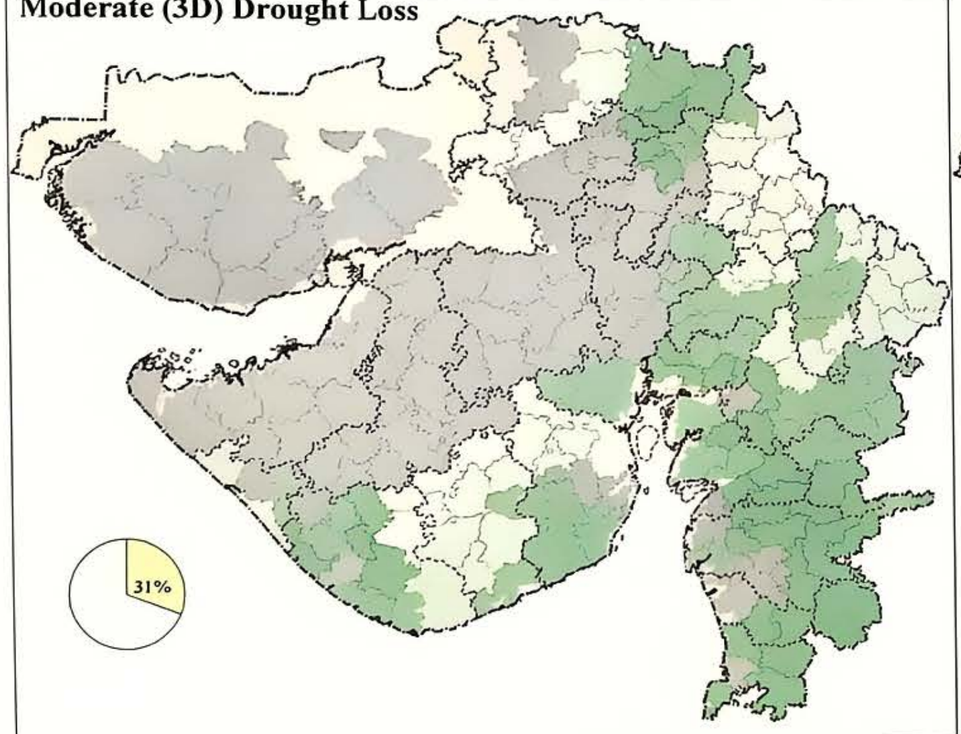
Extreme (1D) Drought Loss



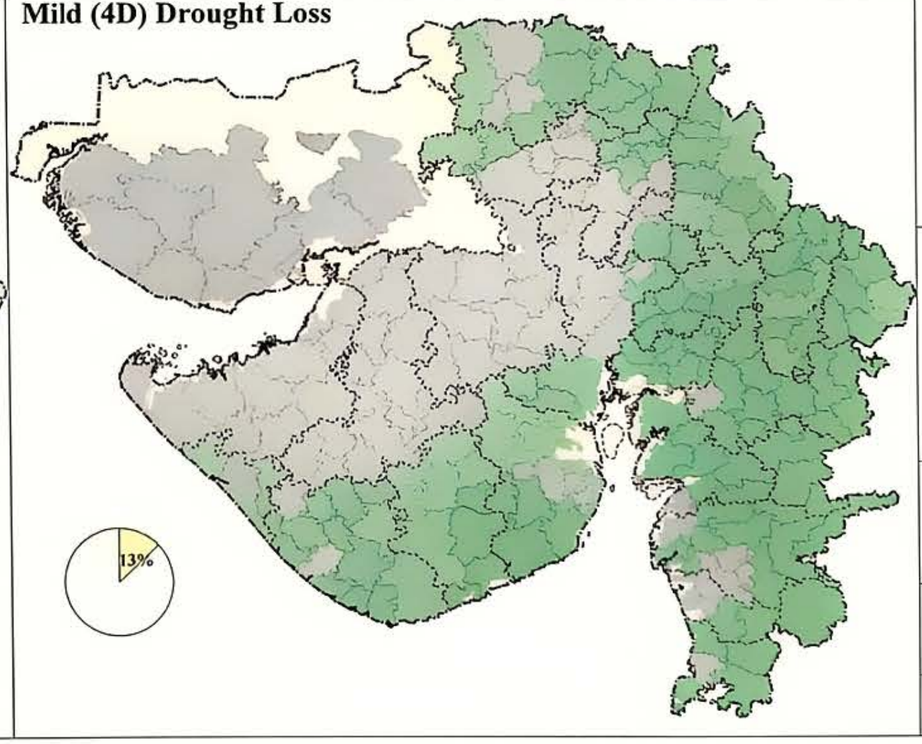
Severe (2D) Drought Loss

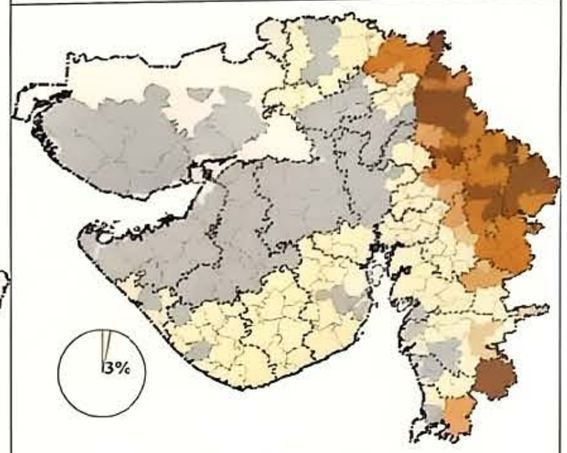


Moderate (3D) Drought Loss



Mild (4D) Drought Loss





Normal (5D) Crop Value (Rs. Million)
- > 0 to 5
- > 5 to 10
- > 10 to 25
- > 25 to 65
- > 65
- No/insignificant production

LEGEND

% Crop Loss
- < 15
- > 15 to 30
- > 30 to 45
- > 45 to 60
- > 60 to 75
- > 75 to 90
- > 90
- No/insignificant production

Inset map pie chart shows the proportion of Maize crop production to total crop production.
Main map pie charts show the proportion of Maize crop loss to total crop loss for the respective decile.

Source: TARU Analysis, 2004; Department of Economics & Statistics, GoG; Department of Agriculture, GoG; FAO/ICRISAT; GAU, Anand; BISAG, GoG.

0 100 km

N

Projection : Lambert Azimuthal Equal Area
Datum : WGS 84

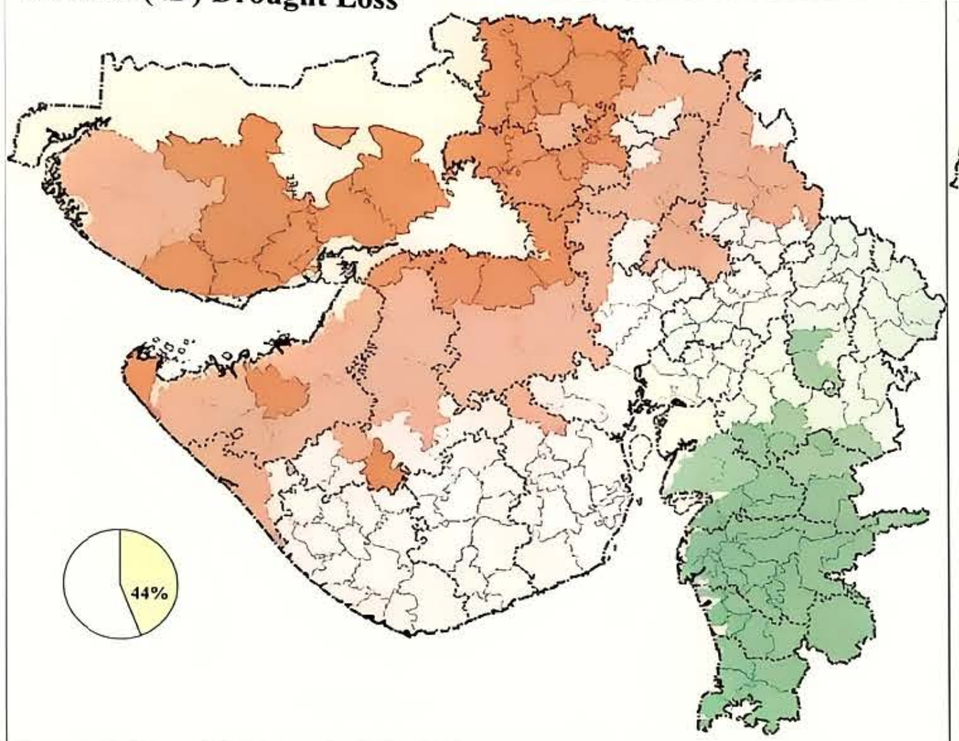
MAP No. : VADM - 06 OF 09

Date : 22/6/2005

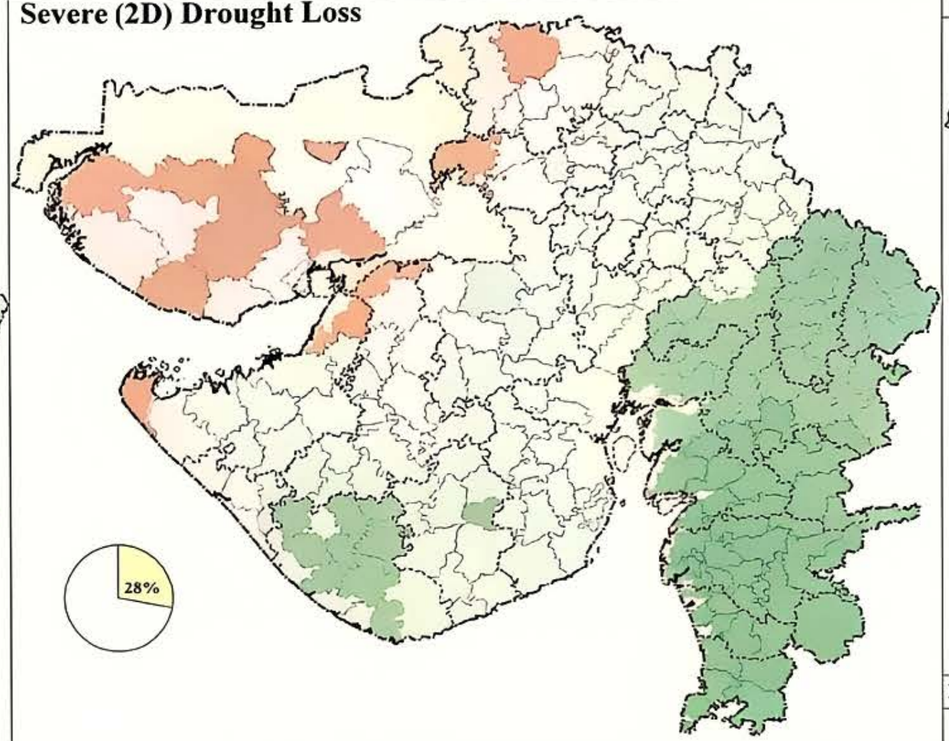
Gujarat Drought Vulnerability Zonation : Pulse Crop Loss (First to Fourth Decile Rainfall)

GSDMA

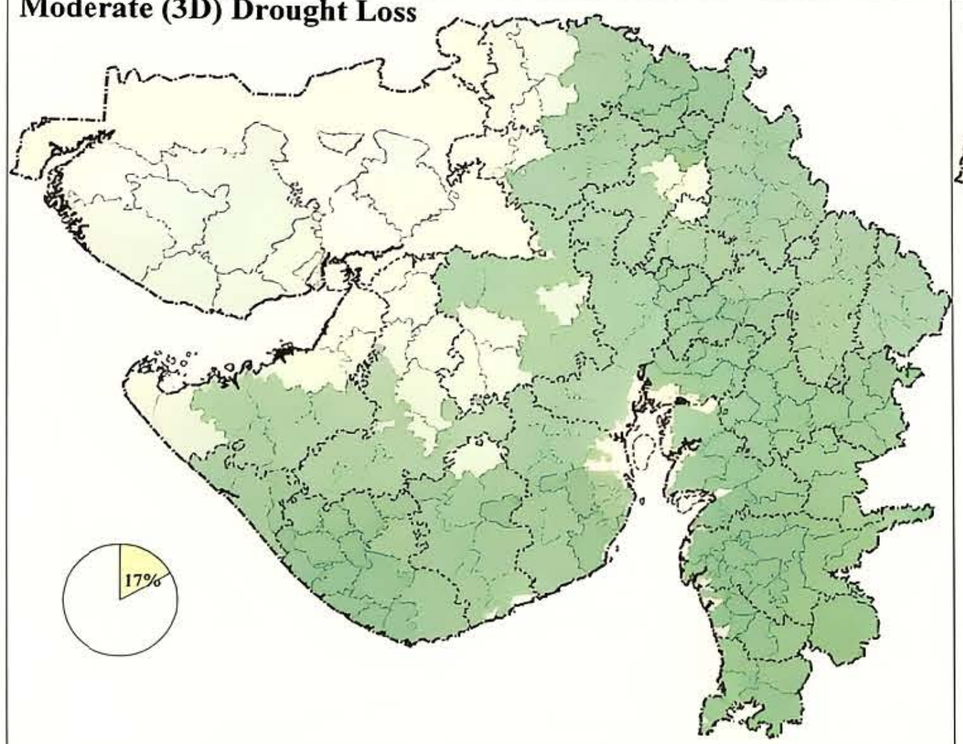
Extreme (1D) Drought Loss



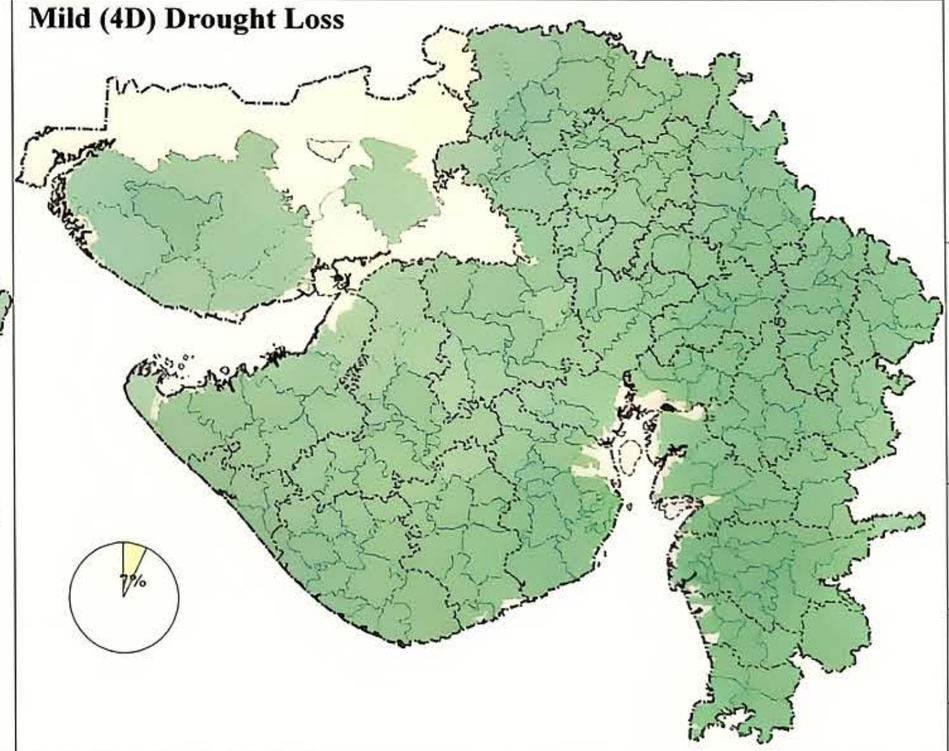
Severe (2D) Drought Loss

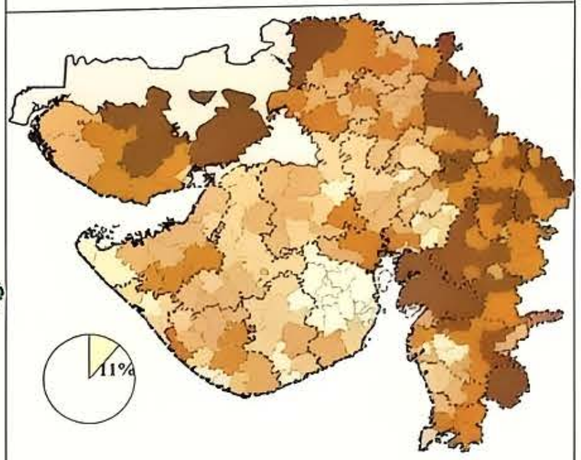


Moderate (3D) Drought Loss



Mild (4D) Drought Loss





Normal (5D) Crop Value (Rs. Million)

- > 0 to 5
- > 5 to 15
- > 15 to 40
- > 40 to 90
- > 90
- No/insignificant production

LEGEND

% Crop Loss

- < 15
- > 15 to 30
- > 30 to 45
- > 45 to 60
- > 60 to 75
- > 75 to 90
- > 90
- No/insignificant production

Inset map pie chart shows the proportion of Pulse crop production to total crop production.
Main map pie charts show the proportion of Pulse crop loss to total crop loss for the respective decile.

Source: TARU Analysis, 2004; Department of Economics & Statistics, GoG; Department of Agriculture, GoG; FAO/ICRISAT; GAU, Anand; BISAG, GoG.

0 100 km

N

Projection : Lambert Azimuthal Equal Area
Datum : WGS 84

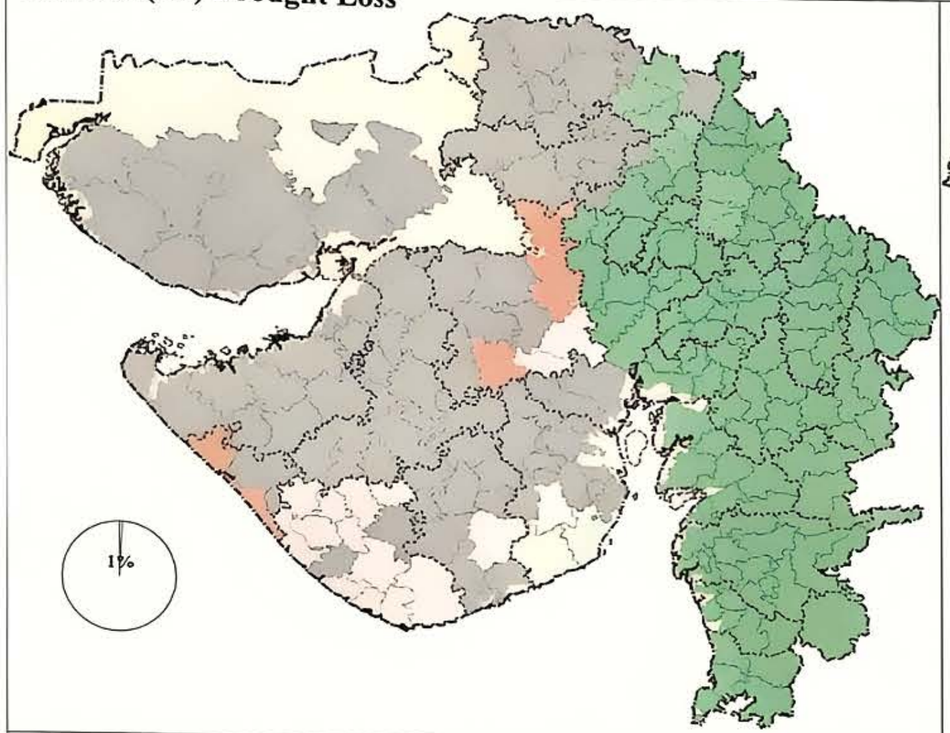
MAP No. : VADM - 07 OF 09

Date : 22/6/2005

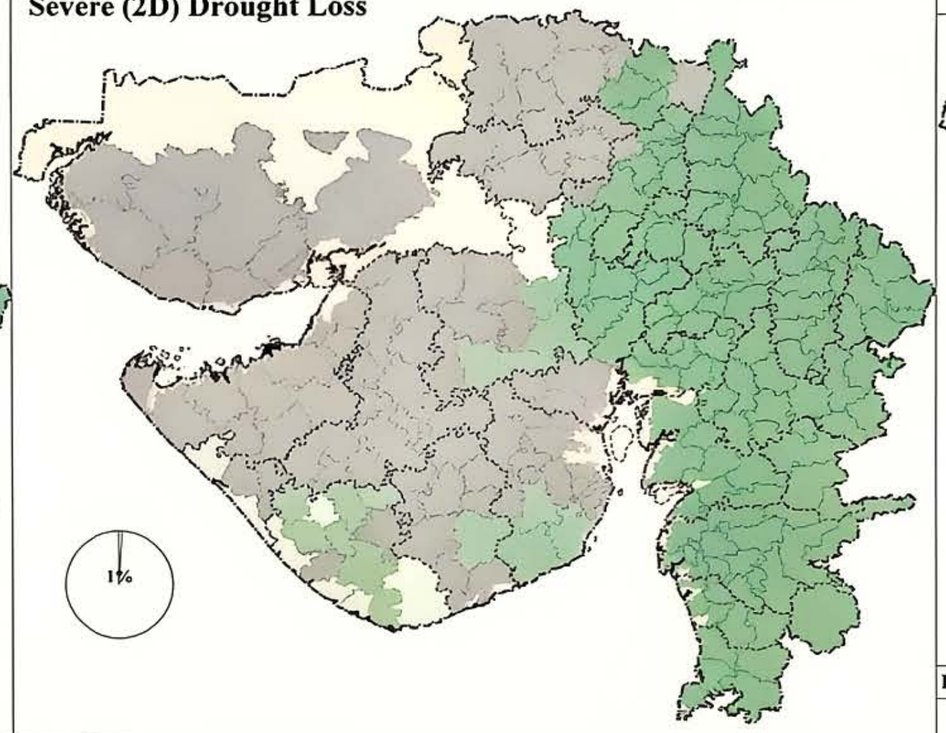
Gujarat Drought Vulnerability Zonation : Rice Crop Loss (First to Fourth Decile Rainfall)

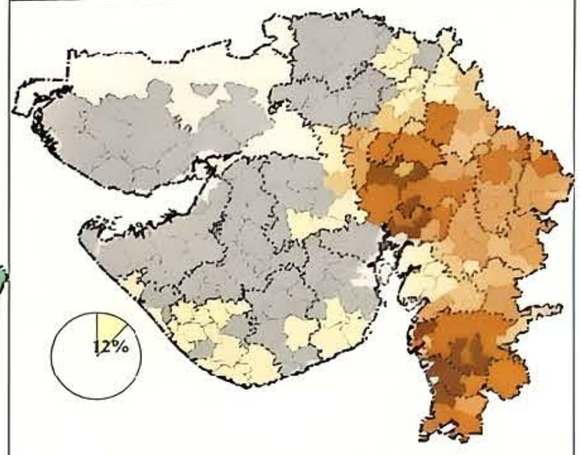
GSDMA

Extreme (1D) Drought Loss



Severe (2D) Drought Loss



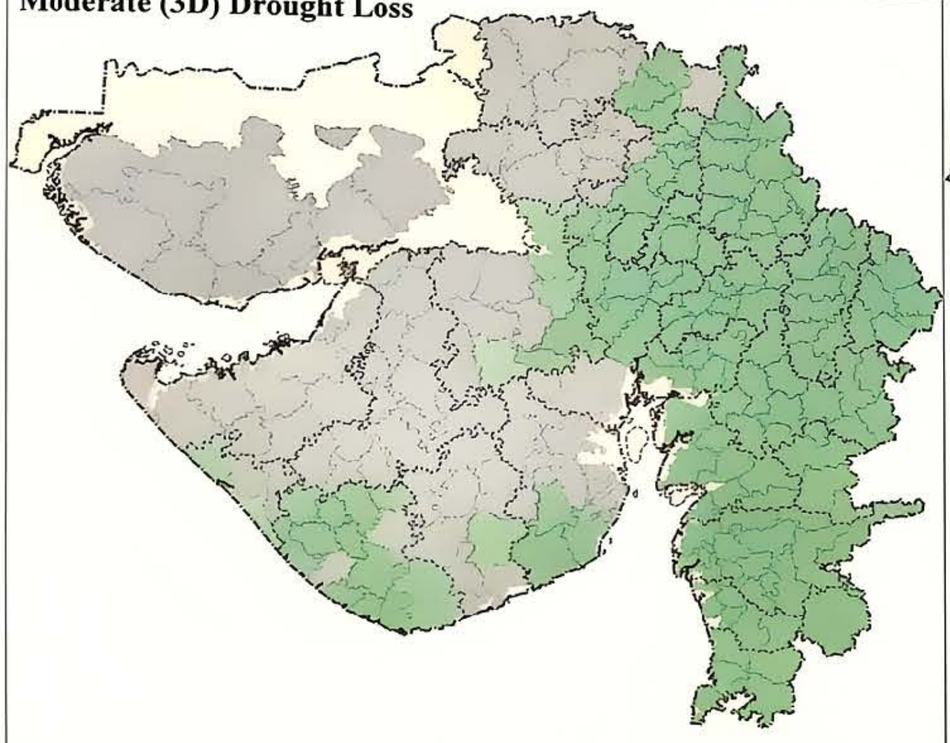


Normal (5D) Crop Value (Rs. Million)

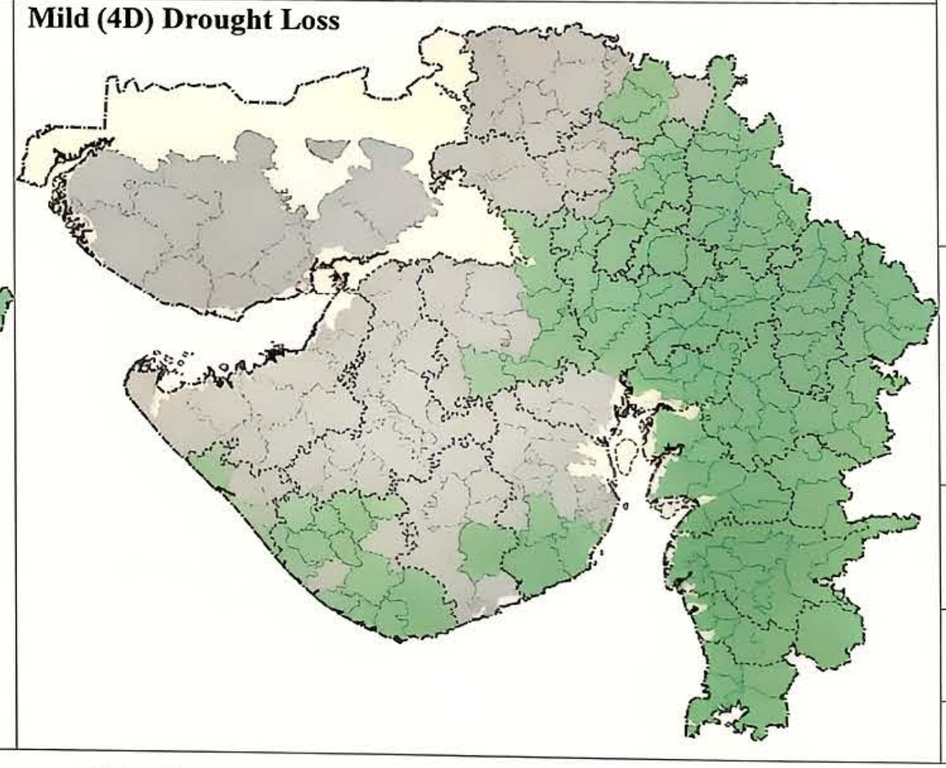
- > 0 to 5
- > 5 to 25
- > 25 to 70
- > 70 to 190
- > 190
- No/insignificant production

LEGEND

Moderate (3D) Drought Loss



Mild (4D) Drought Loss



% Crop Loss

- < 15
- > 15 to 30
- > 30 to 45
- > 45 to 60
- > 60 to 75
- > 75 to 90
- > 90
- No/insignificant production

Inset map pie chart shows the proportion of Rice crop production to total crop production.
Main map pie charts shows the proportion of Rice crop loss to total crop loss for the respective decile.

Source: TARU Analysis, 2004; Department of Economics & Statistics, GoG; Department of Agriculture, GoG; FAO/ICRISAT; GAU, Anand; BISAG, GoG.

0 100 km

N

Projection : Lambert Azimuthal Equal Area
Datum : WGS 84

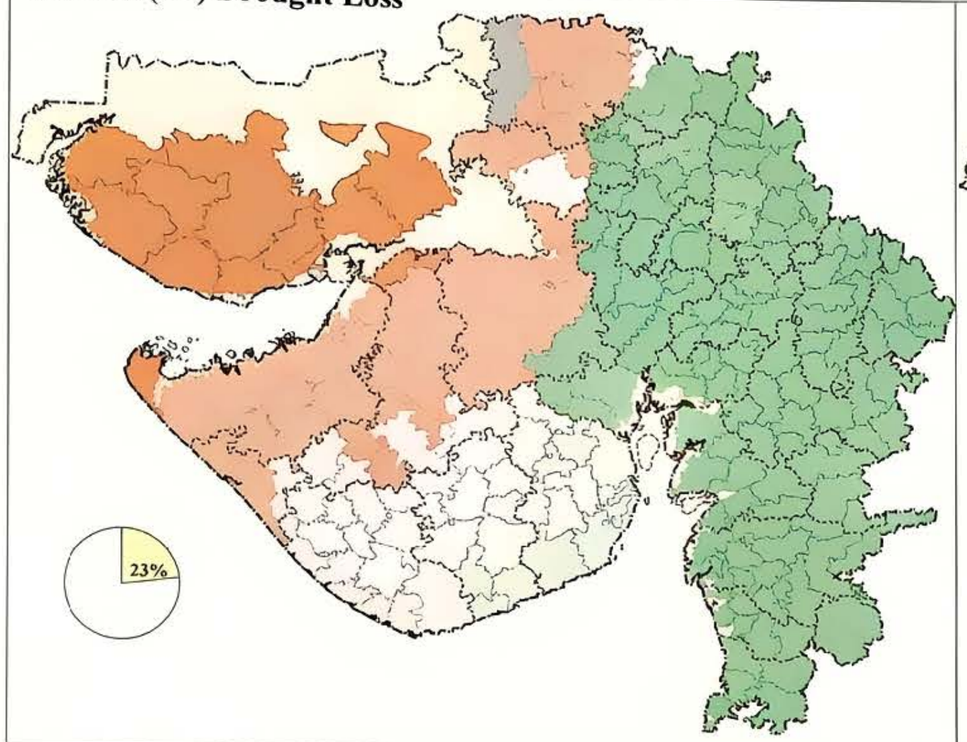
MAP No. : VADM - 08 OF 09

Date : 22/6/2005

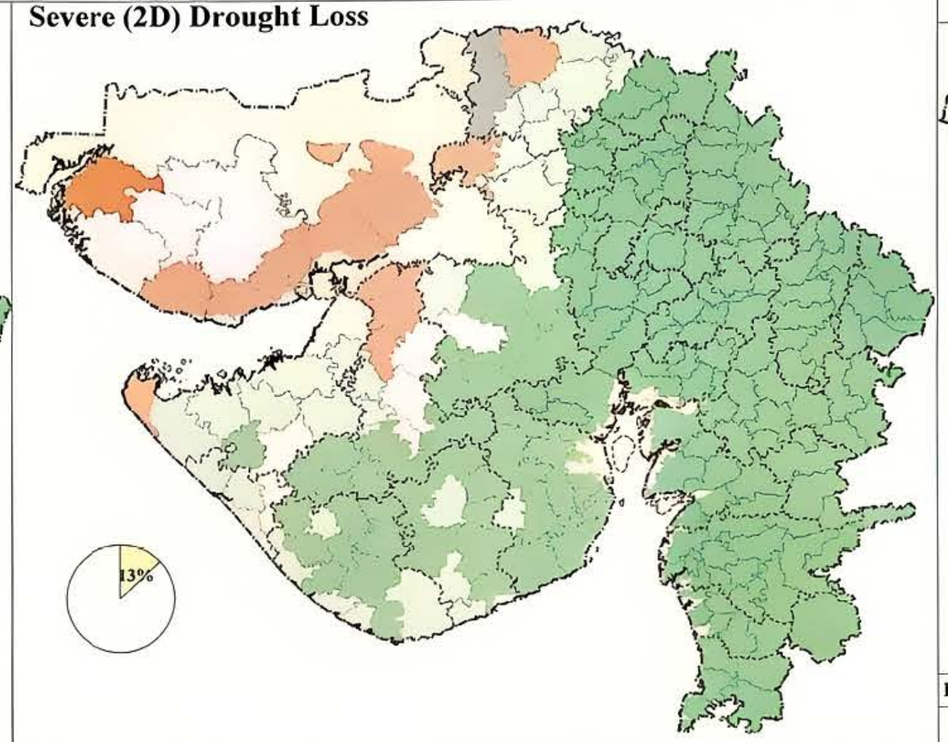
Gujarat Drought Vulnerability Zonation : Wheat Crop Loss (First to Fourth Decile Rainfall)

GSDMA

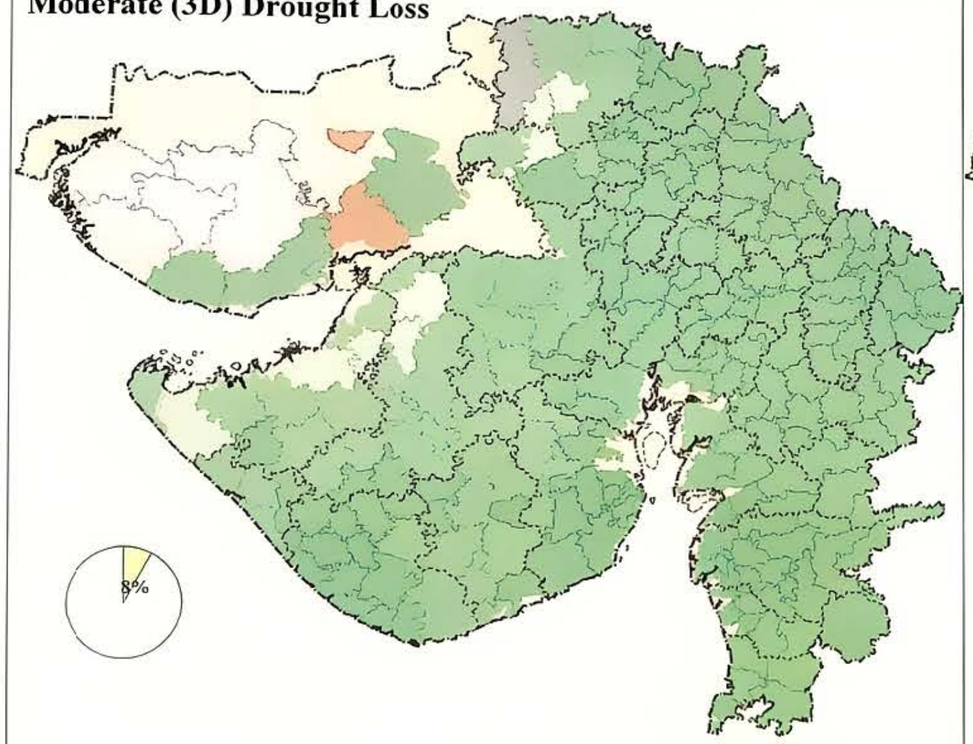
Extreme (1D) Drought Loss



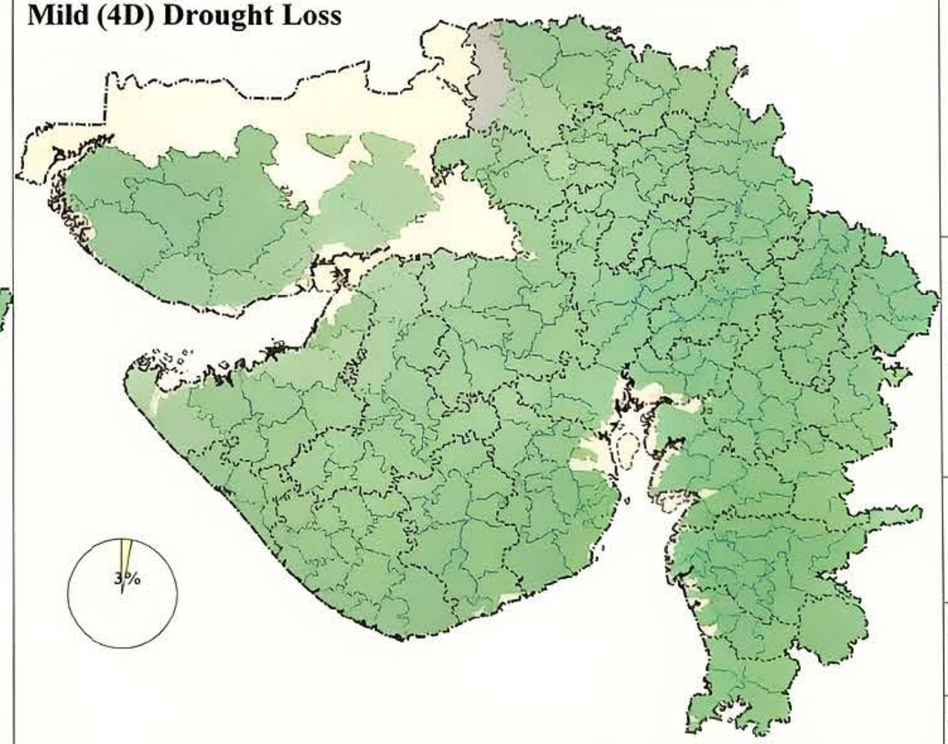
Severe (2D) Drought Loss

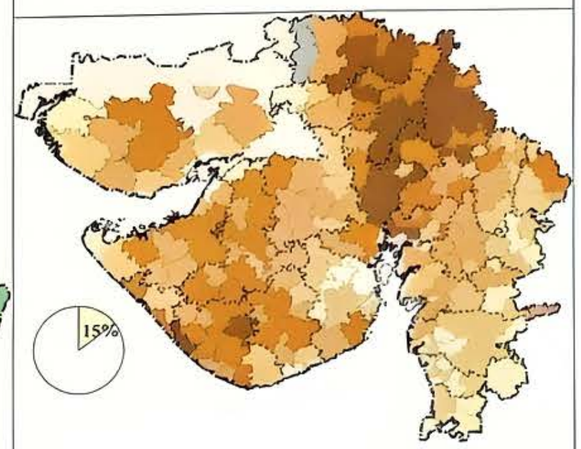


Moderate (3D) Drought Loss



Mild (4D) Drought Loss





Normal (5D) Crop Value (Rs. Million)

- > 0 to 5
- > 5 to 20
- > 20 to 50
- > 50 to 130
- > 130
- No/insignificant production

LEGEND

% Crop Loss

- < 15
- > 15 to 30
- > 30 to 45
- > 45 to 60
- > 60 to 75
- > 75 to 90
- > 90
- No/insignificant production

Inset map pie chart shows the proportion of Wheat crop production to total crop production.
Main map pie charts show the proportion of Wheat crop loss to total crop loss for the respective decile.

Source: TARU Analysis, 2004; Department of Economics & Statistics, GoG; Department of Agriculture, GoG; FAO/ICRISAT; GAU, Anand; BISAG, GoG.

0 100 km

N

Projection : Lambert Azimuthal Equal Area
Datum : WGS 84

MAP No. : VADM - 09 OF 09

Date : 22/6/2005

GUJARAT DROUGHT RISK ZONATION : VALUE OF LOSS OF ALL CROPS (Rs. MILLION 2002-2003 PRICES)

GSDMA

Table No. RADT - 01 of 01

Sr. No	District	Taluka	Normal (5D) production	Loss 1D	Loss 2D	Loss 3D	Loss 4D
1	Ahmadabad	Ahmadabad City	32.3	2.2	1.3	0.6	0.2
2	Ahmadabad	Barwala	184.0	88.3	49.7	27.8	14.8
3	Ahmadabad	Bavla	558.0	75.3	47.9	24.6	12.4
4	Ahmadabad	Daskroi	845.3	73.8	43.0	19.1	5.9
5	Ahmadabad	Detroj-Rampura	187.0	75.2	50.7	31.1	17.4
6	Ahmadabad	Dhandhuka	616.1	295.8	166.4	93.0	49.6
7	Ahmadabad	Dholka	683.9	92.3	58.7	30.2	15.2
8	Ahmadabad	Mandal	266.0	107.0	72.1	44.2	24.8
9	Ahmadabad	Ranpur	167.7	80.5	45.3	25.3	13.5
10	Ahmadabad	Sanand	819.8	54.1	34.0	18.0	5.0
11	Ahmadabad	Viramgam	499.1	200.7	135.2	83.0	46.5
12	Amreli	Amreli	784.8	435.8	292.5	191.2	81.7
13	Amreli	Babra	557.3	307.7	205.1	165.0	87.4
14	Amreli	Bagasara	305.2	168.5	112.7	71.4	38.1
15	Amreli	Dhari	715.1	402.7	283.4	205.7	96.0
16	Amreli	Jafrabad	199.5	103.6	85.2	44.0	19.4
17	Amreli	Khambha	264.0	116.0	100.3	57.7	19.1
18	Amreli	Kunkavav Vadia	507.3	279.0	184.9	114.0	62.6
19	Amreli	Lathi	506.2	291.5	152.5	106.7	47.3
20	Amreli	Lilia	310.0	167.5	99.5	42.4	13.8
21	Amreli	Rajula	602.1	322.9	250.3	104.2	41.1
22	Amreli	Savar Kundla	913.7	433.3	320.0	237.3	81.4
23	Anand	Anand	246.4	18.7	10.3	5.1	1.8
24	Anand	Anklav	406.3	40.1	23.3	10.0	3.8
25	Anand	Borsad	70.4	6.9	4.0	1.7	0.7
26	Anand	Khambhat	645.3	39.4	22.7	11.8	3.8
27	Anand	Petlad	373.6	22.8	13.0	6.9	2.0
28	Anand	Sojitra	197.2	12.0	6.9	3.7	1.1
29	Anand	Tarapur	268.6	16.4	9.4	4.9	1.6
30	Anand	Umreth	134.3	10.2	5.6	2.8	1.0
31	Banas Kantha	Amirgadh	430.9	173.4	97.5	40.6	14.0
32	Banas Kantha	Bhabhar	300.2	221.1	146.1	96.7	21.1
33	Banas Kantha	Danta	331.5	161.4	93.6	29.9	12.0
34	Banas Kantha	Dantiwada	299.0	200.4	132.7	63.9	11.6
35	Banas Kantha	Deesa	1,183.0	804.5	564.9	269.4	60.8
36	Banas Kantha	Deodar	387.7	285.5	188.7	124.9	27.2
37	Banas Kantha	Dhanera	595.8	427.8	287.7	140.1	23.7
38	Banas Kantha	Kankrej	577.6	395.5	265.7	120.4	49.2
39	Banas Kantha	Palanpur	506.7	203.8	114.6	47.8	16.5
40	Banas Kantha	Tharad	636.1	462.4	374.2	261.7	89.8
41	Banas Kantha	Vadgam	533.9	194.3	118.3	46.5	24.1
42	Banas Kantha	Vav	363.4	291.7	204.3	132.9	64.4
43	Bharuch	Amod	454.6	56.3	35.9	20.6	7.6
44	Bharuch	Anklesvar	208.9	17.8	9.6	3.8	1.3
45	Bharuch	Bharuch	548.8	108.7	62.3	27.4	10.0
46	Bharuch	Hansot	242.1	6.6	3.6	1.9	0.6
47	Bharuch	Jambusar	693.8	223.1	142.6	82.3	29.5
48	Bharuch	Jhagadia	402.6	50.7	26.1	11.2	4.2
49	Bharuch	Vagra	468.6	144.3	89.2	54.5	21.6
50	Bharuch	Valia	325.5	33.6	18.0	8.2	4.7
51	Bhavnagar	Bhavnagar	240.0	126.5	76.4	42.7	26.0
52	Bhavnagar	Botad	407.2	215.0	134.3	100.9	50.5
53	Bhavnagar	Gadhada	493.5	266.4	167.3	123.4	62.0
54	Bhavnagar	Gariadhar	507.4	273.1	175.1	92.7	31.2
55	Bhavnagar	Ghogha	229.0	127.6	80.5	45.4	24.1
56	Bhavnagar	Mahuva	1,029.0	538.9	407.4	169.5	60.4
57	Bhavnagar	Palitana	398.5	198.4	133.9	65.8	40.9
58	Bhavnagar	Sihor	331.4	165.5	106.7	49.8	28.7
59	Bhavnagar	Talaja	434.9	188.6	113.2	50.0	0.9
60	Bhavnagar	Umrala	221.4	109.9	60.5	44.8	13.0
61	Bhavnagar	Vallabhipur	175.7	84.8	50.2	33.9	12.6
62	Dohad	Devgadbaria	294.2	109.9	77.4	52.7	19.1
63	Dohad	Dhanpur	189.9	74.2	50.4	36.7	11.8
64	Dohad	Dohad	436.7	155.9	105.8	74.2	44.3
65	Dohad	Fatepura	161.6	43.7	32.6	25.2	9.2
66	Dohad	Garbada	175.2	62.5	42.5	29.8	17.8
67	Dohad	Jhalod	580.5	176.1	134.0	101.5	41.4
68	Dohad	Limkheda	230.5	90.1	61.1	44.5	14.4
69	Gandhinagar	Dehgam	413.7	100.3	60.8	42.4	15.1
70	Gandhinagar	Gandhinagar	446.7	108.3	65.6	45.7	16.3
71	Gandhinagar	Kalol	511.9	93.1	56.5	41.2	14.3
72	Gandhinagar	Mansa	432.3	96.4	65.2	48.1	21.6
73	Jamnagar	Bhanvad	462.0	286.8	159.7	76.9	32.4
74	Jamnagar	Dhrol	466.5	290.5	188.0	143.8	75.5
75	Jamnagar	Jamjodhpur	684.4	434.0	289.2	159.4	52.0
76	Jamnagar	Jamnagar	760.8	525.2	349.7	263.5	75.0
77	Jamnagar	Jodiya	457.9	318.2	265.5	177.2	61.7
78	Jamnagar	Kalavad	909.3	614.2	364.5	223.5	54.2
79	Jamnagar	Kalyanpur	762.8	547.2	349.8	256.1	54.1
80	Jamnagar	Khambhalia	741.5	542.6	300.5	181.3	45.0
81	Jamnagar	Lalpur	664.2	469.3	275.8	110.1	20.1
82	Jamnagar	Okhamandal	99.9	77.5	63.4	34.9	20.0
83	Junagadh	Bhesan	437.8	251.6	140.9	74.9	13.6
84	Junagadh	Junagadh	502.3	290.7	143.6	69.5	21.3
85	Junagadh	Keshod	616.9	367.2	192.1	82.6	17.2
86	Junagadh	Kodinar	497.6	267.2	140.6	68.9	47.3
87	Junagadh	Malia	556.9	329.9	171.3	62.7	22.2
88	Junagadh	Manavadar	526.8	258.0	172.4	79.5	49.9
89	Junagadh	Mangrol	548.6	325.6	202.6	71.8	16.4
90	Junagadh	Mendarda	386.9	233.0	108.4	49.4	16.0
91	Junagadh	Patan-Veraval	89.6	43.0	28.5	7.2	6.8
92	Junagadh	Sutrapada	79.9	38.3	25.4	6.4	6.1
93	Junagadh	Talala	538.8	300.6	153.8	73.4	29.2
94	Junagadh	Una	293.9	164.7	112.5	64.4	27.3
95	Junagadh	Vanthali	353.7	193.8	119.3	46.3	12.5
96	Junagadh	Visavadar	844.7	424.4	268.6	228.7	106.6
97	Kachchh	Abdasa	229.5	160.4	121.1	91.7	33.6
98	Kachchh	Anjar	232.1	192.2	140.0	76.1	57.0
99	Kachchh	Bhachau	418.9	336.6	268.7	224.0	133.9
100	Kachchh	Bhuj	563.0	435.8	303.9	261.2	49.8
101	Kachchh	Gandhidham	37.9	31.3	22.8	12.4	9.3
102	Kachchh	Lakhpat	110.6	76.9	75.7	55.1	15.8
103	Kachchh	Mandvi	401.9	326.8	254.4	126.7	93.9
104	Kachchh	Mundra	162.4	134.8	97.8	55.3	38.7
105	Kachchh	Nakhatrana	561.6	435.7	290.9	269.0	9.3
106	Kachchh	Rapar	467.0	372.6	266.4	169.8	104.5
107	Kheda	Balasinor	202.2	81.8	47.3	30.2	17.9
108	Kheda	Kapadvanj	520.8	222.3	128.0	75.9	41.7
109	Kheda	Kathlal	284.8	121.5	70.0	41.5	22.8
110	Kheda	Kheda	328.7	19.0	10.1	5.1	1.9
111	Kheda	Mahudha	228.7	17.5	10.4	5.1	1.7
112	Kheda	Matar	429.5	17.8	8.6	4.7	1.8
113	Kheda	Mehmedabad	419.6	37.2	21.5	10.3	3.9
114	Kheda	Nadiad	374.3	28.6	17.1	8.3	2.8

GUJARAT DROUGHT RISK ZONATION : VALUE OF LOSS OF ALL CROPS (Rs. MILLION 2002-2003 PRICES)

Table No. RADT - 01 of 01

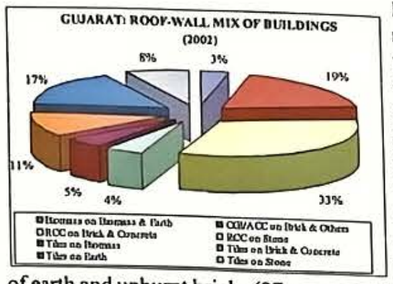
GSDMA

Sr. No	District	Taluka	Normal (5D) production	Loss 1D	Loss 2D	Loss 3D	Loss 4D
115	Kheda	Thasra	421.3	79.7	48.5	28.0	12.2
116	Kheda	Virpur	173.9	70.3	40 6	26.0	15.4
117	Mahesana	Becharaji	281 3	120.2	70.2	40.2	20.1
118	Mahesana	Kadi	621.5	137.4	86.4	63 4	25.5
119	Mahesana	Kheralu	260.2	97.0	59.4	23.2	12.7
120	Mahesana	Mahesana	701.3	240.5	145.0	105 1	55.0
121	Mahesana	Satlasana	247.5	92.3	56.5	22.1	12.0
122	Mahesana	Unjha	246.1	82.4	57.3	28.1	12.7
123	Mahesana	Vadnagar	248.0	92.5	56 6	22.1	12.1
124	Mahesana	Vijapur	695.5	155.5	105.3	77.6	35.0
125	Mahesana	Visnagar	520.5	133.7	88.0	61.3	25.2
126	Narmada	Dediapada	208.5	39.6	17.0	9.3	3.9
127	Narmada	Nandod	434.3	93.9	41.9	21.5	10.6
128	Narmada	Sagbara	327.2	75.7	38.3	23.7	9.3
129	Narmada	Tilakwada	190.2	50.8	28.3	15.0	8.3
130	Navsari	Bansda	214.9	2.6	1 5	0.8	0.3
131	Navsari	Chikhli	590.7	0 6	0.2	0.1	0.1
132	Navsari	Gandevi	279.1	2.2	0.9	0.3	0.2
133	Navsari	Jalalpore	427.3	0.9	0.4	0.2	0.1
134	Navsari	Navsari	213.9	0.5	0.2	0.1	-
135	Panch Mahals	Ghoghamba	251.1	93 8	66.0	45.0	16.3
136	Panch Mahals	Godhra	342.1	100.1	68.5	44.8	23.7
137	Panch Mahals	Halol	229.1	51.1	44.0	32.4	14.3
138	Panch Mahals	Jambughoda	55.2	11.3	9.3	6.1	3.0
139	Panch Mahals	Kadana	215.7	58.3	43.5	33.7	12.2
140	Panch Mahals	Kalol	237.0	44.4	34.2	24.7	11.2
141	Panch Mahals	Khanpur	218.6	37.4	25.7	17.9	8.9
142	Panch Mahals	Lunawada	430.2	73.7	50.6	35.2	17 4
143	Panch Mahals	Morwa (Hadaf)	144.3	42.2	28.9	18.9	10.0
144	Panch Mahals	Santrampur	293.7	79.3	59.2	45.9	16.6
145	Panch Mahals	Shehera	294.1	68.1	43.6	27.3	13.7
146	Patan	Chanasma	316.5	135.2	79.0	45.2	22.6
147	Patan	Harij	205.6	142.5	82.1	42.8	19.5
148	Patan	Patan	590.6	236.2	150.8	81.2	40.1
149	Patan	Radhanpur	198.8	143.1	94.5	60.9	9.4
150	Patan	Sami	445.2	320.4	205.0	96.9	31.5
151	Patan	Santalpur	211.7	155.2	124.1	68.1	30.9
152	Patan	Sidhpur	284.4	95.2	66.2	32.5	14.6
153	Patan	Vagdod	200.9	80.4	51.3	27.6	13.6
154	Porbandar	Kutiyana	146.8	71.7	67.4	18.9	15.6
155	Porbandar	Porbandar	532.6	355.5	256.5	151.9	61.7
156	Porbandar	Ranavav	35.8	23.8	16.8	9 6	4.0
157	Rajkot	Dhoraji	429.1	229.5	144.8	75.2	41.1
158	Rajkot	Gondal	902.7	515.5	329.5	237.8	87.0
159	Rajkot	Jamkandorna	363.5	234.0	129.4	88.6	31.1
160	Rajkot	Jasdan	605.4	333.0	210.6	166.5	76.0
161	Rajkot	Jetpur	607.7	416.2	220.1	108 9	53.6
162	Rajkot	Kotda Sangani	296.2	176.6	122.2	89.3	24.9
163	Rajkot	Lodhika	246.8	151.7	99.1	68.4	19.7
164	Rajkot	Maliya	223.8	169.6	139.3	82.1	46.6
165	Rajkot	Morvi	534.3	312.5	254.5	159.0	86.7
166	Rajkot	Paddhari	403 6	245.6	154.2	91 3	48.7
167	Rajkot	Rajkot	527.1	328.1	223.1	154.7	69.7
168	Rajkot	Tankara	333.3	195.8	155.5	96.7	52.6
169	Rajkot	Upleta	625 8	342.5	220.3	151.0	54.0
170	Rajkot	Wankaner	365 5	247.1	166 0	106 9	49.6
171	Sabar Kantha	Bayad	692 6	274.3	183.2	130.2	71.0
172	Sabar Kantha	Bhiloda	661.1	278.5	190.1	124.6	44.5
173	Sabar Kantha	Dhansura	370.4	155.6	106.2	76.1	29.4
174	Sabar Kantha	Himatnagar	867.0	315.4	212.6	132.9	48.8
175	Sabar Kantha	Idar	948.9	356.9	215.7	119.3	35.1
176	Sabar Kantha	Khedbrahma	524.7	254.4	155.7	69.9	29.8
177	Sabar Kantha	Malpur	268.3	97 0	62.8	47.9	15.4
178	Sabar Kantha	Meghraj	412.0	175.5	120.9	90.3	25.1
179	Sabar Kantha	Modasa	630.3	274 7	190.0	136.8	40.5
180	Sabar Kantha	Prantij	549.9	173.7	120.7	70.4	32.3
181	Sabar Kantha	Talod	573.2	181.2	125.9	73.5	33.8
182	Sabar Kantha	Vadali	366.7	138.7	83.9	46.2	13.7
183	Sabar Kantha	Vijaynagar	247.7	100.6	68.4	41.0	17.4
184	Surat	Bardoli	294.8	0.3	0.1	0.1	-
185	Surat	Chorasi	141.1	4.4	1.4	0.8	0.3
186	Surat	Kamrej	104.8	0.7	0.3	0.1	-
187	Surat	Mahuva	341.4	0.5	0.3	0.1	0 1
188	Surat	Mandvi	444.6	25.2	11.5	5.4	1.7
189	Surat	Mangrol	461.5	49.0	22.6	9.9	4.9
190	Surat	Nizar	220.9	21.3	10.4	5.0	2.0
191	Surat	Olpad	711.4	5.0	2.2	1.1	0.4
192	Surat	Palsana	75.1	0.1	-	-	-
193	Surat	Songadh	492.8	29.3	15.8	6.6	2.2
194	Surat	Surat City	30.0	0.9	0.3	0.2	0 1
195	Surat	Uchchhal	96.7	2.3	1.2	0.4	0.1
196	Surat	Umarpada	331.7	35.2	16.3	7 1	3.5
197	Surat	Valod	180.4	2.6	1.3	0.7	0.2
198	Surat	Vyara	697.9	8.8	4.9	1.9	0 4
199	Surendranagar	Chotila	287.1	198.6	111.3	87.1	41.3
200	Surendranagar	Chuda	151.5	78.7	51.5	29.1	19.1
201	Surendranagar	Dasada	292.2	193.8	114.1	50.0	22.2
202	Surendranagar	Dhrangadhra	539.1	390.4	164.0	116.6	54.3
203	Surendranagar	Halvad	740.0	535.8	328.0	149.9	104 4
204	Surendranagar	Lakhtar	150.9	88.5	51.0	38.4	20.1
205	Surendranagar	Limbdi	337.5	175.3	114.7	64.8	42.4
206	Surendranagar	Muli	451.8	310.5	202.8	124.6	59.2
207	Surendranagar	Sayla	334.1	221.0	117.7	95.0	36.0
208	Surendranagar	Wadhwan	249.0	164.1	82.7	66.3	27.2
209	The Dangs	The Dangs	492.3	98.4	55.7	20.0	5.8
210	Vadodara	Chhota Udaipur	337.1	108.1	62.9	39.1	18.8
211	Vadodara	Dabhoi	647.3	98.5	61.8	35.2	13.2
212	Vadodara	Jetpur Pavi	508.7	79.4	51.4	31.5	15 8
213	Vadodara	Karjan	647.7	60.3	33.2	18.6	6.0
214	Vadodara	Kavant	263.3	84.5	49.1	30.5	14.7
215	Vadodara	Nasvadi	302.6	79.8	41.7	22.7	11.5
216	Vadodara	Padra	378.6	80.6	50.3	29.4	7.6
217	Vadodara	Sankheda	567.1	137.2	94.8	56.4	28.5
218	Vadodara	Savli	449.0	139.7	84 1	51.8	21.8
219	Vadodara	Sinor	357.4	27.4	14.7	7.9	3.6
220	Vadodara	Vadodara	351.2	74.7	38.7	21 1	5 6
221	Vadodara	Vaghodia	397 0	112 4	79.6	46.8	19.0
222	Valsad	Dharampur	152.9	-		-	
223	Valsad	Kaprada	196.4	-	-	-	
224	Valsad	Pardi	185.4	-	-		
225	Valsad	Umbergaon	102.3	-	-		-
226	Valsad	Valsad	229.7				

BUILDING VULNERABILITY & RISK

BUILDINGS IN GUJARAT

The total number of buildings in Gujarat was over 12.4 million (Census 2001). The predominant use was residential (73 percent), residential-cum-commercial and other uses (17 percent), and non-residential (industrial, commercial, institutional) (9 percent). One- and two-room houses account for majority of the urban (73 percent) and rural (86 percent) houses.



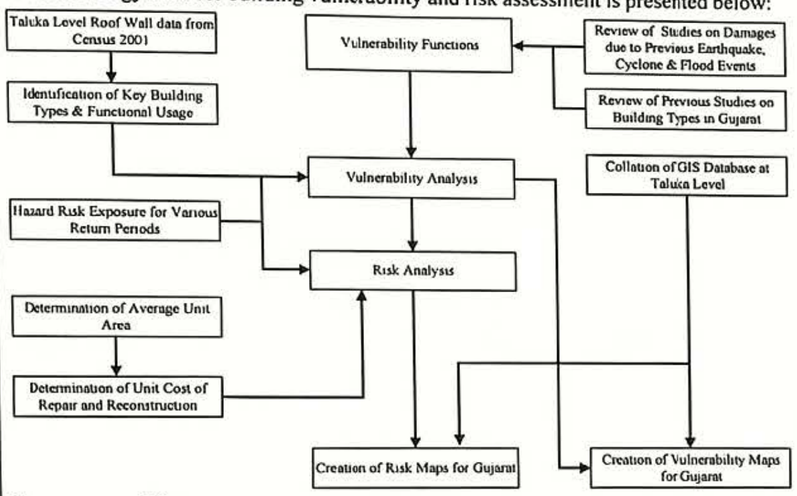
RCC (59 percent) is the most common urban roof type followed by ACC or CGI sheets (23 percent). Tile roofs (60 percent) are the most common rural roof type followed by RCC (16 percent), and CGI and ACC sheet (15 percent). There has been a shift away from tile to RCC and sheet roofing over the last decade.

The predominant material of wall construction in urban areas is brick (75 percent). Rural houses are most commonly constructed out of earth and unburnt bricks (37 percent), closely followed by brick (36 percent) and stone (14 percent).

The primary challenge to physical vulnerability assessment in Gujarat is the overwhelming proportion of non-engineered or partially engineered structures for which formal building codes have limited application. Even buildings erected in conventional materials (e.g. RCC) effectively behave as partially engineered structures as observed in the damage to multi-storied buildings in Ahmedabad (TARU/BMPTC, 2001; GSDMA/CEPT, 2001). Therefore, the use of previous studies to benchmark the building vulnerability analysis has been crucial.

DATA SOURCES AND METHODOLOGY

A methodology used for building vulnerability and risk assessment is presented below:

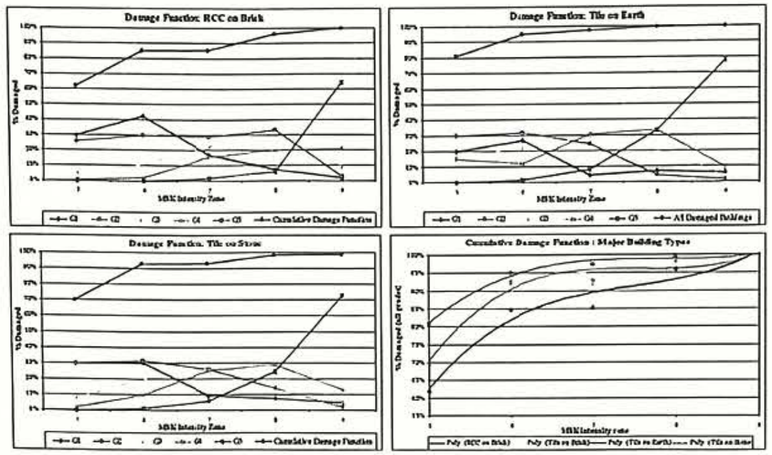


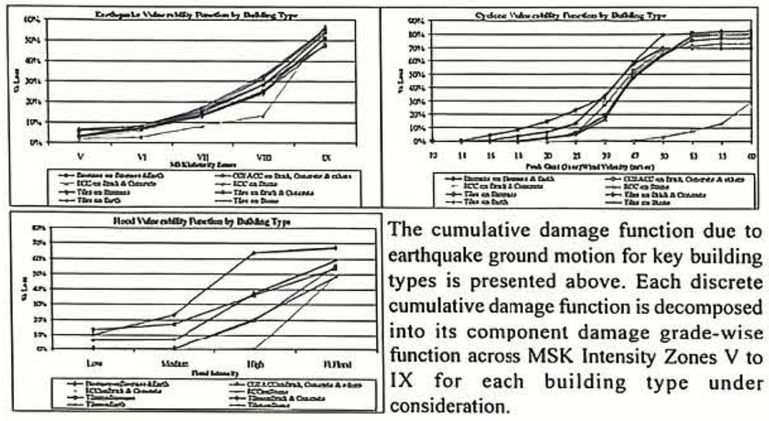
Key sources of data:

- Census 2001: Taluka-wise building inventories and roof wall matrix
- TARU Primary Studies Gujarat, 2004
- TARU (1991-2004) Building Damage Studies
- Studies conducted by TARU (1991-1997) on Gujarat housing and building
- Various BIS publications
- Various Damage Scales (MSK, STCS)

VULNERABILITY FUNCTIONS

Historical datasets of loss, repair and reconstruction costs were used to estimate building vulnerability at different damage grades caused by earthquakes, cyclone and flood. For earthquakes, the MSK scale was used, for cyclones, the modified SS scale and the TARU flood damage scale (TARU 1997, 1998, 1999) were used. These functions were estimated using discrete proportional losses to specified damage grades across building types (by material of construction).



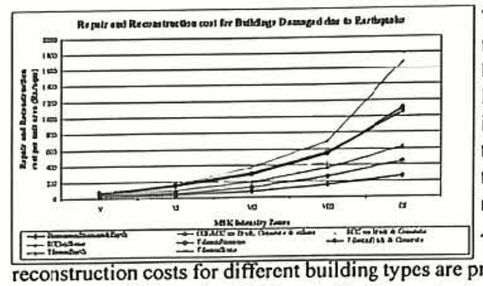


The cumulative damage function due to earthquake ground motion for key building types is presented above. Each discrete cumulative damage function is decomposed into its component damage grade-wise function across MSK Intensity Zones V to IX for each building type under consideration.

The cumulative losses to various building types across different damage grades and respective damage and repair ratios are presented in adjoining figure. Stone and earth walled buildings are the most vulnerable type due to earthquake ground motion % especially those with heavy roofs (e.g. RCC on stone). Framed structures with RCC on brick and concrete suffer lower damage

Tile and thatch roofed buildings typically suffer higher loss due to cyclonic winds and therefore have higher repair ratios. RCC roofed buildings are typically unaffected by moderate to high wind velocities.

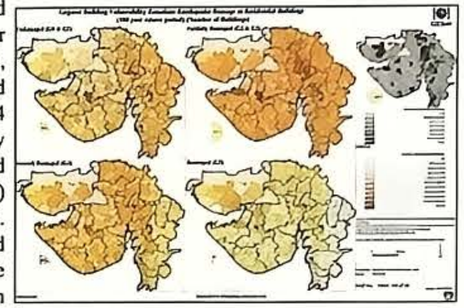
Flood induced damages are directly related to material of wall and mortar type. Hence the vulnerability reflects the influence of low cohesion wall materials (e.g. earth). These functions are only indicative as there is no data in Gujarat on the hydrodynamic action of flood and the relative impact of long duration inundation.

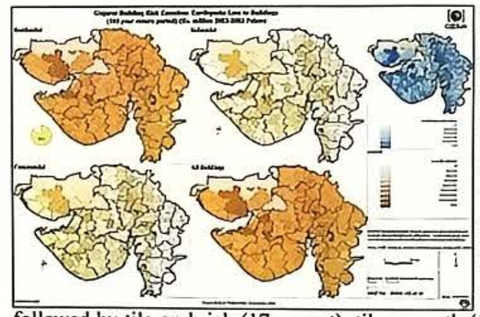


These vulnerability curves if read together indicate that RCC frame and brick load bearing structures with RCC roofs are the least vulnerable in Gujarat. However, the unit cost of these buildings is often three to four times that of more affordable tile roofed buildings.

The unit earthquake repair and reconstruction costs for different building types are presented in the adjoining figure. The repair cost is highest for RCC roofed buildings due to the higher cost of raw material and labour, and the lower recycling potential of these buildings. These repair and reconstruction costs were utilized to derive risk functions and loss functions based on probabilistic seismic hazard assessment.

The total proportion of destroyed residential buildings was estimated for each hazard. In the case of earthquake, this was 5 percent destroyed compared to 20 percent of severely damaged (G4 buildings), 51 percent partially damaged (G2 and G3) buildings and 24 percent undamaged (G0 and G1) buildings for a 100-year return period. The proportion of damaged and severely damaged buildings are estimated to increase dramatically from the 1 percent to 8 percent respectively for the 50-year return period.





The bulk of earthquake risk to buildings in Gujarat is to residential buildings because of the large share (87 percent) of these buildings to the overall building stock in the state. The mean loss across all end-use categories is estimated at 11 percent with a concentration in the highly risk prone talukas of Kachchh and Saurashtra, and major urban centres. The highest proportional loss is to RCC on brick buildings (38 percent) followed by tile on brick (17percent), tile on earth (16 percent), CGI and ACC roofs (9 percent) and RCC on stone (8 percent).

CONCLUSIONS

Buildings in Gujarat are significantly at risk as demonstrated repeatedly by the 1998 cyclone, 2001 earthquake and 2004 floods. Earthquakes are expected to cause the most significant loss over a 100-year return period followed by cyclones and flood at a lower level. Variable risk to buildings is observed due to the significant differential vulnerability of particular building types, wide spatial variation in exposure levels to hazards and the varied concentrations of key building types.

Mitigation planning would, therefore, need to take into account these variations at taluka and district level to be able to reduce the overall risk and vulnerability of buildings in the state. This assignment presents a structured method of defining, updating and refining vulnerability and risk estimates by updating the building inventory (typically every decade after the Census) and vulnerability functions as improved research results become available.

Gujarat Risk & Vulnerability Zonation : Major Building Types

GSDMA



Source : TARU Analysis, 2004; SRTM, 2003; ETOPO, 2003; BISAG, GoG.

Projection : Lambert Azimuthal Equal Area
Datum : WGS 84

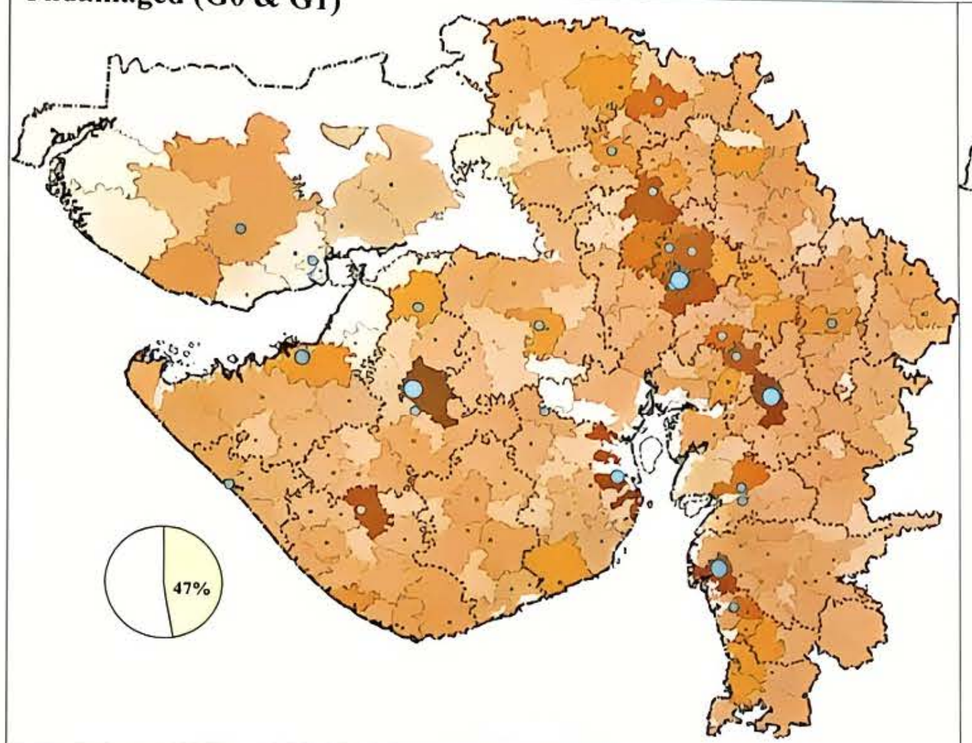
MAP No. : BLTM - 01 OF 01

Date : 13/7/2005

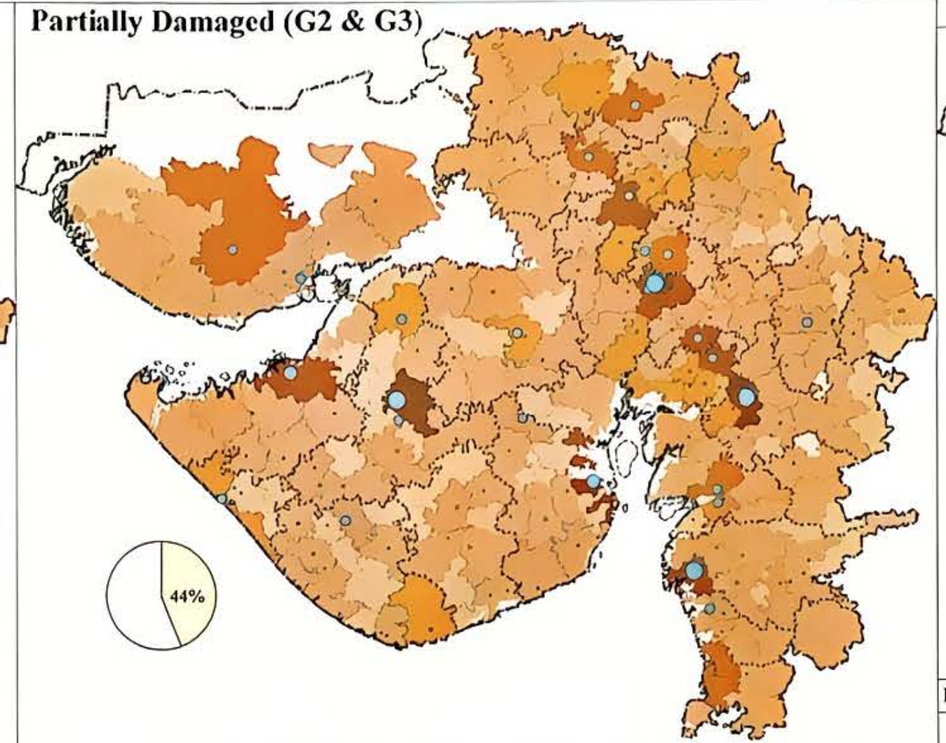
Gujarat Building Vulnerability Zonation: Earthquake Damage to Buildings
(50 year return period) (Number of Buildings)

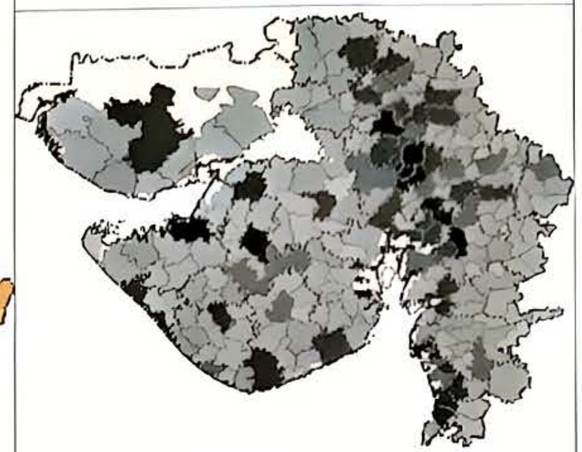
GSDMA

Undamaged (G0 & G1)



Partially Damaged (G2 & G3)

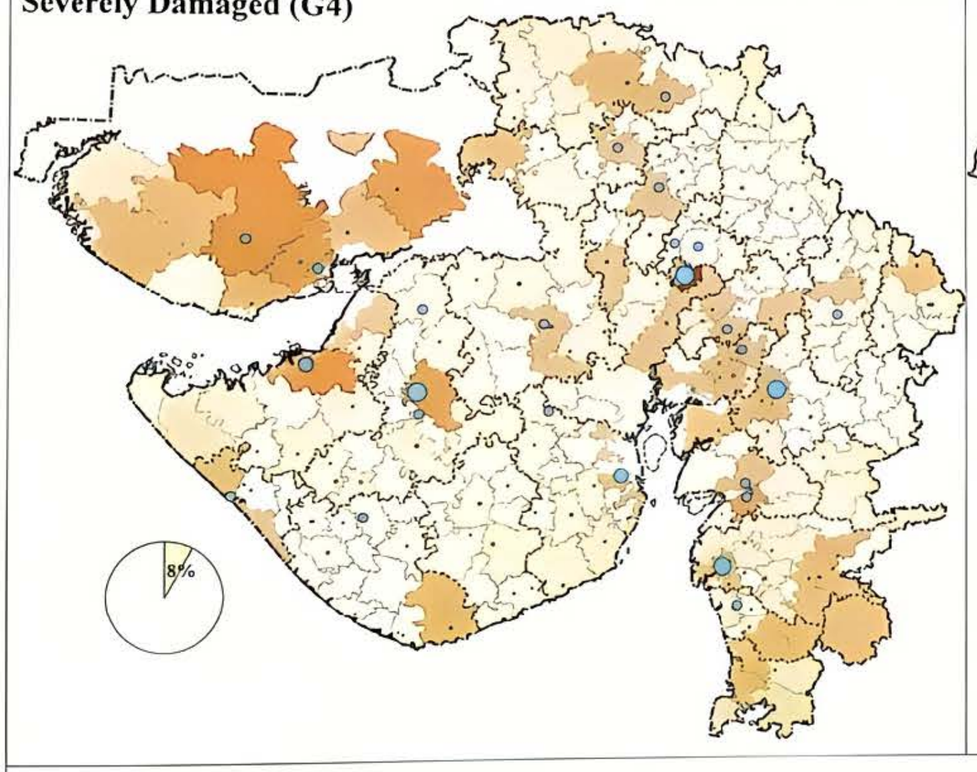




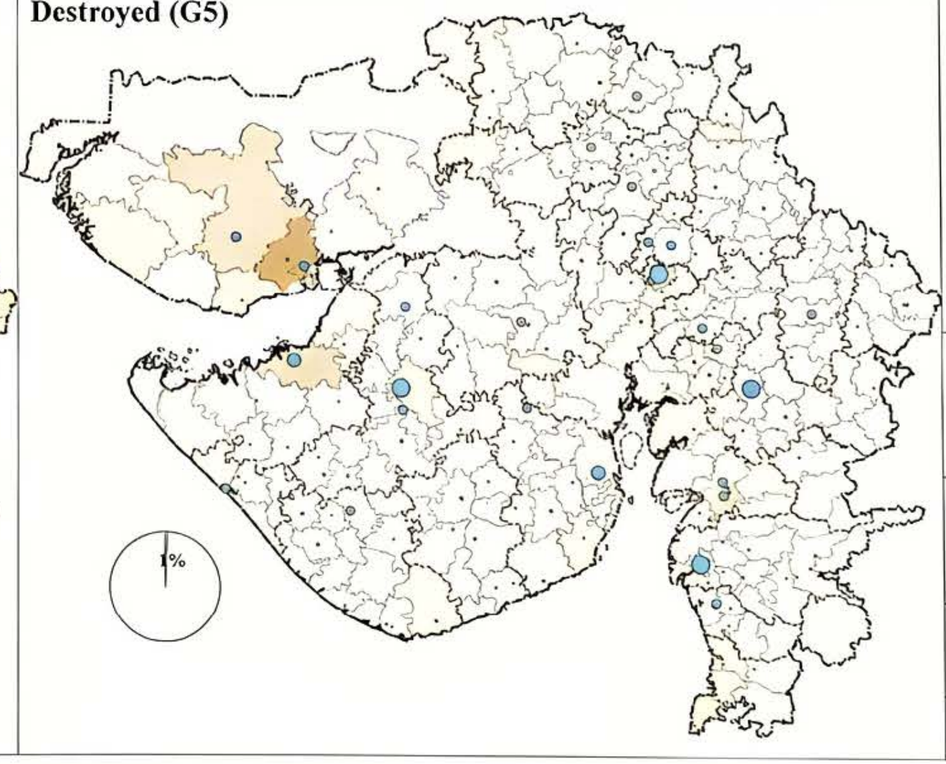
Total Number of Buildings
- < 20000
- > 20000 to 25000
- > 25000 to 30000
- > 30000 to 40000
- > 40000 to 50000
- > 50000 to 60000
- > 60000 to 100000
- > 100000

LEGEND

Severely Damaged (G4)



Destroyed (G5)



Number of Damaged Buildings
- < 500
- > 500 to 1000
- > 1000 to 2500
- > 2500 to 5000
- > 5000 to 10000
- > 10000 to 20000
- > 20000 to 30000
- > 30000 to 40000
- > 40000 to 50000
- > 50000 to 100000
- > 100000
- Urban Centres

Sizes of the urban centres are varying according to their populations.

Main map pie charts show the proportion of number of buildings in respective damage grade to total number of buildings in the all building types.
Building damage classification based on MSK scale.

Source: TARU Studies & Analysis, 1993-2004, Census of India, 2001; BISAG, GoG

0 100 km

N

Projection : Lambert Azimuthal Equal Area
Datum : WGS 84

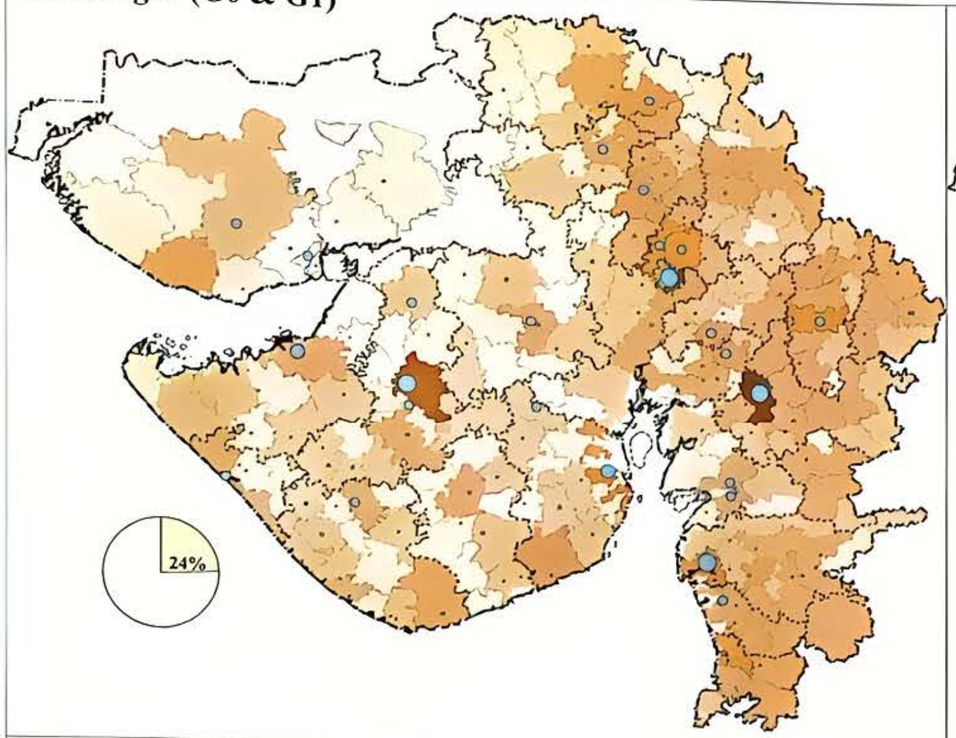
MAP No. : VBLM - 01 OF 07

Date : 16/6/2005

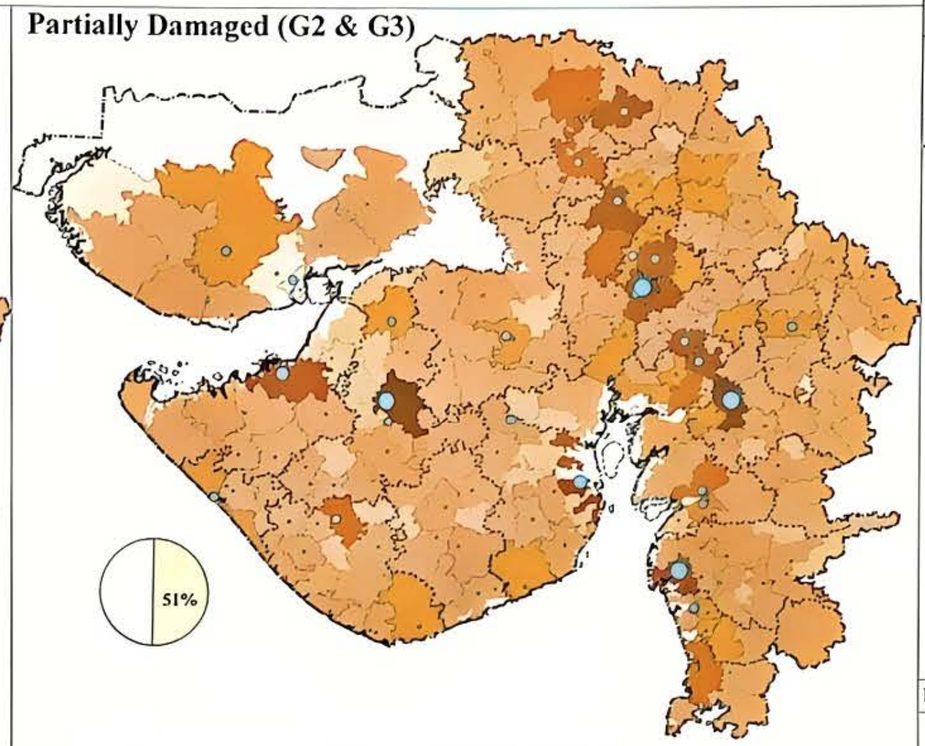
Gujarat Building Vulnerability Zonation: Earthquake Damage to Buildings
(100 year return period) (Number of Buildings)

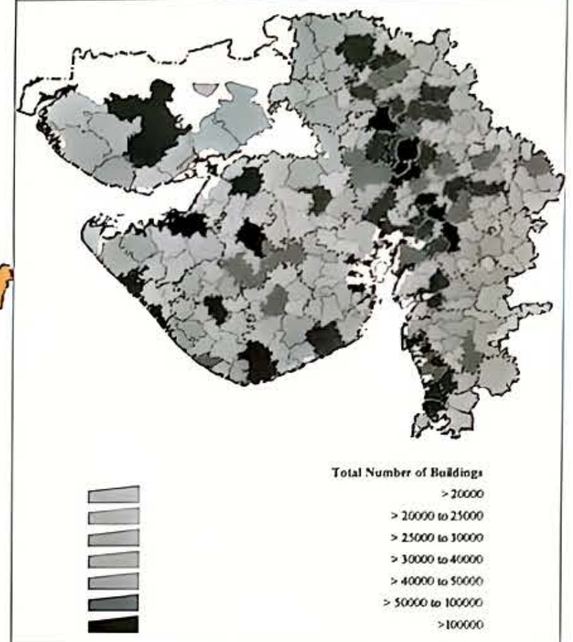
GSDMA

Undamaged (G0 & G1)



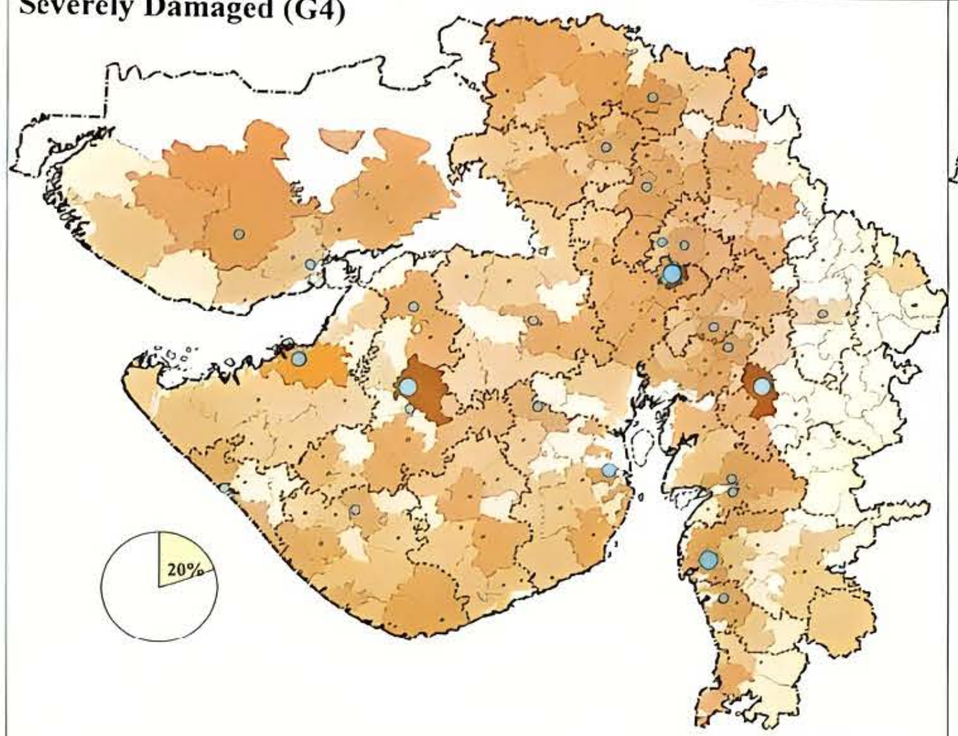
Partially Damaged (G2 & G3)



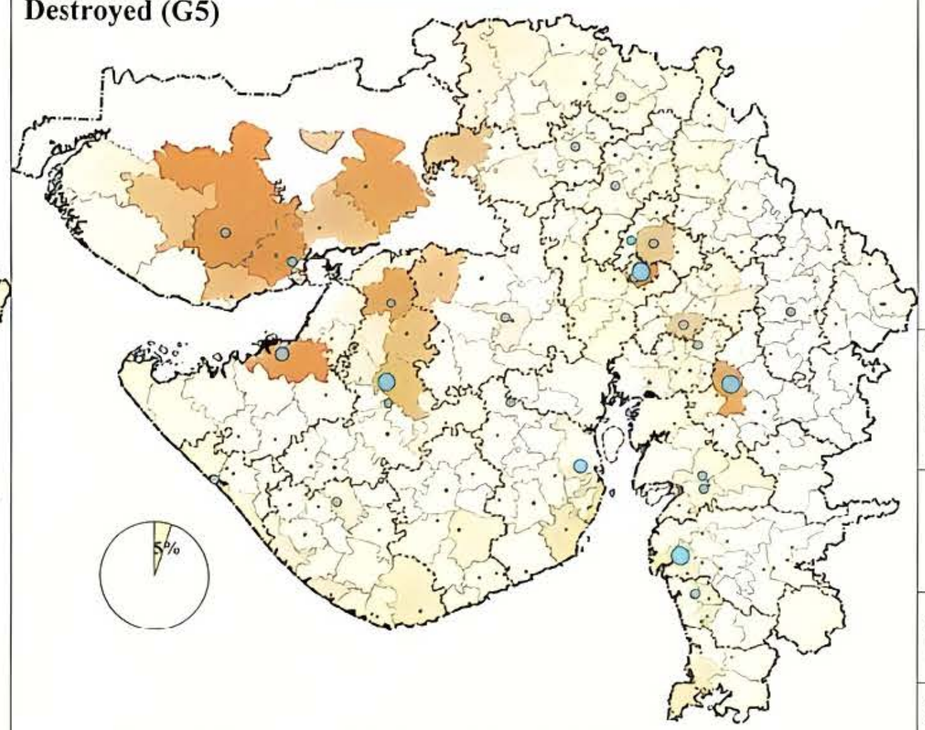


LEGEND

Severely Damaged (G4)



Destroyed (G5)



Number of Damaged Buildings
< 500
> 500 to 1000
> 1000 to 2500
> 2500 to 5000
> 5000 to 10000
> 10000 to 20000
> 20000 to 30000
> 30000 to 40000
> 40000 to 50000
> 50000 to 100000
> 100000
Urban Centres

Sizes of the urban centres are varying according to their populations

Main map pie charts show the proportion of number of buildings in respective damage grade to total number of buildings in the mentioned building type
Building damage classification based on MSK scale

Source TARU Studies & Analysis, 1993-2004, Census of India, 2001, BISAG, GoG

0 100 km

N

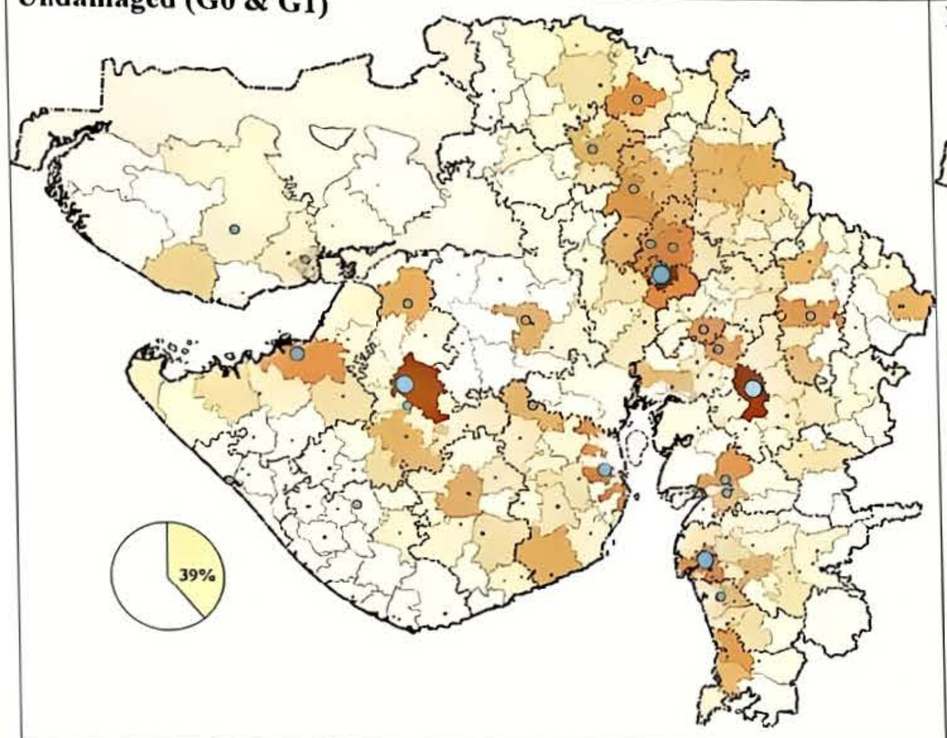
Projection : Lambert Azimuthal Equal Area
Datum : WGS 84

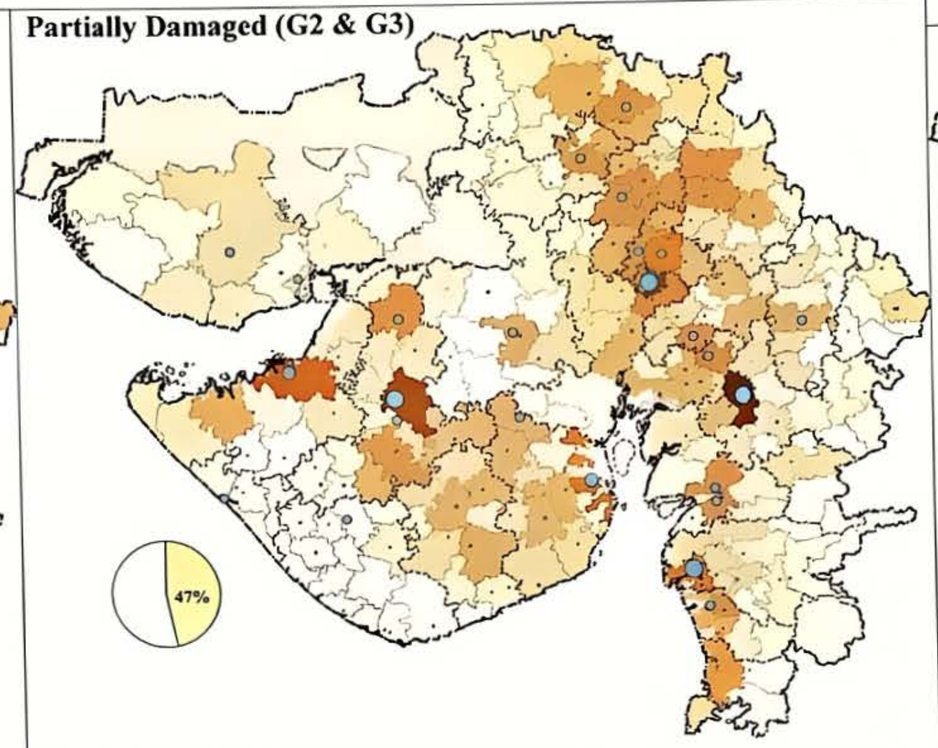
MAP No. : VBLM - 02 OF 07

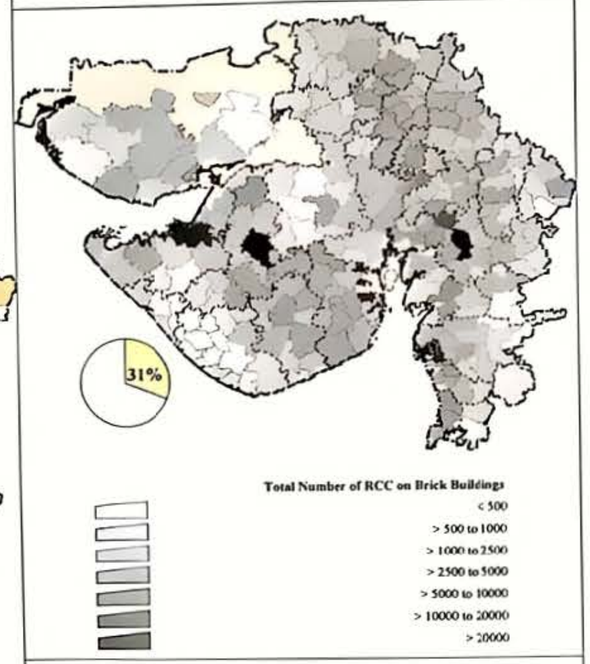
Date : 16/6/2005

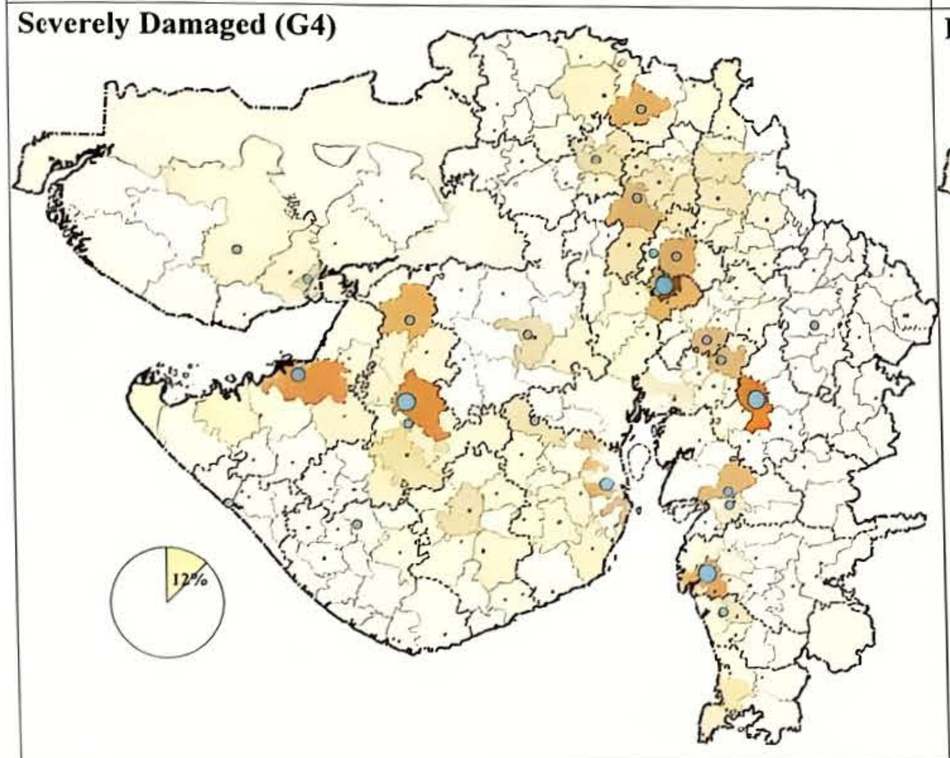
Gujarat Building Vulnerability Zonation: Earthquake Damage to RCC on Brick Residential Buildings (100 year return period) (Number of Buildings)

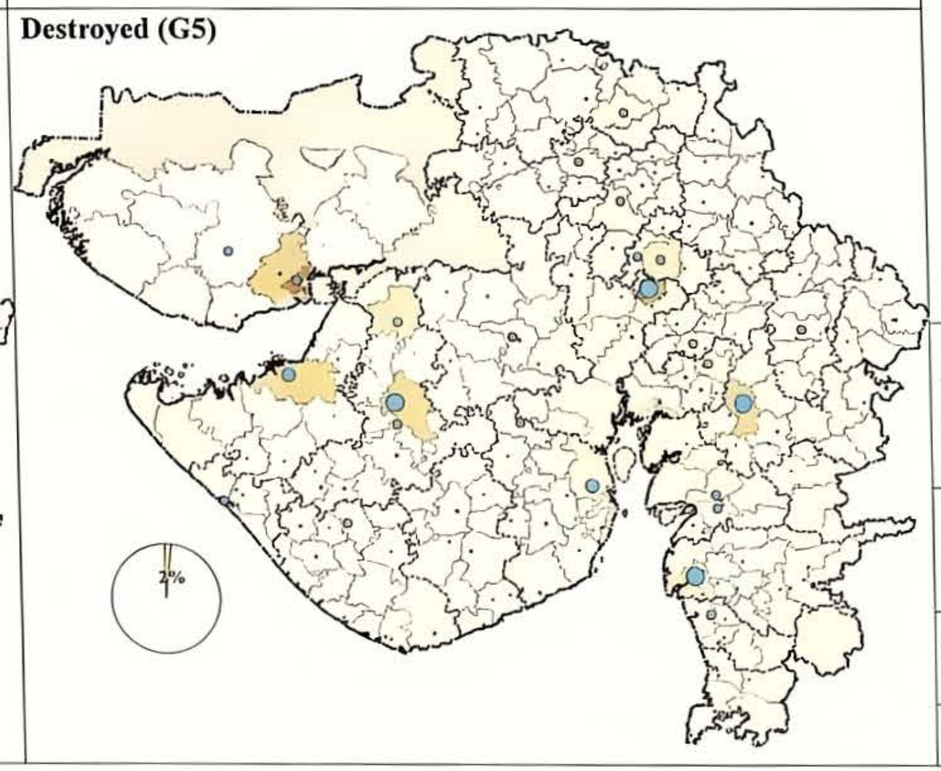
GSDMA











LEGEND

Number of Damaged Buildings
< 500
> 500 to 1000
> 1000 to 2500
> 2500 to 5000
> 5000 to 10000
> 10000 to 20000
> 20000 to 30000
> 30000 to 40000
> 40000 to 50000
> 50000 to 100000
> 100000
Urban Centres

Sizes of the urban centres are varying according to their populations
Inset pie chart shows the proportion of number of RCC on brick residential buildings to total number of residential buildings
Main map pie charts show the proportion of number of buildings in respective damage grade to total number of buildings in the mentioned building type
Building damage classification based on MSK Scale

Source: TARU Studies & Analysis, 1993-2004, Census of India, 2001, BISAG, GoG

0 100 km

N

Projection : Lambert Azimuthal Equal Area
Datum : WGS 84

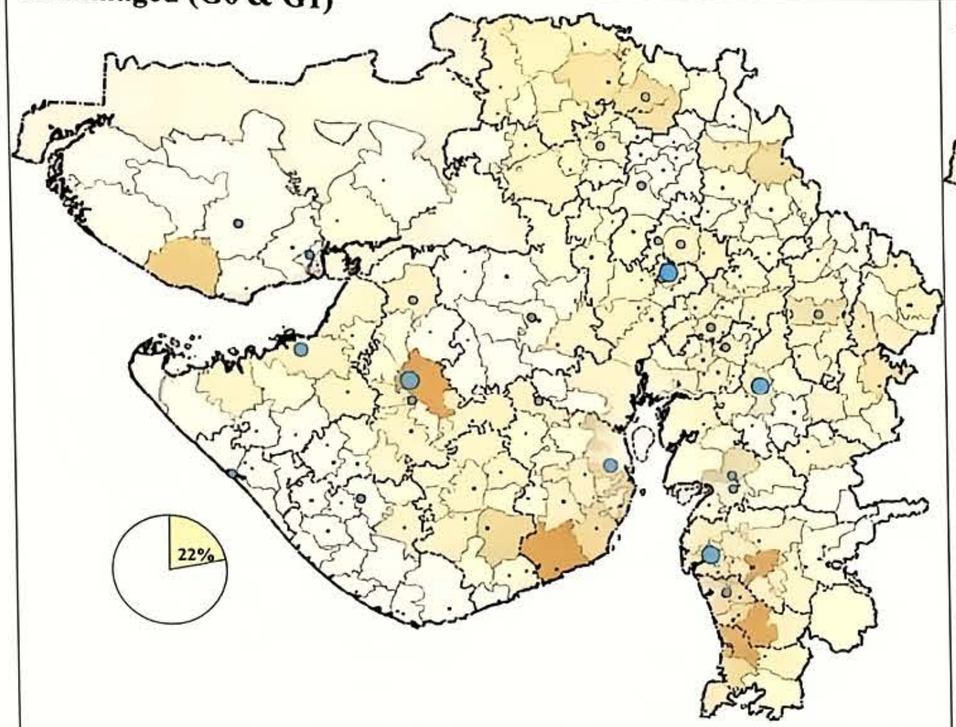
MAP No. : VBLM - 03 OF 07

Date : 16/6/2005

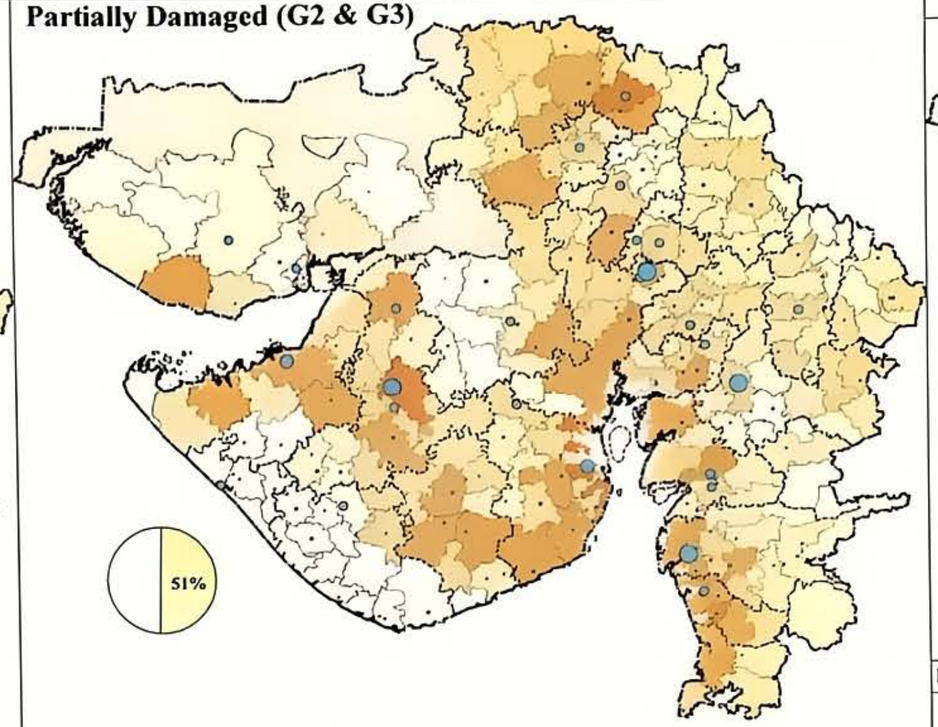
Gujarat Building Vulnerability Zonation: Earthquake Damage to Tile on Brick Residential Buildings (100 year return period) (Number of Buildings)

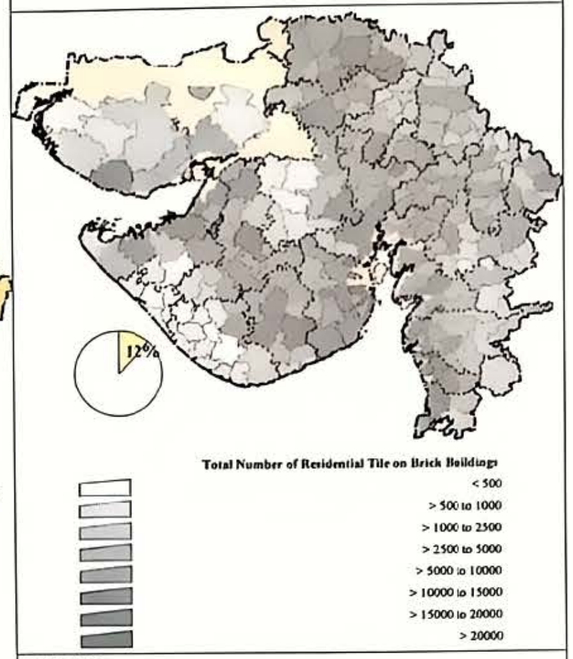
GSDMA

Undamaged (G0 & G1)

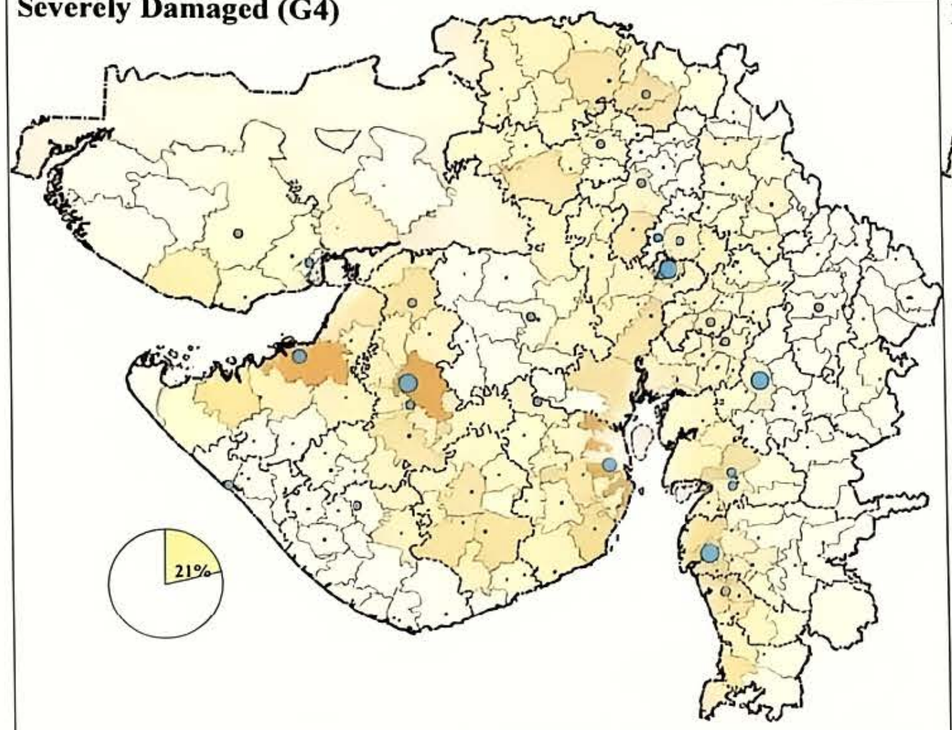


Partially Damaged (G2 & G3)

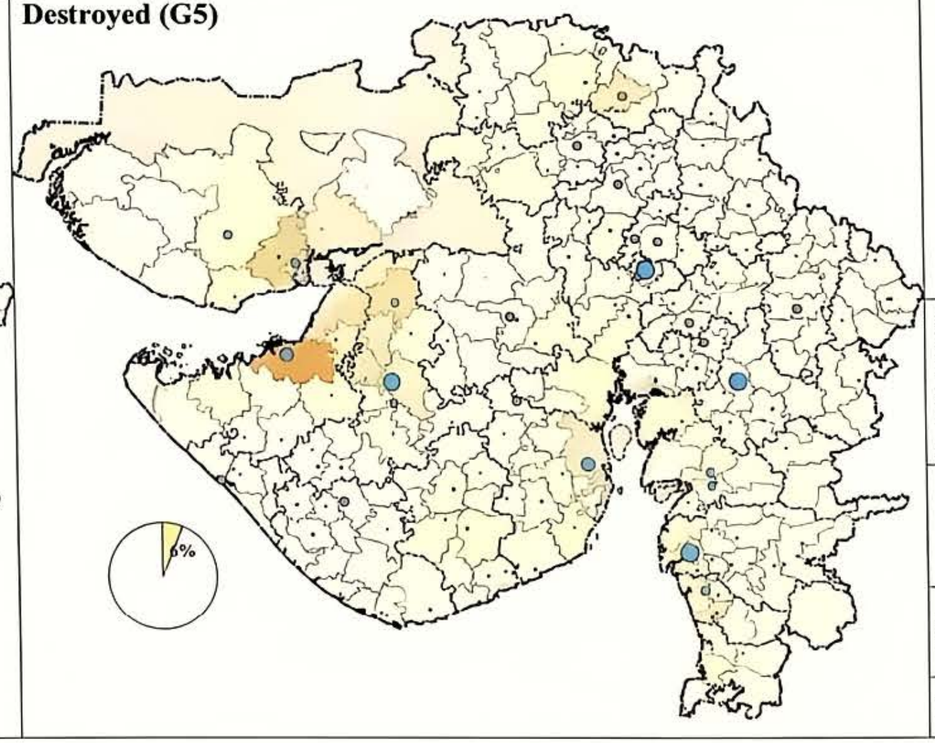




Severely Damaged (G4)



Destroyed (G5)



LEGEND

Number of Damaged Buildings
- < 500
- > 500 to 1000
- > 1000 to 2500
- > 2500 to 5000
- > 5000 to 10000
- > 10000 to 20000
- > 20000 to 30000
- > 30000 to 40000
- > 40000 to 50000
- > 50000 to 100000
- > 100000

Urban Centres

Sizes of the urban centres are varying according to their populations
Inset pie chart shows the proportion of number of RCC on brick residential buildings to total number of residential buildings
Main map pie charts show the proportion of number of buildings in respective damage grade to total number of buildings in the mentioned building type
Building damage classification based on MSK Scale

Source TARU Studies & Analysis, 1993-2004, Census of India, 2001, BISAG, GoG

0 100 km

N

Projection : Lambert Azimuthal Equal Area
Datum : WGS 84

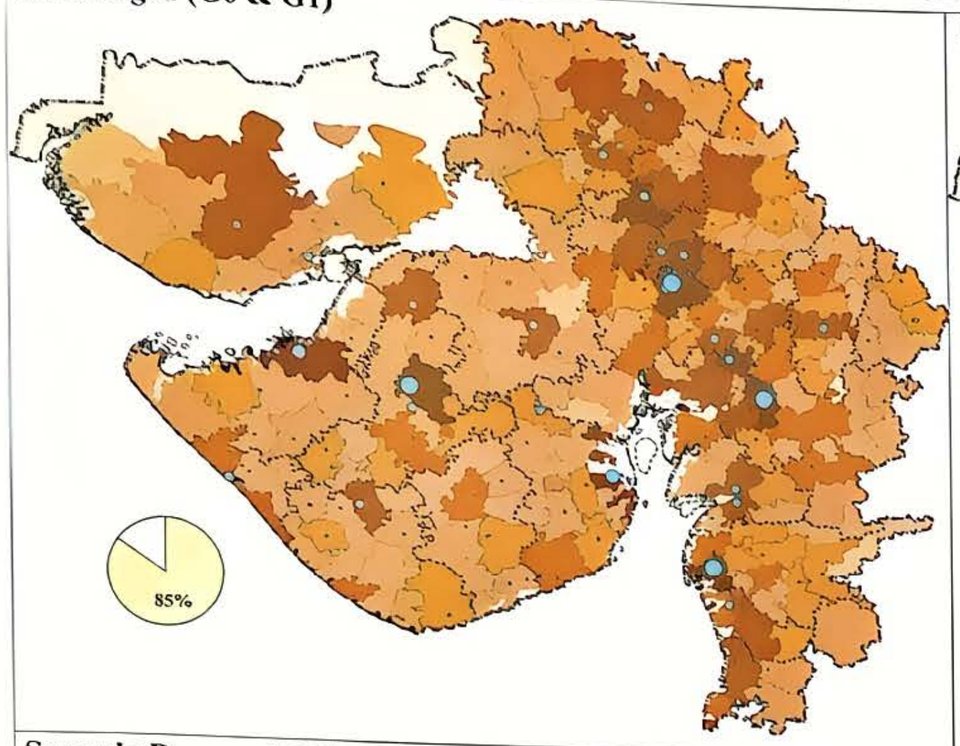
MAP No. : VBLM - 04 OF 07

Date : 16/6/2005

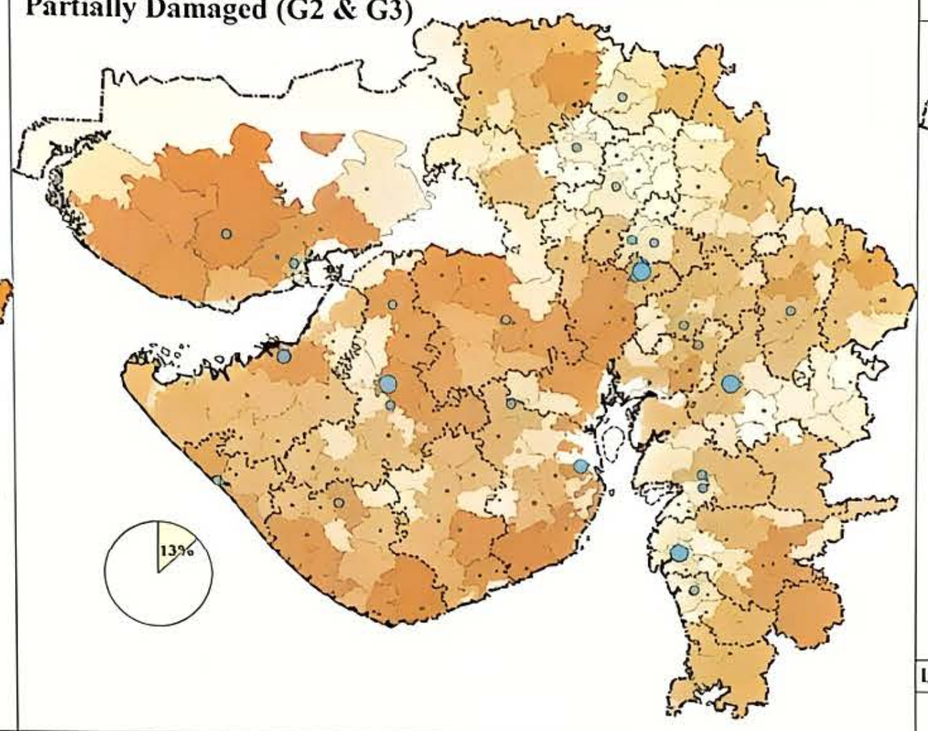
Gujarat Building Vulnerability Zonation: Cyclonic Storms & Wind Damage to Buildings
(50 year return period) (Number of Buildings)

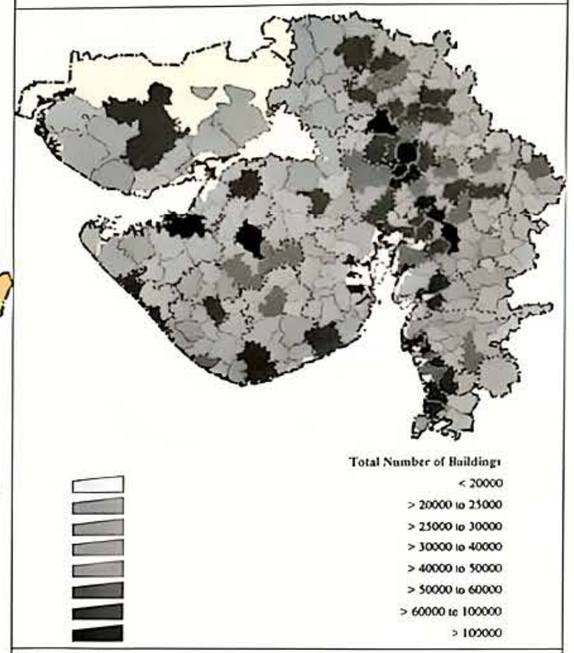
GSDMA

Undamaged (G0 & G1)

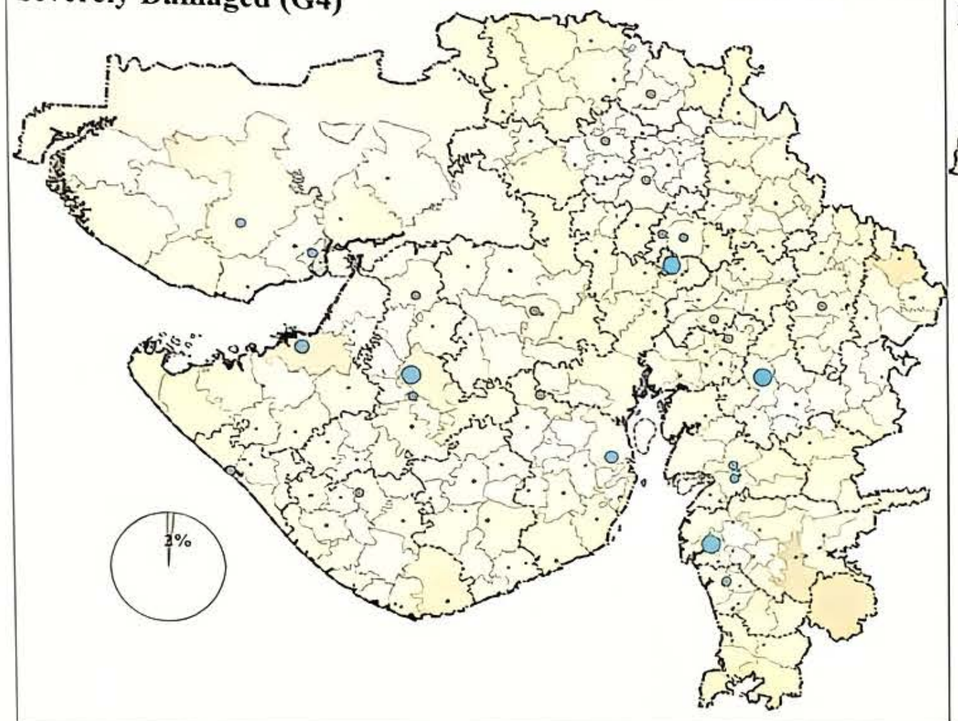


Partially Damaged (G2 & G3)

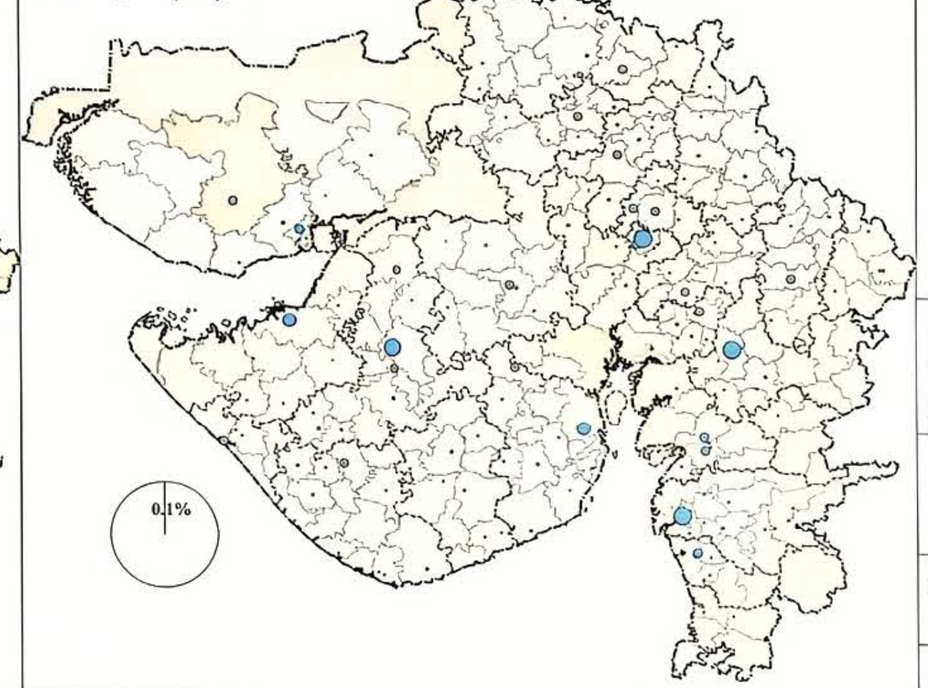




Severely Damaged (G4)



Destroyed (G5)



LEGEND

Number of Damaged Buildings
- < 500
- > 500 to 1000
- > 1000 to 2500
- > 2500 to 5000
- > 5000 to 10000
- > 10000 to 20000
- > 20000 to 30000
- > 30000 to 40000
- > 40000 to 50000
- > 50000 to 100000
- > 100000

Urban Centres

Sizes of the urban centres are varying according to their populations.
Main map pie charts show the proportion of number of buildings in respective damage grade to total number of buildings in the all building types.

Source: TARU Studies & Analysis, 1993-2004; Census of India, 2001;
The Saffir-Simpson Tropical Cyclone Scale, WERI, 1999, BISAG, GoG.

0 100 km

N

Projection : Lambert Azimuthal Equal Area
Datum : WGS 84

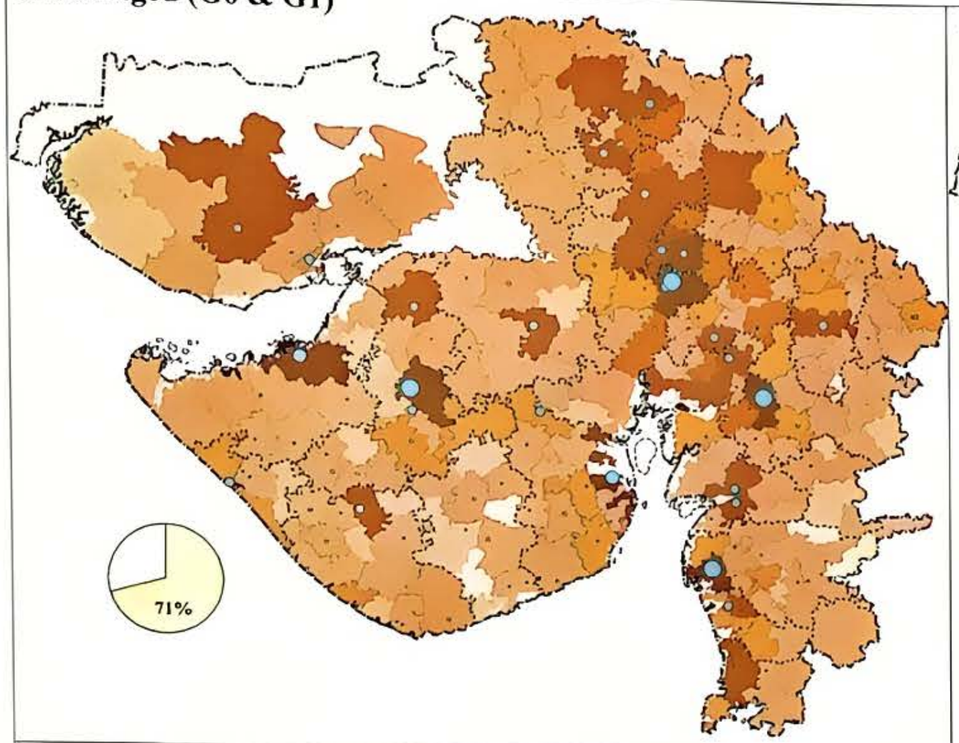
MAP No. : VBLM - 05 OF 07

Date : 16/6/2005

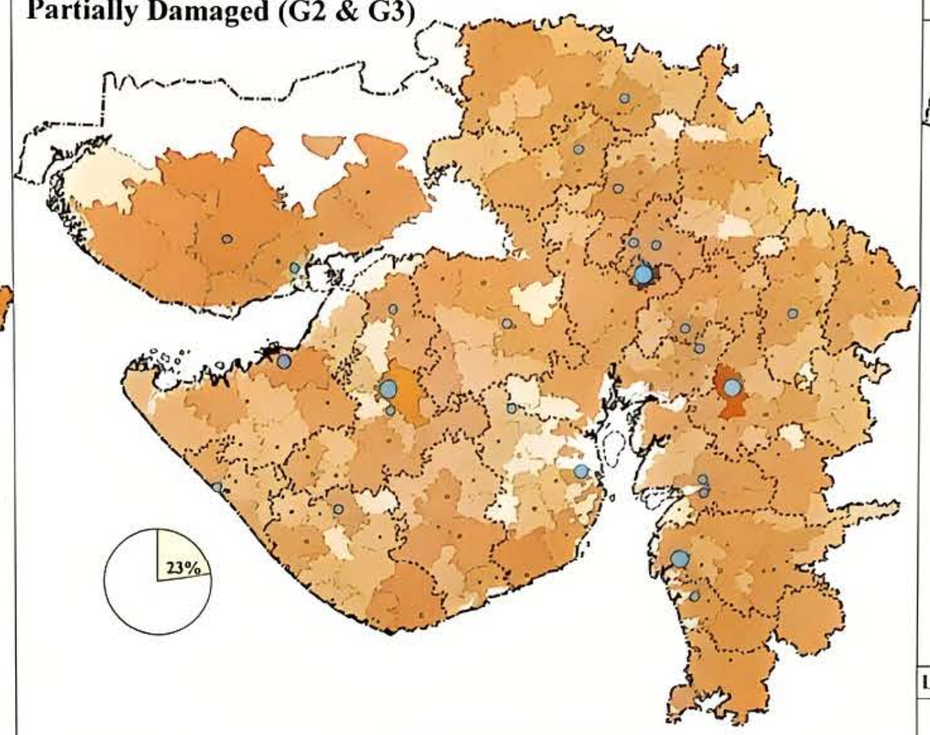
Gujarat Building Vulnerability Zonation: Cyclonic Storms & Wind Damage to Buildings
(100 year return period) (Number of Buildings)

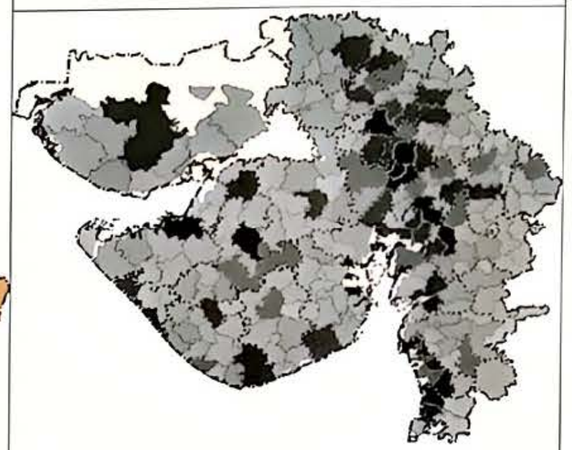
GSDMA

Undamaged (G0 & G1)



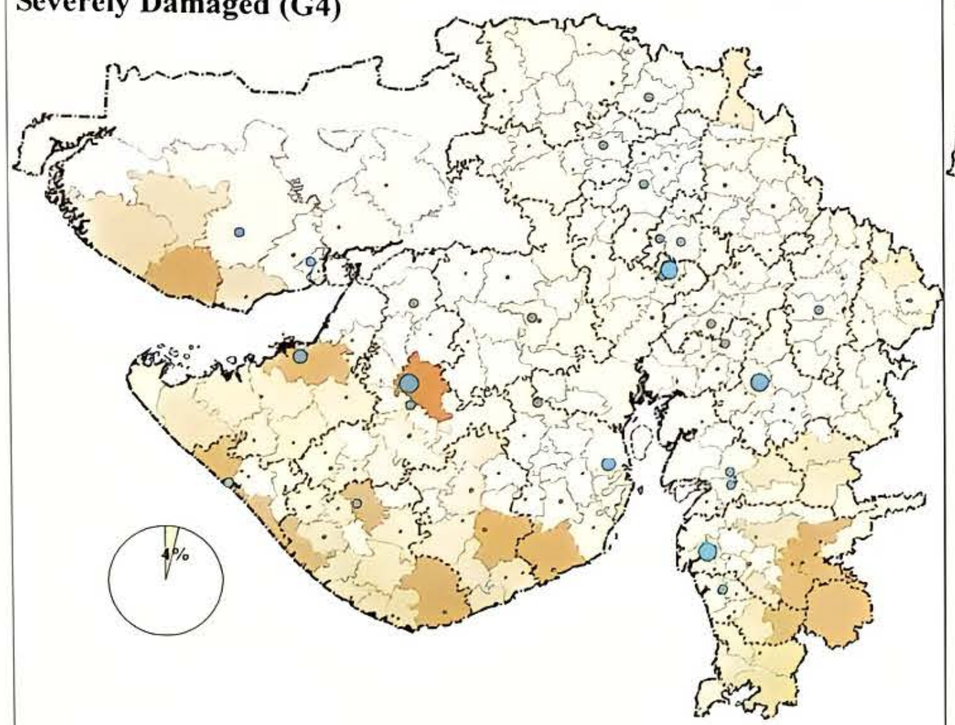
Partially Damaged (G2 & G3)



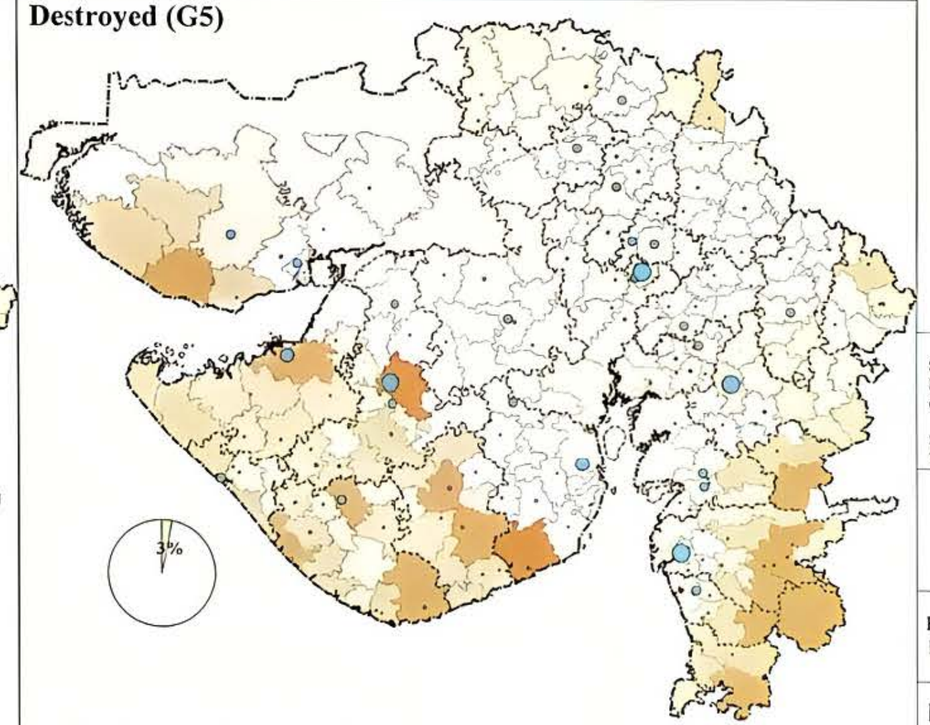


Total Number of Buildings
- < 20000
- > 20000 to 25000
- > 25000 to 30000
- > 30000 to 40000
- > 40000 to 50000
- > 50000 to 60000
- > 60000 to 100000
- > 100000

Severely Damaged (G4)



Destroyed (G5)



LEGEND

Number of Damaged Buildings
- < 500
- > 500 to 1000
- > 1000 to 2500
- > 2500 to 5000
- > 5000 to 10000
- > 10000 to 20000
- > 20000 to 30000
- > 30000 to 40000
- > 40000 to 50000
- > 50000 to 100000
- > 100000

Urban Centres

Sizes of the urban centres are varying according to their populations.
Main map pie charts show the proportion of number of buildings in respective damage grade to total number of buildings in the all building types.

Source: TARU Studies & Analysis, 1993-2004; Census of India, 2001, The Saffir-Simpson Tropical Cyclone Scale, WERI, 1999, BISAG, GoG

0 100 km

N

Projection : Lambert Azimuthal Equal Area
Datum : WGS 84

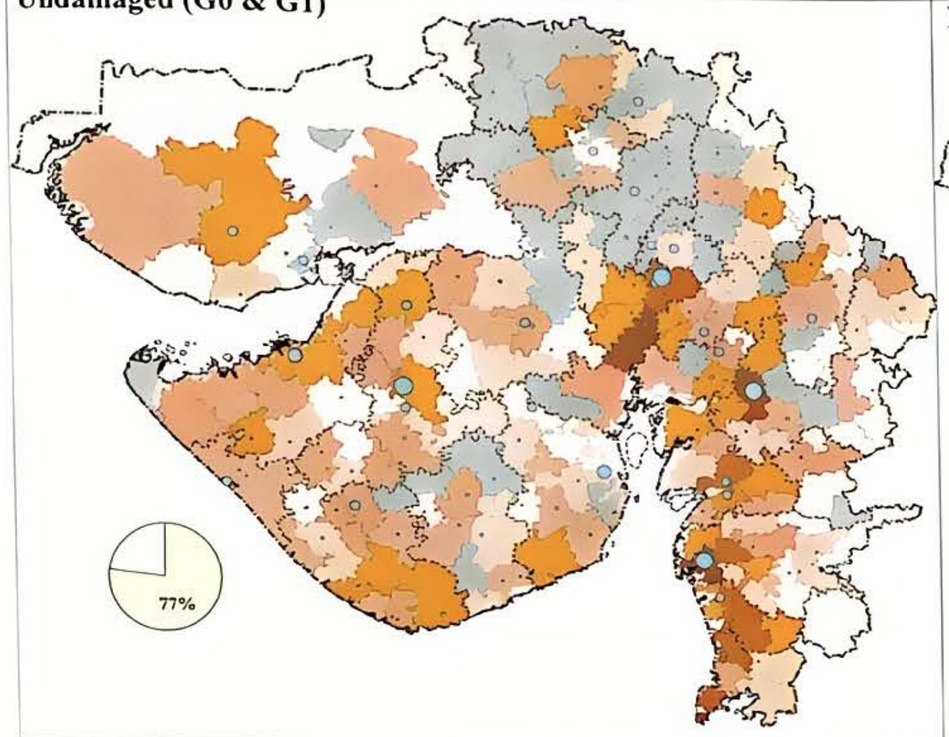
MAP No. : VBLM - 06 OF 07

Date : 16/6/2005

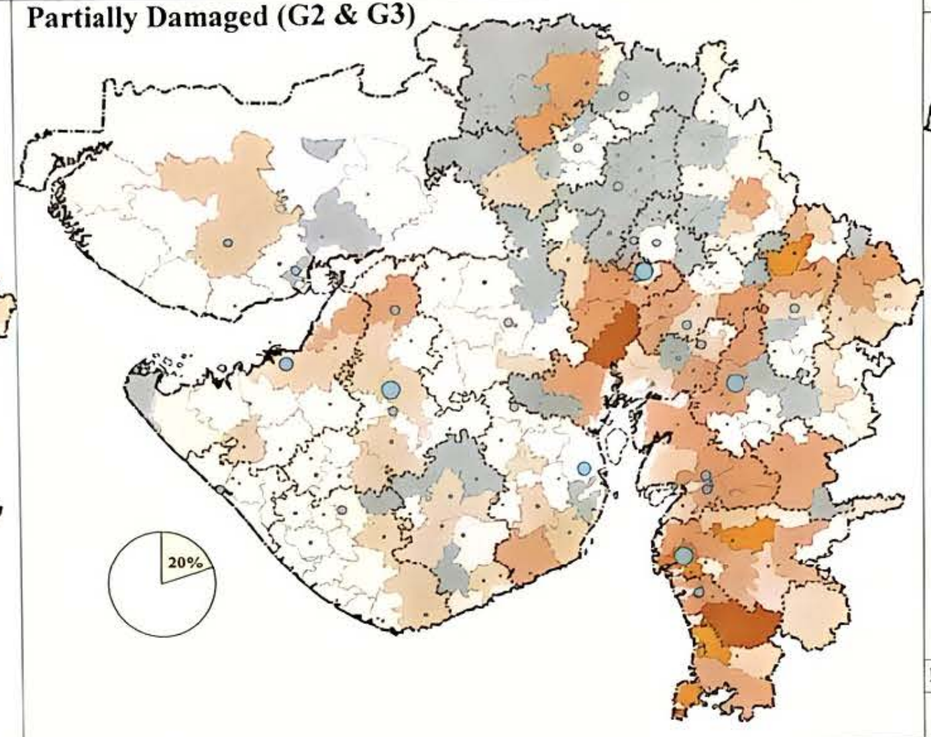
Gujarat Building Vulnerability Zonation: Flood Damage to Buildings (Number of Buildings)

GSDMA

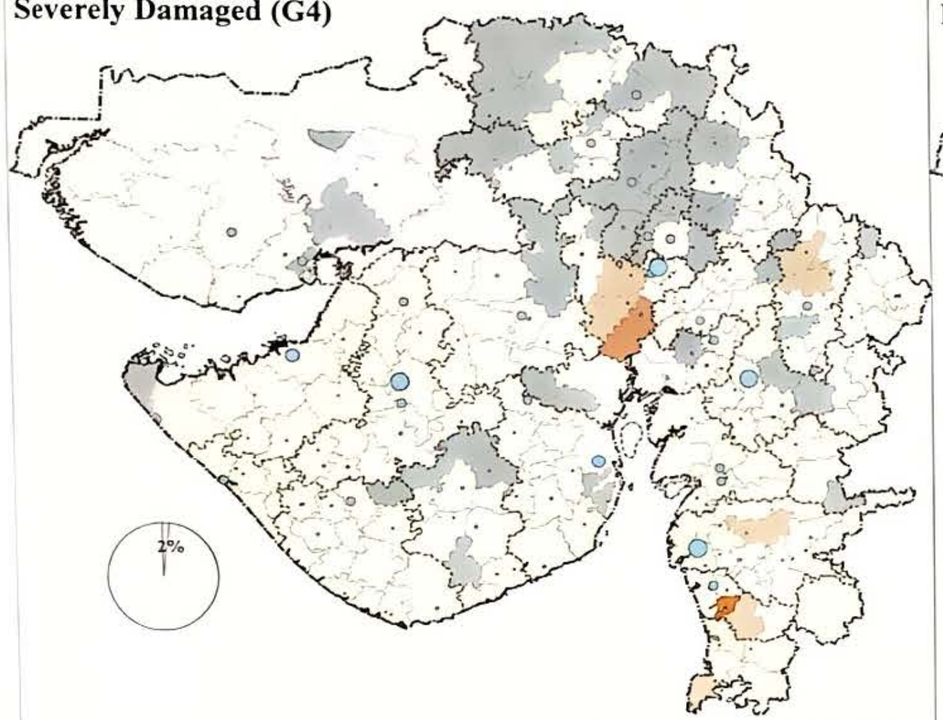
Undamaged (G0 & G1)



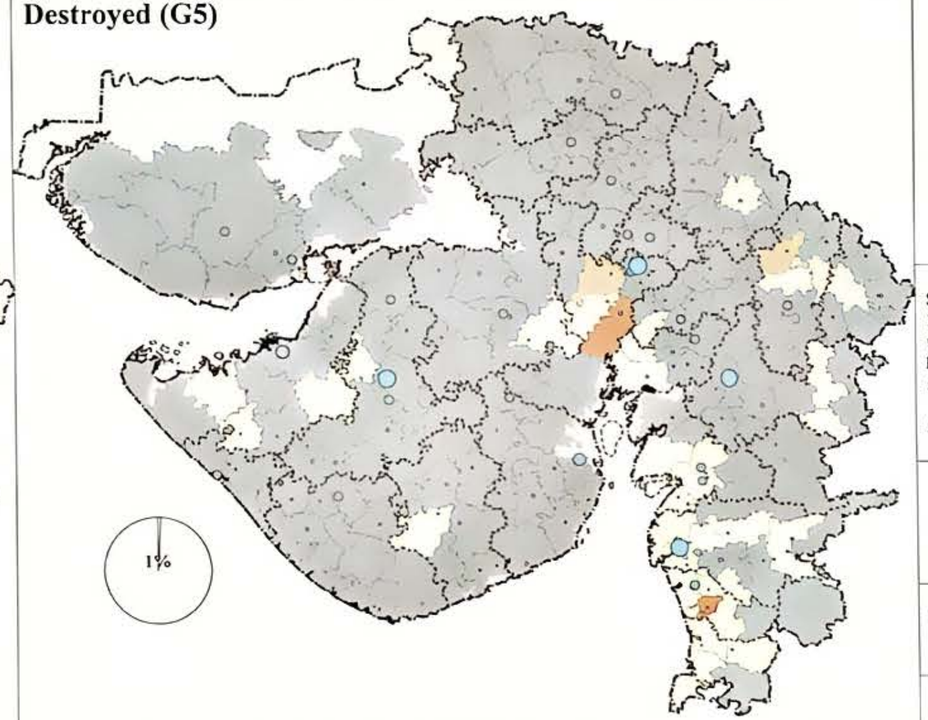
Partially Damaged (G2 & G3)

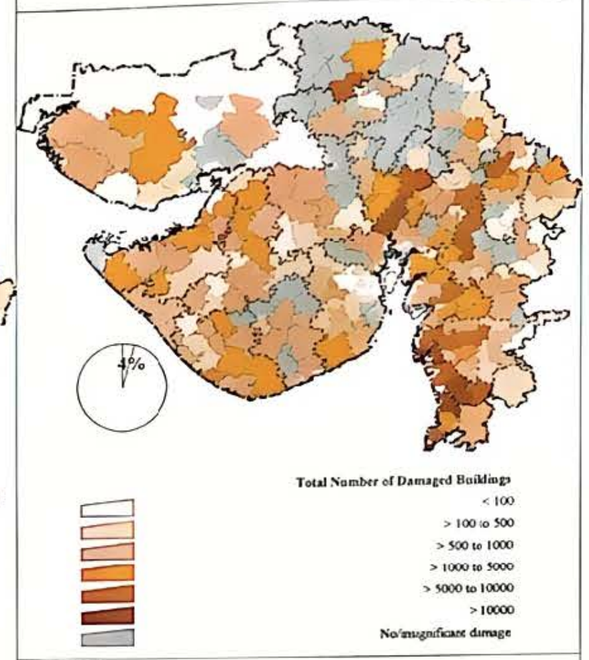


Severely Damaged (G4)



Destroyed (G5)





LEGEND

Number of Damaged Buildings
> 0 to 100
> 100 to 200
> 200 to 500
> 500 to 1000
> 1000 to 2000
> 2000 to 5000
> 5000 to 10000
> 10000
No/insignificant damage
Urban Centres

Sizes of the urban centres are varying according to their populations
Inset pie chart shows the proportion of number of damaged buildings to total number of buildings.
Main map pie charts show the proportion of number of buildings in respective damage grade to total number of flood damaged buildings

Source: TARU Studies & Analysis, 2004, Census of India, 2001, Flood Contol Cell, GoG, SWDC, Flood Memorandum, 2003, BISAG, GoG

0 100 km

N

Projection : Lambert Azimuthal Equal Area
Datum : WGS 84

MAP No. : VBLM - 07 OF 07

Date 16/6/2005

GUJARAT BUILDING VULNERABILITY ZONATION: EARTHQUAKE DAMAGE TO BUILDINGS (100 YEAR RETURN PERIOD)
(NUMBER OF BUILDINGS in '00s) (BY DAMAGE GRADE) Table No. VBLT - 01 of 03

GSDMA

Sr. No	District	Taluka	Undamaged	G2 & G3	G4	G5	Total
1	Ahmadabad	Ahmadabad City	100	5,175	1,921	313	10,000
2	Ahmadabad	Barwala	21	75	37	9	142
3	Ahmadabad	Bavla	59	216	108	25	408
4	Ahmadabad	Daskroi	283	648	264	50	1,245
5	Ahmadabad	Detroj-Rampura	37	136	68	16	257
6	Ahmadabad	Dhandhuka	52	188	94	22	355
7	Ahmadabad	Dholka	101	325	156	35	617
8	Ahmadabad	Mandal	33	122	61	14	230
9	Ahmadabad	Ranpur	22	83	42	10	157
10	Ahmadabad	Sanand	82	296	148	35	561
11	Ahmadabad	Viramgam	75	280	141	33	529
12	Amreli	Amreli	112	269	113	22	517
13	Amreli	Babra	44	131	61	13	249
14	Amreli	Bagasara	34	86	37	7	165
15	Amreli	Dhari	50	147	69	15	281
16	Amreli	Jafrabad	30	110	55	13	208
17	Amreli	Khambha	27	100	50	12	190
18	Amreli	Kunkavav Vadia	46	119	53	11	228
19	Amreli	Lathi	58	159	72	15	303
20	Amreli	Lilia	25	78	37	8	149
21	Amreli	Rajula	52	168	80	18	318
22	Amreli	Savar Kundla	87	259	121	26	493
23	Anand	Anand	274	623	253	47	1,198
24	Anand	Anklav	46	167	83	19	315
25	Anand	Borsad	124	420	205	47	797
26	Anand	Khambhat	124	364	168	37	692
27	Anand	Petlad	108	333	157	35	634
28	Anand	Sojitra	42	137	66	15	259
29	Anand	Tarapur	30	106	52	12	200
30	Anand	Umreth	61	187	88	20	356
31	Banas Kantha	Amirgadh	27	107	55	13	202
32	Banas Kantha	Bhabhar	27	110	57	14	207
33	Banas Kantha	Danta	48	172	86	20	325
34	Banas Kantha	Dantiwada	35	106	50	11	201
35	Banas Kantha	Deesa	126	408	197	44	775
36	Banas Kantha	Deodar	42	168	86	21	317
37	Banas Kantha	Dhanera	54	187	92	21	355
38	Banas Kantha	Kankrej	60	221	111	26	418
39	Banas Kantha	Palanpur	214	509	212	41	975
40	Banas Kantha	Tharad	47	212	113	28	400
41	Banas Kantha	Vadgam	115	290	125	25	556
42	Banas Kantha	Vav	39	195	106	26	367
43	Bharuch	Amod	38	133	66	15	252
44	Bharuch	Anklesvar	147	364	155	31	698
45	Bharuch	Bharuch	195	478	202	40	915
46	Bharuch	Hansot	25	93	46	11	176
47	Bharuch	Jambusar	82	277	135	31	526
48	Bharuch	Jhagadia	54	214	110	26	404
49	Bharuch	Vagra	29	123	64	15	231
50	Bharuch	Valia	36	163	86	21	306
51	Bhavnagar	Bhavnagar	339	722	281	49	1,392
52	Bhavnagar	Botad	96	240	103	20	459
53	Bhavnagar	Gadhada	63	177	80	17	337
54	Bhavnagar	Gariadhar	42	120	55	12	228
55	Bhavnagar	Ghogha	29	94	45	10	178
56	Bhavnagar	Mahuva	290	358	65	8	721
57	Bhavnagar	Palitana	69	196	89	19	373
58	Bhavnagar	Sihor	76	207	92	19	394
59	Bhavnagar	Talaja	79	243	115	25	462
60	Bhavnagar	Umrala	35	93	41	8	178
61	Bhavnagar	Vallabhipur	30	89	42	9	170
62	Dohad	Devgadbaria	134	190	38	5	367
63	Dohad	Dhanpur	59	91	19	3	173
64	Dohad	Dohad	200	244	44	5	492
65	Dohad	Fatepura	102	155	33	4	294
66	Dohad	Garbada	76	113	23	3	215
67	Dohad	Jhalod	198	288	59	8	553
68	Dohad	Limkheda	121	185	39	5	350
69	Gandhinagar	Dehgam	105	322	151	34	611
70	Gandhinagar	Gandhinagar	309	685	274	50	1,318
71	Gandhinagar	Kalol	361	374	56	6	797
72	Gandhinagar	Mansa	120	303	130	26	580
73	Jamnagar	Bhanvad	40	126	60	13	239
74	Jamnagar	Dhrol	18	86	49	34	187
75	Jamnagar	Jamjodhpur	51	154	72	16	293
76	Jamnagar	Jamnagar	148	746	344	204	1,442
77	Jamnagar	Jodiya	21	99	61	45	226
78	Jamnagar	Kalavad	80	206	90	18	394
79	Jamnagar	Kalyanpur	59	164	74	16	313
80	Jamnagar	Khambhalia	95	233	99	19	446
81	Jamnagar	Lalpur	46	126	57	12	241
82	Jamnagar	Okhamandal	49	130	58	12	249
83	Junagadh	Bhesan	27	77	35	8	147
84	Junagadh	Junagadh	153	413	184	39	789
85	Junagadh	Keshod	80	233	107	23	443
86	Junagadh	Kodinar	74	218	101	22	415
87	Junagadh	Malia	51	155	73	16	295
88	Junagadh	Manavadar	57	172	81	18	328
89	Junagadh	Mangrol	80	242	113	25	460
90	Junagadh	Mendarda	25	80	38	9	152
91	Junagadh	Patan-Veraval	106	279	123	25	534
92	Junagadh	Sutrapada	39	116	54	12	220
93	Junagadh	Talala	42	124	57	13	235
94	Junagadh	Una	103	333	160	36	631
95	Junagadh	Vanthali	43	129	60	13	245
96	Junagadh	Visavadar	51	148	68	15	282
97	Kachchh	Abdasa	46	150	72	16	285
98	Kachchh	Anjar	20	33	58	281	393
99	Kachchh	Bhachau	34	148	107	87	376
100	Kachchh	Bhuj	89	397	263	205	953
101	Kachchh	Gandhidham	18	42	76	299	435
102	Kachchh	Lakhpat	11	46	33	27	117
103	Kachchh	Mandvi	199	237	42	5	483
104	Kachchh	Mundra	25	109	80	65	280
105	Kachchh	Nakhatrana	32	139	102	84	357
106	Kachchh	Rapar	36	149	118	100	403
107	Kheda	Balasinor	117	143	25	3	288
108	Kheda	Kapadvanj	89	298	145	33	565
109	Kheda	Kathlal	57	231	119	29	436
110	Kheda	Kheda	51	160	76	17	304
111	Kheda	Mahudha	41	149	75	18	282
112	Kheda	Matar	56	187	91	21	355
113	Kheda	Mehmedabad	72	275	140	33	520
114	Kheda	Nadiad	216	570	251	52	1,089

GUJARAT BUILDING VULNERABILITY ZONATION: EARTHQUAKE DAMAGE TO BUILDINGS (100 YEAR RETURN PERIOD)
(NUMBER OF BUILDINGS in '00s) (BY DAMAGE GRADE) Table No. VBLT - 01 of 03

GSDMA

Sr. No	District	Taluka	Undamaged	G2 & G3	G4	G5	Total
115	Kheda	Thasra	108	363	177	40	688
116	Kheda	Virpur	71	94	18	2	186
117	Mahesana	Becharaji	37	118	56	13	224
118	Mahesana	Kadi	159	450	205	44	857
119	Mahesana	Kheralu	56	161	74	16	307
120	Mahesana	Mahesana	246	601	254	50	1,151
121	Mahesana	Satlasana	34	97	45	10	186
122	Mahesana	Unjha	112	260	107	20	499
123	Mahesana	Vadnagar	58	169	78	17	322
124	Mahesana	Vijapur	135	339	145	29	648
125	Mahesana	Visnagar	156	372	155	30	714
126	Narmada	Dediapada	109	177	39	5	331
127	Narmada	Nandod	190	249	47	6	492
128	Narmada	Sagbara	69	111	24	3	208
129	Narmada	Tilakwada	47	63	12	2	124
130	Navsari	Bansda	147	224	48	6	426
131	Navsari	Chikhli	242	326	63	8	640
132	Navsari	Gandevi	104	300	138	30	572
133	Navsari	Jalalpore	103	271	120	25	518
134	Navsari	Navsari	147	350	146	28	672
135	Panch Mahals	Ghoghamba	96	144	30	4	274
136	Panch Mahals	Godhra	302	341	56	7	707
137	Panch Mahals	Halol	159	192	34	4	389
138	Panch Mahals	Jambughoda	22	29	5	1	57
139	Panch Mahals	Kadana	77	113	23	3	216
140	Panch Mahals	Kalol	157	198	36	5	396
141	Panch Mahals	Khanpur	70	99	20	3	191
142	Panch Mahals	Lunawada	212	267	49	6	535
143	Panch Mahals	Morwa (Hadaf)	67	104	22	3	196
144	Panch Mahals	Santrampur	142	209	43	6	401
145	Panch Mahals	Shehera	163	240	50	7	459
146	Patan	Chanasma	75	213	97	21	406
147	Patan	Harij	34	114	56	13	217
148	Patan	Patan	170	446	196	41	853
149	Patan	Radhanpur	41	129	62	14	246
150	Patan	Sami	57	226	116	28	427
151	Patan	Santalpur	18	73	66	59	216
152	Patan	Sidhpur	107	268	115	23	513
153	Patan	Vagdod	35	110	52	12	209
154	Porbandar	Kutiyana	33	100	47	10	191
155	Porbandar	Porbandar	120	328	147	31	627
156	Porbandar	Ranavav	36	103	47	10	196
157	Rajkot	Dhoraji	69	187	83	17	357
158	Rajkot	Gondal	123	279	113	21	536
159	Rajkot	Jamkandorna	33	90	41	9	172
160	Rajkot	Jasdan	96	277	127	28	528
161	Rajkot	Jetpur	99	246	106	21	472
162	Rajkot	Kotda Sangani	46	106	44	8	204
163	Rajkot	Lodhika	29	71	30	6	136
164	Rajkot	Maliya	15	63	46	38	162
165	Rajkot	Morvi	75	370	183	116	744
166	Rajkot	Paddhari	19	92	53	38	203
167	Rajkot	Rajkot	755	1,441	516	79	2,792
168	Rajkot	Tankara	17	81	48	35	181
169	Rajkot	Upleta	82	225	101	21	430
170	Rajkot	Wankaner	37	171	106	79	394
171	Sabar Kantha	Bayad	70	226	108	24	429
172	Sabar Kantha	Bhiloda	194	244	45	6	488
173	Sabar Kantha	Dhansura	35	111	53	12	211
174	Sabar Kantha	Himatnagar	137	332	140	27	636
175	Sabar Kantha	Idar	141	356	153	31	681
176	Sabar Kantha	Khedbruhma	61	210	103	24	398
177	Sabar Kantha	Malpur	78	101	19	2	200
178	Sabar Kantha	Meghraj	114	164	33	4	316
179	Sabar Kantha	Modasa	82	234	107	23	445
180	Sabar Kantha	Prantij	65	184	84	18	350
181	Sabar Kantha	Talod	56	169	79	17	321
182	Sabar Kantha	Vadali	40	110	49	10	211
183	Sabar Kantha	Vijaynagar	84	120	24	3	232
184	Surat	Bardoli	204	241	42	5	493
185	Surat	Chorasi	340	716	276	48	1,380
186	Surat	Kamrej	70	192	87	18	367
187	Surat	Mahuva	105	151	31	4	290
188	Surat	Mandvi	150	218	45	6	419
189	Surat	Mangrol	61	215	106	25	407
190	Surat	Nizar	82	126	27	4	238
191	Surat	Olpad	81	241	112	25	459
192	Surat	Palsana	56	146	64	13	279
193	Surat	Songadh	153	235	50	7	444
194	Surat	Surat City	3,345	2,736	264	21	6,365
195	Surat	Uchchhal	44	70	15	2	131
196	Surat	Umarpada	50	80	17	2	150
197	Surat	Valod	70	96	19	2	188
198	Surat	Vyara	192	281	58	8	539
199	Surendranagar	Chotila	61	190	90	20	361
200	Surendranagar	Chuda	27	100	51	12	190
201	Surendranagar	Dasada	46	175	88	21	330
202	Surendranagar	Dhrangadhra	72	213	99	22	406
203	Surendranagar	Halvad	27	117	85	69	298
204	Surendranagar	Lakhtar	21	78	39	9	147
205	Surendranagar	Limbdi	65	213	103	23	404
206	Surendranagar	Muli	30	102	50	11	194
207	Surendranagar	Sayla	28	112	58	14	211
208	Surendranagar	Wadhwan	161	395	168	33	756
209	The Dangs	The Dangs	147	237	52	7	443
210	Vadodara	Chhota Udaipur	93	117	22	3	234
211	Vadodara	Dabhoi	198	239	42	5	484
212	Vadodara	Jetpur Pavi	111	140	26	3	280
213	Vadodara	Karjan	71	219	103	23	415
214	Vadodara	Kavant	70	101	21	3	195
215	Vadodara	Nasvadi	85	125	26	3	239
216	Vadodara	Padra	100	326	157	35	618
217	Vadodara	Sankheda	176	222	41	5	445
218	Vadodara	Savli	202	265	50	7	524
219	Vadodara	Sinor	78	96	18	2	194
220	Vadodara	Vadodara	1,130	2,235	823	132	4,321
221	Vadodara	Vaghodia	128	161	30	4	323
222	Valsad	Dharampur	120	181	38	5	345
223	Valsad	Kaprada	120	192	42	6	359
224	Valsad	Pardi	166	451	201	42	861
225	Valsad	Umbergaon	79	256	123	28	486
226	Valsad	Valsad	370	402	64	8	844

GUJARAT BUILDING VULNERABILITY ZONATION: CYCLONE DAMAGE TO BUILDINGS (100 YEAR RETURN PERIOD)
(NUMBER OF BUILDINGS in '00s) (BY DAMAGE GRADE) Table No. VBLT - 02 of 03

GSDMA

Sr. No	District	Taluka	Undamaged	G2 & G3	G4	G5	Total
1	Ahmadabad	Ahmadabad City	8,853	1,126	11	10	10,000
2	Ahmadabad	Barwala	97	37	6	3	142
3	Ahmadabad	Bavla	283	109	13	3	408
4	Ahmadabad	Daskroi	1,027	199	12	7	1,245
5	Ahmadabad	Detroj-Rampura	170	74	9	4	257
6	Ahmadabad	Dhandhuka	232	100	15	9	356
7	Ahmadabad	Dholka	441	156	15	5	618
8	Ahmadabad	Mandal	160	63	6	1	231
9	Ahmadabad	Ranpur	103	43	7	4	157
10	Ahmadabad	Sanand	384	149	20	8	561
11	Ahmadabad	Viramgam	364	145	16	4	529
12	Amreli	Amreli	280	138	47	51	517
13	Amreli	Babra	94	88	31	37	249
14	Amreli	Bagasara	78	52	18	17	165
15	Amreli	Dhari	98	107	36	39	281
16	Amreli	Jafrabad	54	88	33	34	208
17	Amreli	Khambha	47	82	28	33	190
18	Amreli	Kunkavav Vadia	102	75	26	26	228
19	Amreli	Lathi	236	59	7	1	303
20	Amreli	Lilia	50	58	19	22	149
21	Amreli	Rajula	103	123	45	47	318
22	Amreli	Savar Kundla	180	186	61	66	493
23	Anand	Anand	994	183	14	7	1,198
24	Anand	Anklav	221	82	10	2	315
25	Anand	Borsad	570	200	22	6	797
26	Anand	Khambhat	514	154	18	7	693
27	Anand	Petlad	459	156	14	5	634
28	Anand	Sojitra	184	68	6	2	260
29	Anand	Tarapur	139	53	6	2	200
30	Anand	Umreth	262	85	7	2	356
31	Banas Kantha	Amirgadh	132	57	9	4	202
32	Banas Kantha	Bhabhar	134	59	9	4	207
33	Banas Kantha	Danta	203	91	18	14	326
34	Banas Kantha	Dantiwada	140	51	6	4	201
35	Banas Kantha	Deesa	547	194	24	10	776
36	Banas Kantha	Deodar	206	92	13	6	317
37	Banas Kantha	Dhanera	246	91	13	5	355
38	Banas Kantha	Kankrej	281	115	16	7	419
39	Banas Kantha	Palanpur	785	178	9	4	976
40	Banas Kantha	Tharad	241	123	22	14	400
41	Banas Kantha	Vadgam	431	116	7	2	556
42	Banas Kantha	Vav	214	121	21	11	367
43	Bharuch	Amod	175	71	6	1	253
44	Bharuch	Anklesvar	549	131	11	7	698
45	Bharuch	Bharuch	731	166	13	6	916
46	Bharuch	Hansot	118	50	6	2	176
47	Bharuch	Jambusar	372	141	11	2	526
48	Bharuch	Jhagadia	218	132	27	28	404
49	Bharuch	Vagra	154	67	8	2	231
50	Bharuch	Valia	151	106	25	25	307
51	Bhavnagar	Bhavnagar	1,187	189	14	4	1,393
52	Bhavnagar	Botad	366	80	10	4	459
53	Bhavnagar	Gadhada	258	66	10	3	337
54	Bhavnagar	Gariadhar	172	49	6	2	229
55	Bhavnagar	Ghogha	124	48	5	2	179
56	Bhavnagar	Mahuva	240	276	98	107	721
57	Bhavnagar	Palitana	280	80	10	4	374
58	Bhavnagar	Sihor	300	84	9	2	395
59	Bhavnagar	Talaja	321	126	12	3	462
60	Bhavnagar	Umrala	135	36	5	3	178
61	Bhavnagar	Vallabhipur	125	40	4	1	170
62	Dohad	Devgadbaria	235	113	15	5	368
63	Dohad	Dhanpur	100	57	10	5	173
64	Dohad	Dohad	330	125	22	15	492
65	Dohad	Fatepura	164	99	19	12	294
66	Dohad	Garbada	135	68	10	3	215
67	Dohad	Jhalod	272	193	46	42	553
68	Dohad	Limkheda	214	113	18	5	350
69	Gandhinagar	Dehgam	449	147	13	3	612
70	Gandhinagar	Gandhinagar	1,101	200	11	7	1,318
71	Gandhinagar	Kalol	640	148	6	4	798
72	Gandhinagar	Mansa	452	120	5	3	580
73	Jamnagar	Bhanvad	101	80	30	28	239
74	Jamnagar	Dhrol	93	57	19	18	187
75	Jamnagar	Jamjodhpur	142	86	34	31	293
76	Jamnagar	Jamnagar	1,004	264	91	82	1,442
77	Jamnagar	Jodiya	170	52	4	1	227
78	Jamnagar	Kalavad	194	119	43	39	394
79	Jamnagar	Kalyanpur	150	95	36	32	313
80	Jamnagar	Khambhalia	233	126	45	42	446
81	Jamnagar	Lalpur	103	80	30	28	241
82	Jamnagar	Okhamandal	141	56	25	26	249
83	Junagadh	Bhesan	63	50	17	17	147
84	Junagadh	Junagadh	537	144	56	52	789
85	Junagadh	Keshod	255	109	41	39	443
86	Junagadh	Kodinar	198	126	50	41	415
87	Junagadh	Malia	122	99	40	34	295
88	Junagadh	Manavadar	163	95	36	34	328
89	Junagadh	Mangrol	195	153	60	51	460
90	Junagadh	Mendarda	68	49	18	17	152
91	Junagadh	Patan-Veraval	368	97	38	32	534
92	Junagadh	Sutrapada	95	73	29	24	220
93	Junagadh	Talala	112	70	29	25	235
94	Junagadh	Una	245	221	85	80	631
95	Junagadh	Vanthali	122	71	27	25	245
96	Junagadh	Visavadar	116	99	34	33	282
97	Kachchh	Abdasa	87	112	45	41	285
98	Kachchh	Anjar	272	111	7	2	393
99	Kachchh	Bhachau	236	126	10	4	376
100	Kachchh	Bhuj	692	222	23	16	953
101	Kachchh	Gandhidham	379	52	3	1	435
102	Kachchh	Lakhpat	67	44	4	3	117
103	Kachchh	Mandvi	214	158	59	53	483
104	Kachchh	Mundra	100	103	40	38	280
105	Kachchh	Nakhatrana	147	116	48	47	357
106	Kachchh	Rapar	213	171	13	6	403
107	Kheda	Balasinor	206	69	9	4	289
108	Kheda	Kapadvanj	405	142	14	4	565
109	Kheda	Kathlal	293	124	16	4	436
110	Kheda	Kheda	215	78	7	4	304
111	Kheda	Mahudha	193	79	8	3	282
112	Kheda	Matar	249	94	9	4	355
113	Kheda	Mehmedabad	357	142	17	4	520
114	Kheda	Nadiad	846	213	21	9	1,090

GUJARAT BUILDING VULNERABILITY ZONATION: CYCLONE DAMAGE TO BUILDINGS (100 YEAR RETURN PERIOD)
(NUMBER OF BUILDINGS in '00s) (BY DAMAGE GRADE) Table No. VBLT - 02 of 03

GSDMA

Sr. No	District	Taluka	Undamaged	G2 & G3	G4	G5	Total
115	Kheda	Thasra	493	173	19	5	689
116	Kheda	Virpur	126	50	7	2	186
117	Mahesana	Becharaji	158	61	4	2	224
118	Mahesana	Kadi	642	198	13	4	858
119	Mahesana	Kheralu	225	78	3	2	308
120	Mahesana	Mahesana	912	222	10	7	1,151
121	Mahesana	Satlasana	138	42	4	2	186
122	Mahesana	Unjha	407	87	3	2	499
123	Mahesana	Vadnagar	236	80	4	2	322
124	Mahesana	Vijapur	506	135	4	4	648
125	Mahesana	Visnagar	573	134	4	3	714
126	Narmada	Dediapada	81	143	49	58	331
127	Narmada	Nandod	266	154	33	38	492
128	Narmada	Sagbara	138	57	13	-	208
129	Narmada	Tilakwada	78	39	4	4	124
130	Navsari	Bansda	151	167	50	58	427
131	Navsari	Chikhli	339	205	45	47	637
132	Navsari	Gandevi	392	149	19	17	578
133	Navsari	Jalalpore	379	119	12	10	520
134	Navsari	Navsari	522	125	13	11	671
135	Panch Mahals	Ghoghamba	153	91	18	13	274
136	Panch Mahals	Godhra	531	148	20	8	707
137	Panch Mahals	Halol	259	100	17	14	390
138	Panch Mahals	Jambughoda	36	16	2	2	57
139	Panch Mahals	Kadana	136	66	10	3	216
140	Panch Mahals	Kalol	271	103	14	9	397
141	Panch Mahals	Khanpur	127	54	8	2	191
142	Panch Mahals	Lunawada	382	133	17	3	535
143	Panch Mahals	Morwa (Hadaf)	124	62	9	1	196
144	Panch Mahals	Santrampur	257	123	18	3	401
145	Panch Mahals	Shehera	304	134	19	2	459
146	Patan	Chanasma	299	101	4	2	407
147	Patan	Harij	147	61	6	3	217
148	Patan	Patan	658	183	9	4	853
149	Patan	Radhanpur	166	64	10	7	246
150	Patan	Sami	284	124	15	4	427
151	Patan	Santalpur	127	75	10	5	216
152	Patan	Sidhpur	405	103	4	2	513
153	Patan	Vagdod	150	54	4	1	209
154	Porbandar	Kutiyana	87	59	24	21	191
155	Porbandar	Porbandar	379	142	57	48	627
156	Porbandar	Ranavav	106	52	21	18	196
157	Rajkot	Dhoraji	224	77	30	26	357
158	Rajkot	Gondal	320	128	44	44	536
159	Rajkot	Jamkandorna	86	50	18	17	172
160	Rajkot	Jasdan	383	131	12	1	528
161	Rajkot	Jetpur	275	116	41	40	472
162	Rajkot	Kotda Sangani	113	55	19	17	204
163	Rajkot	Lodhika	67	42	14	13	136
164	Rajkot	Maliya	109	47	4	2	162
165	Rajkot	Morvi	616	119	9	1	745
166	Rajkot	Paddhari	97	64	21	20	203
167	Rajkot	Rajkot	2,212	347	118	115	2,792
168	Rajkot	Tankara	138	40	3	0	181
169	Rajkot	Upleta	253	101	39	36	430
170	Rajkot	Wankaner	277	110	7	0	394
171	Sabar Kantha	Bayad	312	102	12	3	429
172	Sabar Kantha	Bhiloda	337	122	20	9	488
173	Sabar Kantha	Dhansura	153	50	6	2	211
174	Sabar Kantha	Himatnagar	518	104	10	4	636
175	Sabar Kantha	Idar	536	129	11	6	681
176	Sabar Kantha	Khedbrahma	235	110	27	26	398
177	Sabar Kantha	Malpur	139	51	7	2	200
178	Sabar Kantha	Meghraj	205	91	15	5	316
179	Sabar Kantha	Modasa	337	92	12	5	445
180	Sabar Kantha	Prantij	264	78	6	2	350
181	Sabar Kantha	Talod	236	74	8	3	321
182	Sabar Kantha	Vadali	161	43	5	2	211
183	Sabar Kantha	Vijaynagar	150	67	11	4	232
184	Surat	Bardoli	333	126	18	17	493
185	Surat	Chorasi	1,176	186	12	10	1,383
186	Surat	Kamrej	269	87	7	5	367
187	Surat	Mahuva	131	104	27	29	291
188	Surat	Mandvi	176	153	42	48	419
189	Surat	Mangrol	243	119	23	22	407
190	Surat	Nizar	170	55	13	-	238
191	Surat	Olpad	322	114	13	9	459
192	Surat	Palsana	205	63	6	4	277
193	Surat	Songadh	146	178	55	64	444
194	Surat	Surat City	5,868	483	8	8	6,367
195	Surat	Uchchhal	38	55	18	21	131
196	Surat	Umarpada	44	63	20	23	150
197	Surat	Valod	95	63	15	16	189
198	Surat	Vyara	202	202	62	72	538
199	Surendranagar	Chotila	219	134	8	1	361
200	Surendranagar	Chuda	130	53	6	1	190
201	Surendranagar	Dasada	201	105	15	9	330
202	Surendranagar	Dhrangadhra	272	125	8	1	406
203	Surendranagar	Halvad	184	105	7	2	298
204	Surendranagar	Lakhtar	97	42	5	2	147
205	Surendranagar	Limbdi	288	102	12	2	405
206	Surendranagar	Muli	109	76	6	2	194
207	Surendranagar	Sayla	128	73	8	2	212
208	Surendranagar	Wadhwan	601	141	12	3	756
209	The Dangs	The Dangs	124	187	61	71	443
210	Vadodara	Chhota Udaipur	158	64	8	5	235
211	Vadodara	Dabhoi	353	125	3	3	484
212	Vadodara	Jetpur Pavi	181	78	11	10	281
213	Vadodara	Karjan	298	109	5	3	416
214	Vadodara	Kavant	85	70	19	21	195
215	Vadodara	Nasvadi	105	88	22	25	239
216	Vadodara	Padra	441	160	13	4	618
217	Vadodara	Sankheda	298	124	11	11	445
218	Vadodara	Savli	356	144	16	8	524
219	Vadodara	Sinor	139	53	1	1	194
220	Vadodara	Vadodara	3,847	451	14	10	4,321
221	Vadodara	Vaghodia	220	89	8	6	323
222	Valsad	Dharampur	127	135	40	46	348
223	Valsad	Kaprada	119	147	45	50	361
224	Valsad	Pardi	597	199	31	32	858
225	Valsad	Umbergaon	302	139	21	22	483
226	Valsad	Valsad	604	183	28	27	843

GUJARAT BUILDING VULNERABILITY ZONATION: FLOOD DAMAGE TO BUILDINGS (NUMBER OF BUILDINGS) (BY DAMAGE GRADE) Table No. VBLT - 03 of 03

GSDMA

Sr. No	District	Taluka	Undamaged	G2 & G3	G4	G5	Total
1	Ahmadabad	Ahmadabad City	7,765	65	1	-	7,831
2	Ahmadabad	Barwala	-	-	-	-	-
3	Ahmadabad	Bavla	2,003	1,306	230	171	3,710
4	Ahmadabad	Daskroi	6,889	683	50	-	7,623
5	Ahmadabad	Detroj-Rampura	-	-	-	-	-
6	Ahmadabad	Dhandhuka	1,024	680	43	-	1,747
7	Ahmadabad	Dholka	16,088	6,863	1,049	745	24,746
8	Ahmadabad	Mandal	215	120	11	-	345
9	Ahmadabad	Ranpur	-	-	-	-	-
10	Ahmadabad	Sanand	2,397	1,735	292	212	4,636
11	Ahmadabad	Viramgam	491	278	25	-	794
12	Amreli	Amreli	1,025	275	19	-	1,319
13	Amreli	Babra	-	-	-	-	-
14	Amreli	Bagasara	182	50	3	-	235
15	Amreli	Dhari	881	382	28	2	1,293
16	Amreli	Jafrabad	401	106	10	-	516
17	Amreli	Khambha	-	-	-	-	-
18	Amreli	Kunkavav Vadia	-	-	-	-	-
19	Amreli	Lathi	-	-	-	-	-
20	Amreli	Lilia	442	224	20	-	686
21	Amreli	Rajula	786	228	20	-	1,034
22	Amreli	Savar Kundla	385	170	13	-	568
23	Anand	Anand	1,597	211	16	-	1,824
24	Anand	Anklav	2,238	1,292	121	-	3,651
25	Anand	Borsad	2,053	977	90	-	3,120
26	Anand	Khambhat	533	215	34	24	805
27	Anand	Petlad	-	-	-	-	-
28	Anand	Sojitra	-	-	-	-	-
29	Anand	Tarapur	810	497	85	63	1,455
30	Anand	Umreth	93	28	3	-	123
31	Banas Kantha	Amirgadh	-	-	-	-	-
32	Banas Kantha	Bhabhar	-	-	-	-	-
33	Banas Kantha	Danta	-	-	-	-	-
34	Banas Kantha	Dantiwada	303	128	7	-	438
35	Banas Kantha	Deesa	1,791	868	65	-	2,724
36	Banas Kantha	Deodar	-	-	-	-	-
37	Banas Kantha	Dhanera	-	-	-	-	-
38	Banas Kantha	Kankrej	2,890	1,985	153	-	5,028
39	Banas Kantha	Palanpur	-	-	-	-	-
40	Banas Kantha	Tharad	-	-	-	-	-
41	Banas Kantha	Vadgam	266	44	2	-	313
42	Banas Kantha	Vav	-	-	-	-	-
43	Bharuch	Amod	1,464	505	42	-	2,011
44	Bharuch	Anklesvar	3,772	666	81	51	4,571
45	Bharuch	Bharuch	6,694	1,307	169	117	8,287
46	Bharuch	Hansot	704	417	63	46	1,230
47	Bharuch	Jambusar	2,376	837	74	-	3,287
48	Bharuch	Jhagadia	2,096	1,420	37	-	3,552
49	Bharuch	Vagra	429	396	70	52	947
50	Bharuch	Valia	1,697	1,834	57	-	3,588
51	Bhavnagar	Bhavnagar	363	45	3	-	411
52	Bhavnagar	Botad	154	46	4	-	204
53	Bhavnagar	Gadhada	392	183	16	-	591
54	Bhavnagar	Gariadhar	180	80	7	-	267
55	Bhavnagar	Ghogha	-	-	-	-	-
56	Bhavnagar	Mahuva	2,097	817	68	-	2,982
57	Bhavnagar	Palitana	590	255	19	-	864
58	Bhavnagar	Sihor	206	70	5	-	282
59	Bhavnagar	Talaja	984	370	27	-	1,380
60	Bhavnagar	Umrala	761	271	16	-	1,048
61	Bhavnagar	Vallabhipur	26	11	1	-	39
62	Dohad	Devgadbaria	270	208	17	-	495
63	Dohad	Dhanpur	185	248	19	-	452
64	Dohad	Dohad	445	275	18	-	738
65	Dohad	Fatepura	-	-	-	-	-
66	Dohad	Garbada	149	159	15	-	323
67	Dohad	Jhalod	1,003	1,286	55	-	2,344
68	Dohad	Limkheda	405	710	136	102	1,353
69	Gandhinagar	Dehgam	-	-	-	-	-
70	Gandhinagar	Gandhinagar	400	31	2	-	433
71	Gandhinagar	Kalol	-	-	-	-	-
72	Gandhinagar	Mansa	-	-	-	-	-
73	Jamnagar	Bhanvad	2,243	320	32	1	2,597
74	Jamnagar	Dhrol	1,133	234	12	-	1,379
75	Jamnagar	Jamjodhpur	290	26	2	-	318
76	Jamnagar	Jamnagar	2,550	235	13	-	2,798
77	Jamnagar	Jodiya	2,574	646	28	-	3,248
78	Jamnagar	Kalavad	194	33	2	0	229
79	Jamnagar	Kalyanpur	1,933	150	10	-	2,093
80	Jamnagar	Khambhalia	563	96	6	1	667
81	Jamnagar	Lalpur	1,249	195	12	-	1,456
82	Jamnagar	Okhamandal	-	-	-	-	-
83	Junagadh	Bhesan	-	-	-	-	-
84	Junagadh	Junagadh	1,924	111	10	-	2,044
85	Junagadh	Keshod	352	33	3	-	388
86	Junagadh	Kodinar	1,562	51	5	-	1,617
87	Junagadh	Malia	223	9	1	-	234
88	Junagadh	Manavadar	92	10	1	-	103
89	Junagadh	Mangrol	1,269	58	5	-	1,333
90	Junagadh	Mendarda	1,118	145	15	-	1,278
91	Junagadh	Patan-Veraval	2,145	34	3	-	2,181
92	Junagadh	Sutrapada	553	17	1	-	572
93	Junagadh	Talala	3,207	124	8	-	3,340
94	Junagadh	Una	3,364	422	40	-	3,826
95	Junagadh	Vanthali	1,438	128	13	-	1,578
96	Junagadh	Visavadar	830	230	16	-	1,076
97	Kachchh	Abdasa	920	78	5	-	1,002
98	Kachchh	Anjar	193	20	1	-	214
99	Kachchh	Bhachau	-	-	-	-	-
100	Kachchh	Bhuj	3,402	428	15	-	3,845
101	Kachchh	Gandhidham	-	-	-	-	-
102	Kachchh	Lakhpat	825	128	3	-	957
103	Kachchh	Mandvi	59	8	0	-	67
104	Kachchh	Mundra	342	52	4	-	397
105	Kachchh	Nakhatrana	668	71	4	-	744
106	Kachchh	Rapar	633	75	3	-	711
107	Kheda	Balasinor	-	-	-	-	-
108	Kheda	Kapadvanj	237	94	9	-	341
109	Kheda	Kathlal	261	182	17	-	460
110	Kheda	Kheda	3,008	872	65	-	3,945
111	Kheda	Mahudha	996	449	39	-	1,485
112	Kheda	Matar	2,329	1,069	168	123	3,689
113	Kheda	Mehmedabad	1,007	601	56	-	1,664
114	Kheda	Nadiad	842	206	17	-	1,065

GUJARAT BUILDING VULNERABILITY ZONATION: FLOOD DAMAGE TO BUILDINGS (NUMBER OF BUILDINGS) (BY DAMAGE GRADE) Table No. VBLT - 03 of 03

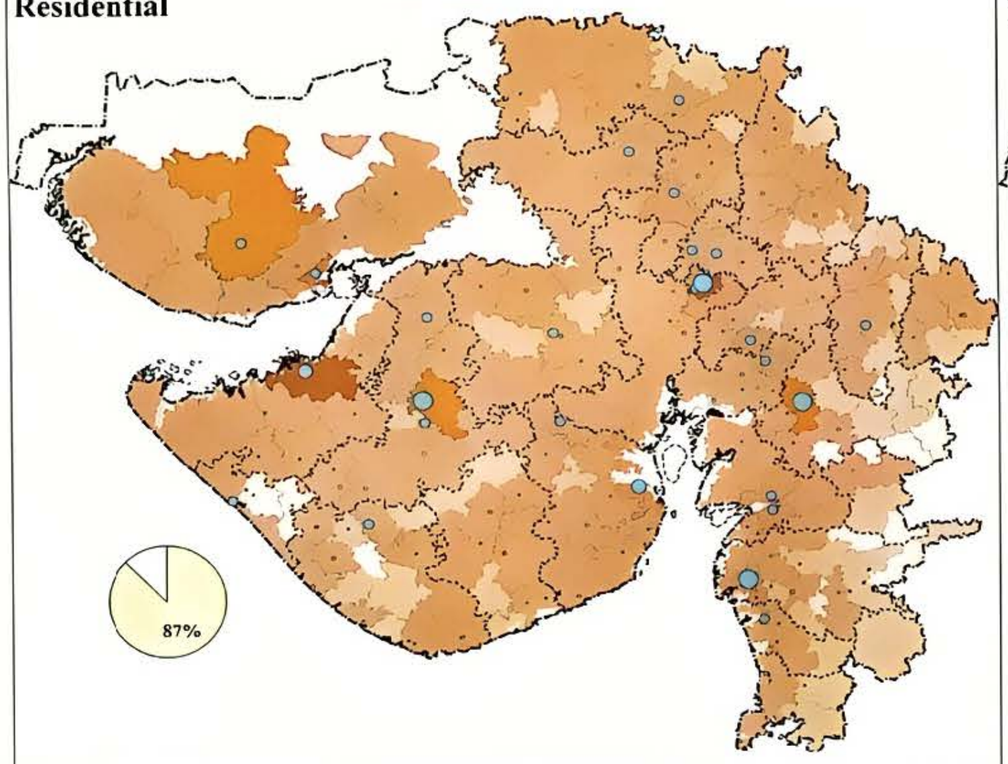
GSDMA

Sr. No	District	Taluka	Undamaged	G2 & G3	G4	G5	Total
115	Kheda	Thasra	4,159	1,879	175	-	6,214
116	Kheda	Virpur	-	-	-	-	-
117	Mahesana	Becharaji	-	-	-	-	-
118	Mahesana	Kadi	-	-	-	-	-
119	Mahesana	Kheralu	-	-	-	-	-
120	Mahesana	Mahesana	-	-	-	-	-
121	Mahesana	Satlasana	-	-	-	-	-
122	Mahesana	Unjha	-	-	-	-	-
123	Mahesana	Vadnagar	-	-	-	-	-
124	Mahesana	Vijapur	-	-	-	-	-
125	Mahesana	Visnagar	-	-	-	-	-
126	Narmada	Dediapada	197	629	1	-	827
127	Narmada	Nandod	1,012	600	5	-	1,617
128	Narmada	Sagbara	-	-	-	-	-
129	Narmada	Tilakwada	108	26	1	-	135
130	Navsari	Bansda	3,163	5,693	30	-	8,885
131	Navsari	Chikhli	5,698	5,973	387	119	12,177
132	Navsari	Gandevi	7,426	5,759	2,185	1,417	16,788
133	Navsari	Jalalpore	4,195	1,122	69	32	5,418
134	Navsari	Navsari	5,588	1,144	65	26	6,823
135	Panch Mahals	Ghoghamba	60	74	5	-	139
136	Panch Mahals	Godhra	551	238	20	-	809
137	Panch Mahals	Halol	116	57	3	-	176
138	Panch Mahals	Jambughoda	9	5	0	-	15
139	Panch Mahals	Kadana	344	375	36	-	755
140	Panch Mahals	Kalol	-	-	-	-	-
141	Panch Mahals	Khanpur	764	754	74	-	1,591
142	Panch Mahals	Lunawada	3,629	2,521	475	358	6,983
143	Panch Mahals	Morwa (Hadaf)	390	748	155	119	1,411
144	Panch Mahals	Santrampur	61	68	7	-	136
145	Panch Mahals	Shehera	658	1,003	203	156	2,021
146	Patan	Chanasma	738	71	4	-	813
147	Patan	Harij	-	-	-	-	-
148	Patan	Patan	147	18	1	-	167
149	Patan	Radhanpur	-	-	-	-	-
150	Patan	Sami	504	356	29	-	889
151	Patan	Santalpur	-	-	-	-	-
152	Patan	Sidhpur	944	76	5	-	1,026
153	Patan	Vagdod	-	-	-	-	-
154	Porbandar	Kutiyana	692	40	3	-	736
155	Porbandar	Porbandar	825	22	2	-	848
156	Porbandar	Ranavav	543	19	2	-	563
157	Rajkot	Dhoraji	258	12	1	-	272
158	Rajkot	Gondal	1,374	241	17	-	1,633
159	Rajkot	Jamkandorna	121	22	2	-	144
160	Rajkot	Jasdan	216	69	6	-	291
161	Rajkot	Jetpur	1,566	233	16	-	1,814
162	Rajkot	Kotda Sangani	456	68	4	-	527
163	Rajkot	Lodhika	128	30	2	-	160
164	Rajkot	Maliya	364	125	8	-	497
165	Rajkot	Morvi	3,995	546	36		4,577
166	Rajkot	Paddhari	1,195	299	29	21	1,544
167	Rajkot	Rajkot	4,081	307	20	-	4,408
168	Rajkot	Tankara	1,877	431	27	-	2,335
169	Rajkot	Upleta	1,785	144	11	-	1,940
170	Rajkot	Wankaner	456	47	4	-	507
171	Sabar Kantha	Bayad	387	171	16	-	574
172	Sabar Kantha	Bhiloda	264	179	14	-	457
173	Sabar Kantha	Dhansura	499	216	19	-	733
174	Sabar Kantha	Himatnagar	539	107	9	-	655
175	Sabar Kantha	Idar	-	-	-	-	-
176	Sabar Kantha	Khedbrahma	156	124	5	-	284
177	Sabar Kantha	Malpur	60	42	4	-	106
178	Sabar Kantha	Meghraj	95	105	10	-	210
179	Sabar Kantha	Modasa	2,198	956	160	115	3,429
180	Sabar Kantha	Prantij	-	-	-	-	-
181	Sabar Kantha	Talod	-	-	-	-	-
182	Sabar Kantha	Vadali	-	-	-	-	-
183	Sabar Kantha	Vijaynagar	48	54	5	-	107
184	Surat	Bardoli	2,416	839	22		3,277
185	Surat	Chorasi	31,253	2,362	160	78	33,853
186	Surat	Kamrej	6,660	1,466	146	90	8,362
187	Surat	Mahuva	338	578	37	10	963
188	Surat	Mandvi	1,914	3,753	234	43	5,945
189	Surat	Mangrol	380	224	8	-	612
190	Surat	Nizar	138	216	3	-	357
191	Surat	Olpad	4,359	1,722	184	117	6,383
192	Surat	Palsana	495	97	3	-	594
193	Surat	Songadh	238	575	30	1	844
194	Surat	Surat City	80,879	808	15	-	81,702
195	Surat	Uchchhal	4	8	0	-	12
196	Surat	Umarpada	67	158	0		226
197	Surat	Valod	899	796	11		1,706
198	Surat	Vyara	165	265	1	-	432
199	Surendranagar	Chotila	108	11	1	-	120
200	Surendranagar	Chuda	491	284	27	-	801
201	Surendranagar	Dasada	-	-	-	-	-
202	Surendranagar	Dhrangadhra	475	33	3		511
203	Surendranagar	Halvad	1,296	125	8	-	1,429
204	Surendranagar	Lakhtar	-	-	-		-
205	Surendranagar	Limbdi	110	59	5	1	175
206	Surendranagar	Muli	718	113	8	-	838
207	Surendranagar	Sayla	304	146	14	-	464
208	Surendranagar	Wadhwan	1,441	184	15	-	1,640
209	The Dangs	The Dangs	80	204	1	-	285
210	Vadodara	Chhota Udaipur	63	28	1		92
211	Vadodara	Dabhoi	946	46	2		994
212	Vadodara	Jetpur Pavi	825	382	34	17	1,257
213	Vadodara	Karjan	452	67	5		525
214	Vadodara	Kavant	154	185	2	-	341
215	Vadodara	Nasvadi	16	24	2	0	41
216	Vadodara	Padra	2,707	798	72		3,577
217	Vadodara	Sankheda	-	-	-	-	-
218	Vadodara	Savli	4,437	1,816	145	-	6,398
219	Vadodara	Sinor	260	9	0	-	269
220	Vadodara	Vadodara	27,685	726	39	-	28,451
221	Vadodara	Vaghodia	-	-	-	-	-
222	Valsad	Dharampur	203	369	4	0	576
223	Valsad	Kaprada	263	649	9	-	921
224	Valsad	Pardi	1,497	525	33	10	2,066
225	Valsad	Umbergaon	5,999	2,833	201	73	9,106
226	Valsad	Valsad	7,851	2,665	171	61	10,748

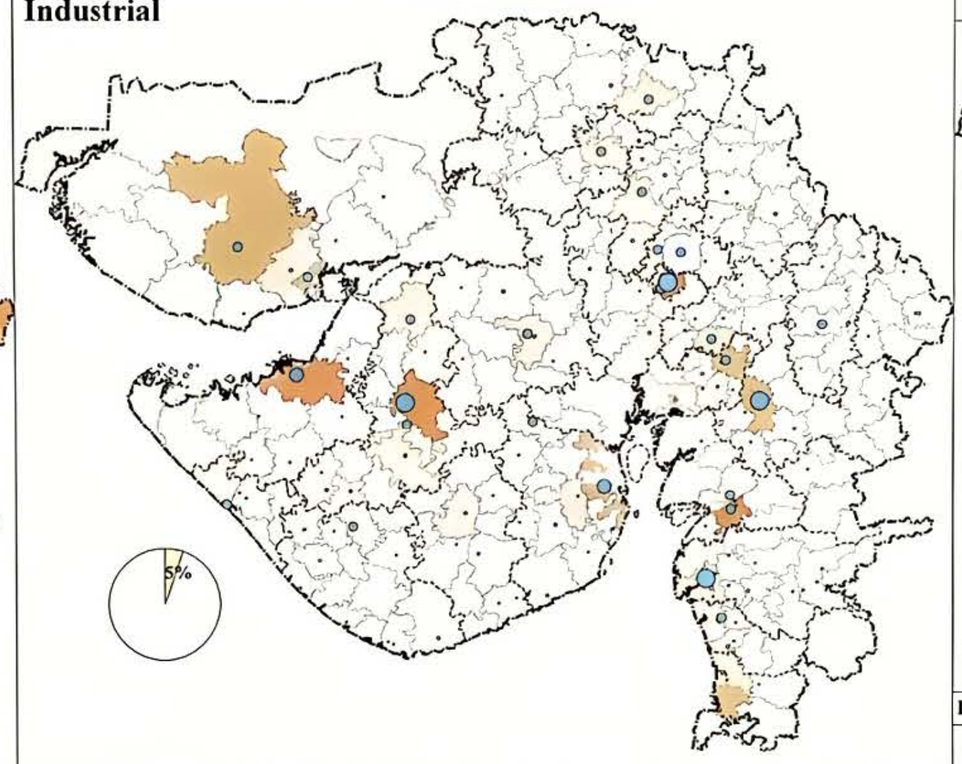
Gujarat Building Risk Zonation: Earthquake Loss to Buildings
(50 year return period) (Rs. Million 2002-2003 Prices)

GSDMA

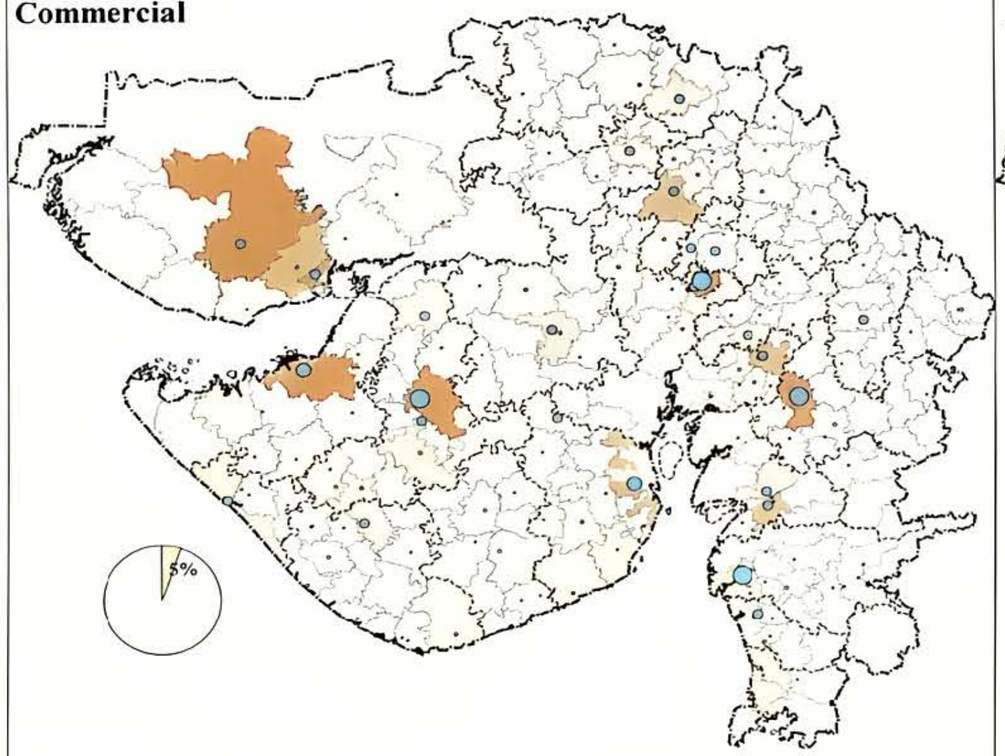
Residential



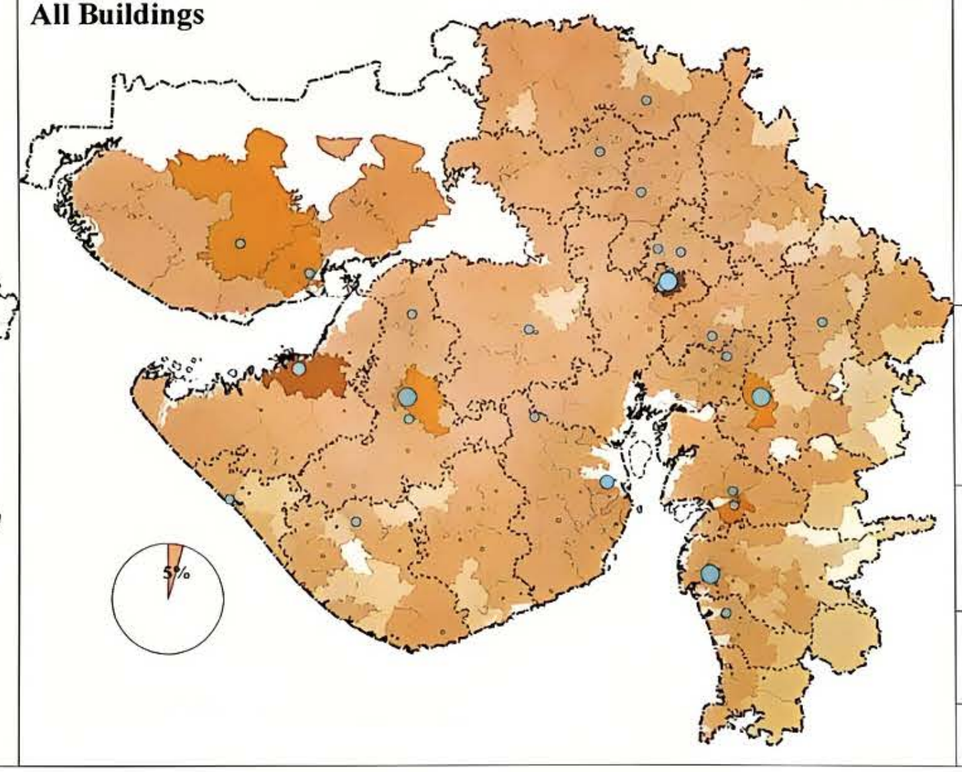
Industrial

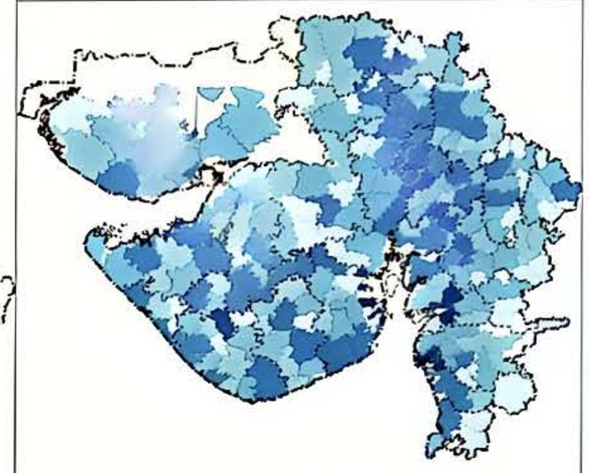


Commercial



All Buildings





LEGEND

Loss (Rs. Million)
< 10
> 10 to 20
> 20 to 50
> 50 to 100
> 100 to 500
> 500 to 1000
> 1000 to 2000
> 2000 to 5000
> 5000
Urban Centres

Sizes of the urban centres are varying according to their populations. The first three main map pie charts show the proportion of loss to buildings in respective category to total loss to all buildings The fourth main map pie chart shows the proportion of loss to all buildings to total cost of all buildings

Source: TARU Studies & Analysis, 1993-2004; Census of India, 2001; BISAG, GoG

0 100 km

N

Projection : Lambert Azimuthal Equal Area
Datum : WGS 84

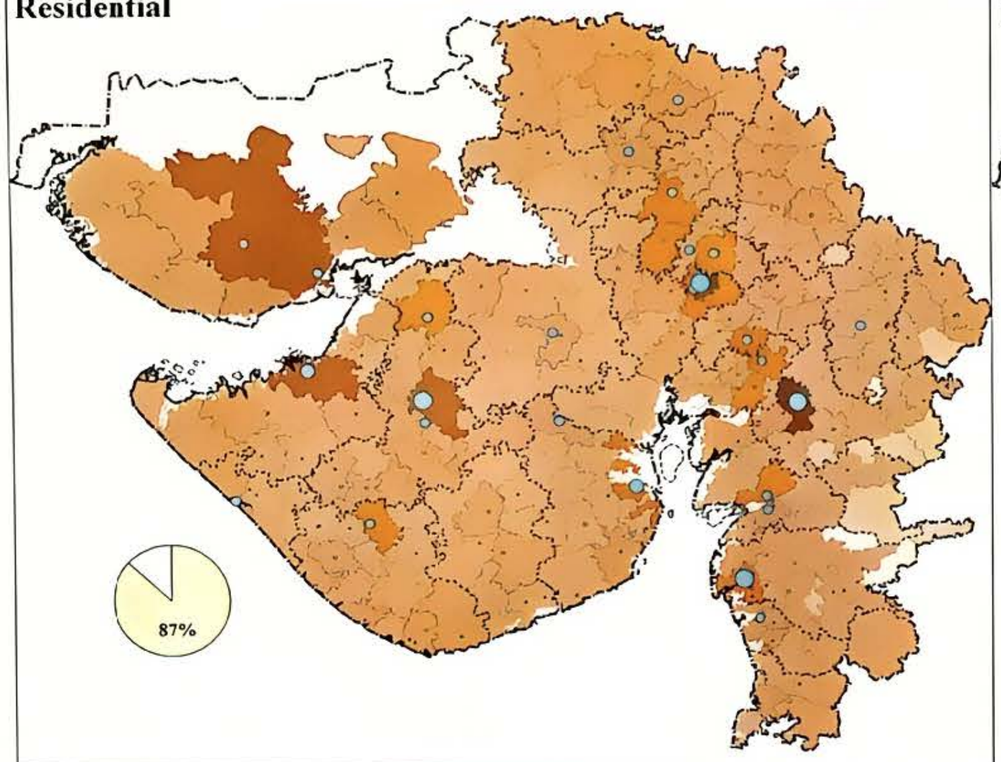
MAP No. : RBLM - 01 OF 05

Date : 10/8/2005

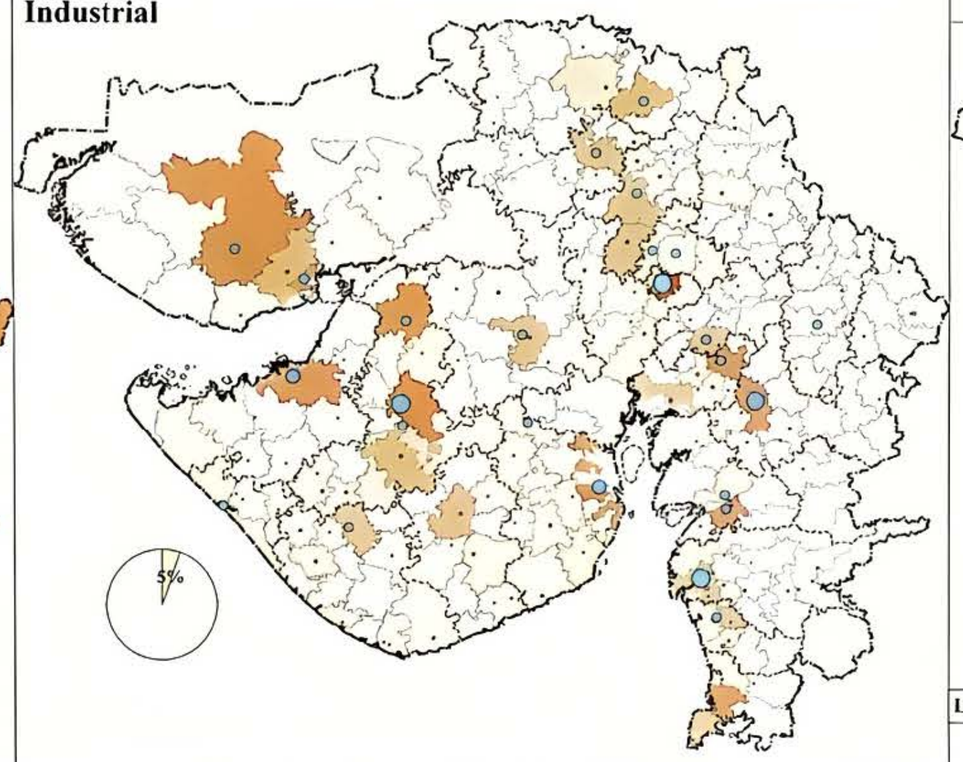
Gujarat Building Risk Zonation: Earthquake Loss to Buildings
(100 year return period) (Rs. Million 2002-2003 prices)

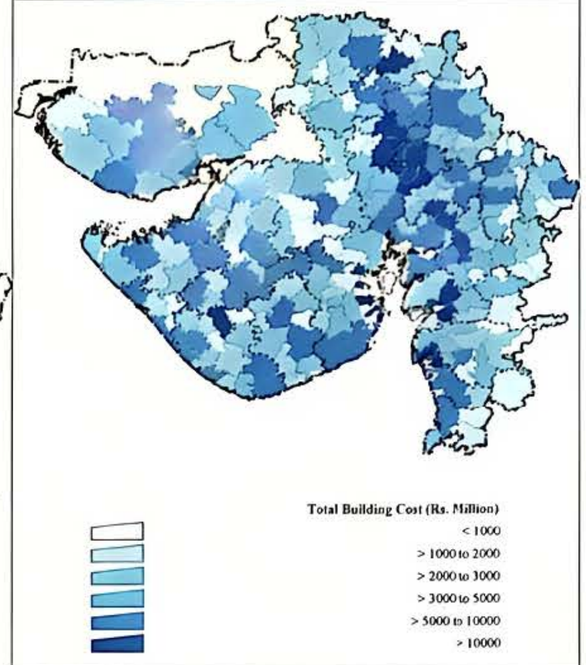
GSDMA

Residential

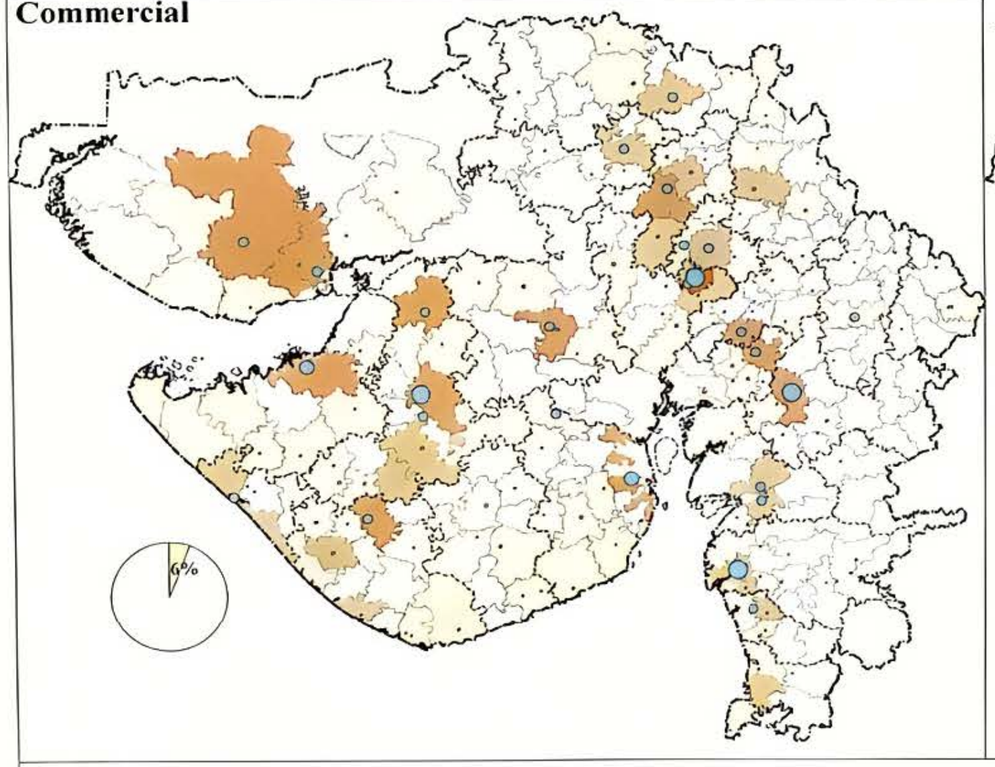


Industrial

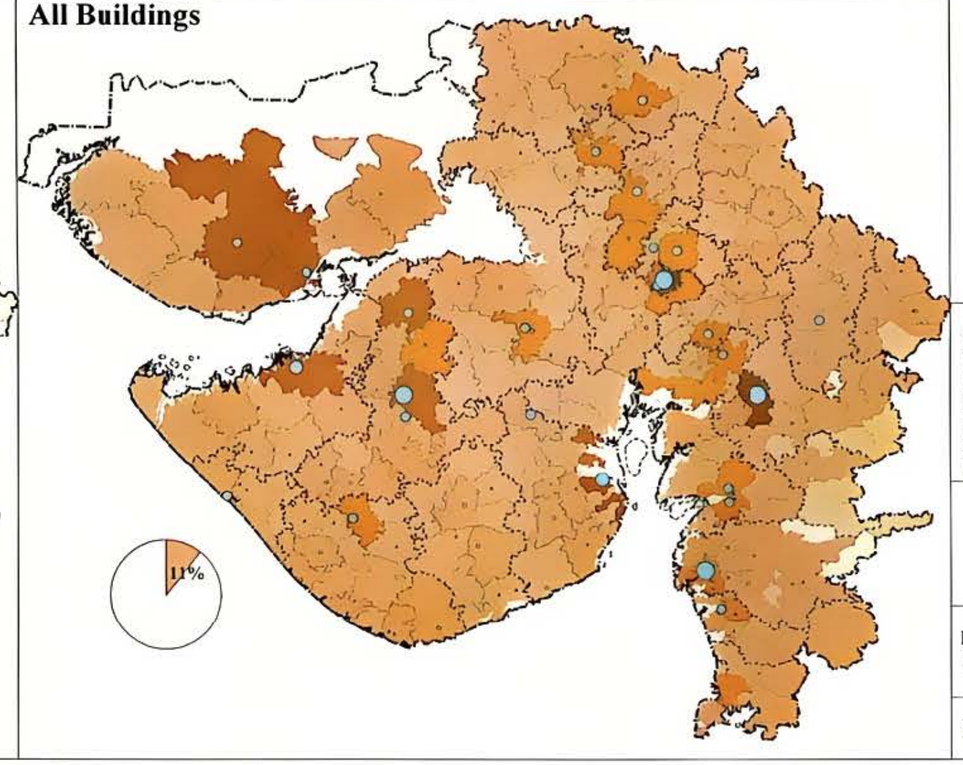




Commercial



All Buildings



LEGEND

Loss (Rs. Million)
- < 10
- > 10 to 20
- > 20 to 50
- > 50 to 100
- > 100 to 500
- > 500 to 1000
- > 1000 to 2000
- > 2000 to 5000
- > 5000
- Urban Centres

Sizes of the urban centres are varying according to their populations
The first three main map pie charts show the proportion of loss to buildings in respective category to total loss to all buildings. The fourth main map pie chart shows the proportion of loss to all buildings to total cost of all buildings.
Source: TARU Studies & Analysis, 1993-2004; Census of India, 2001; BISAG, GoG.

0 100 km

N

Projection : Lambert Azimuthal Equal Area
Datum : WGS 84

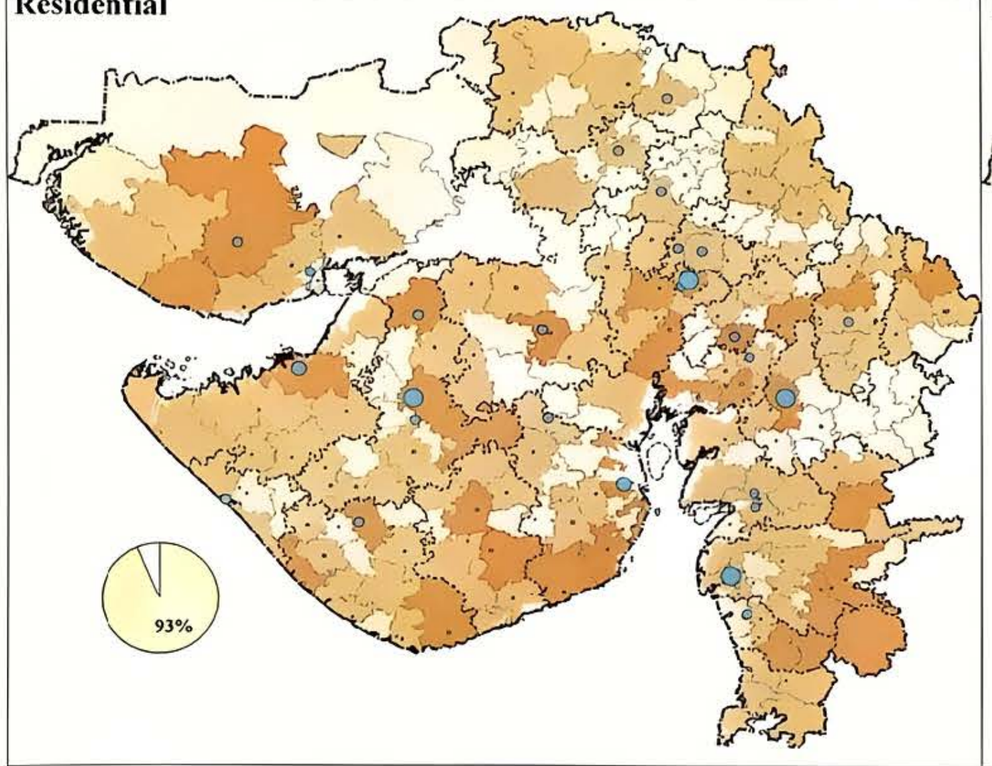
MAP No. : RBLM - 02 OF 05

Date : 15/6/2005

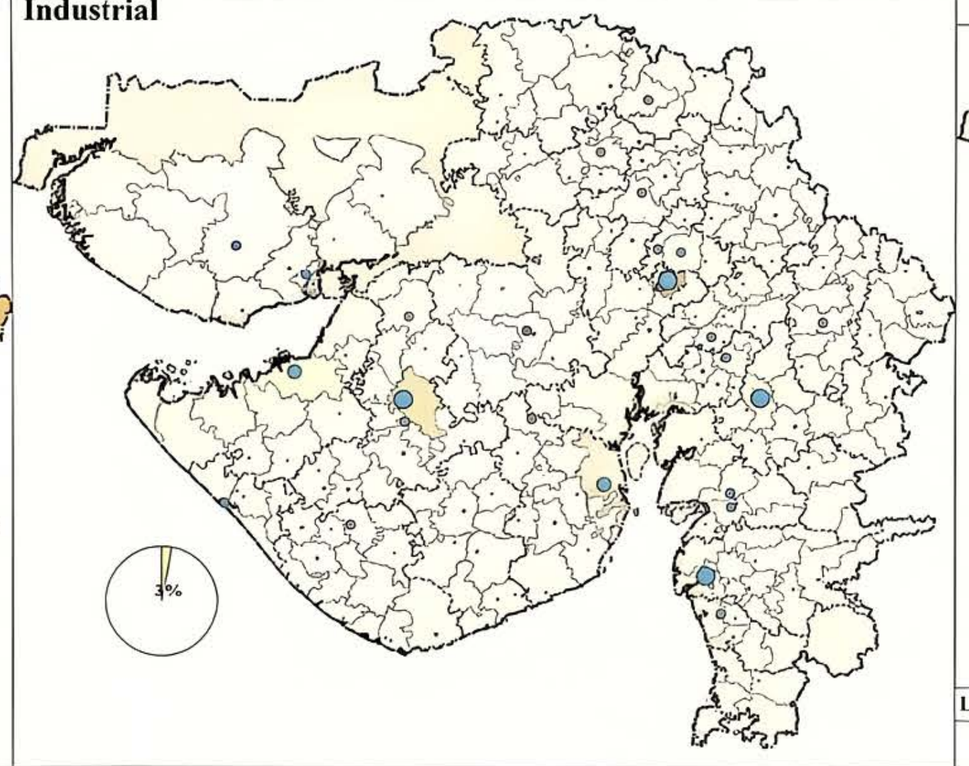
Gujarat Building Risk Zonation: Cyclonic Storms & Wind Loss to Buildings
(50 year return period) (Rs. Million 2002-2003 prices)

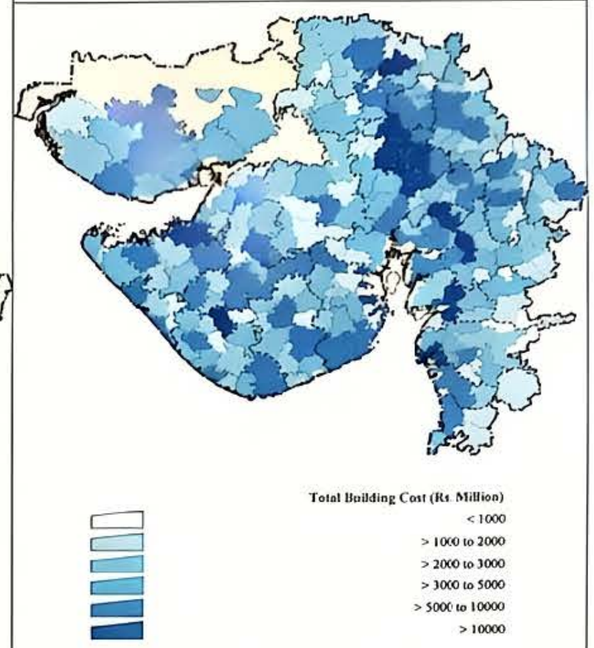
GSDMA

Residential

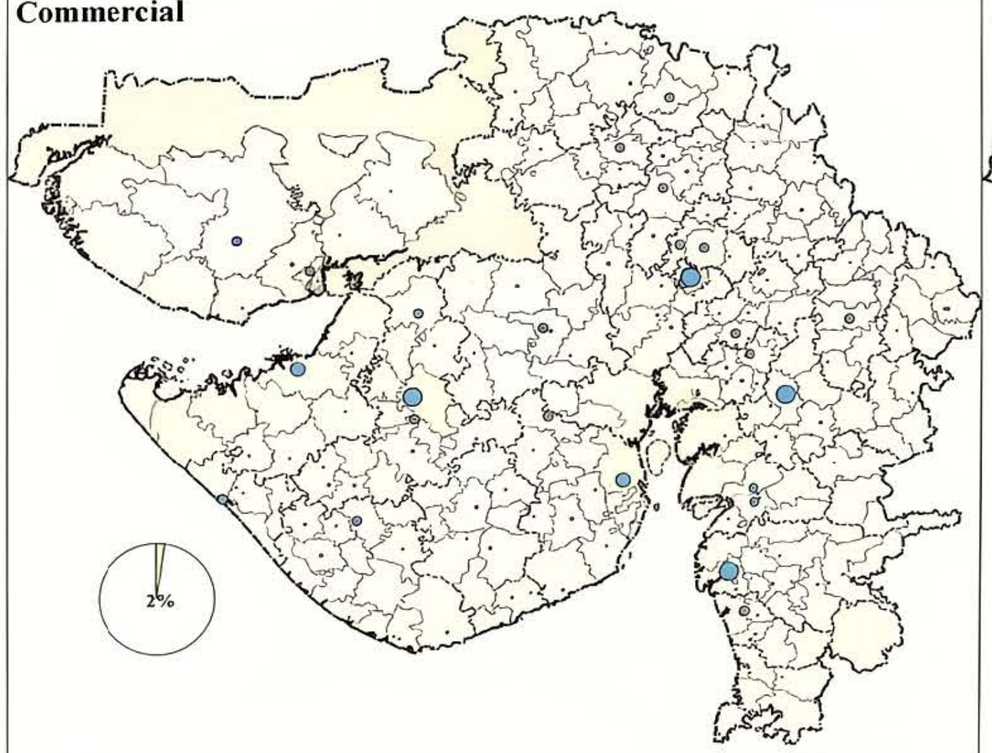


Industrial

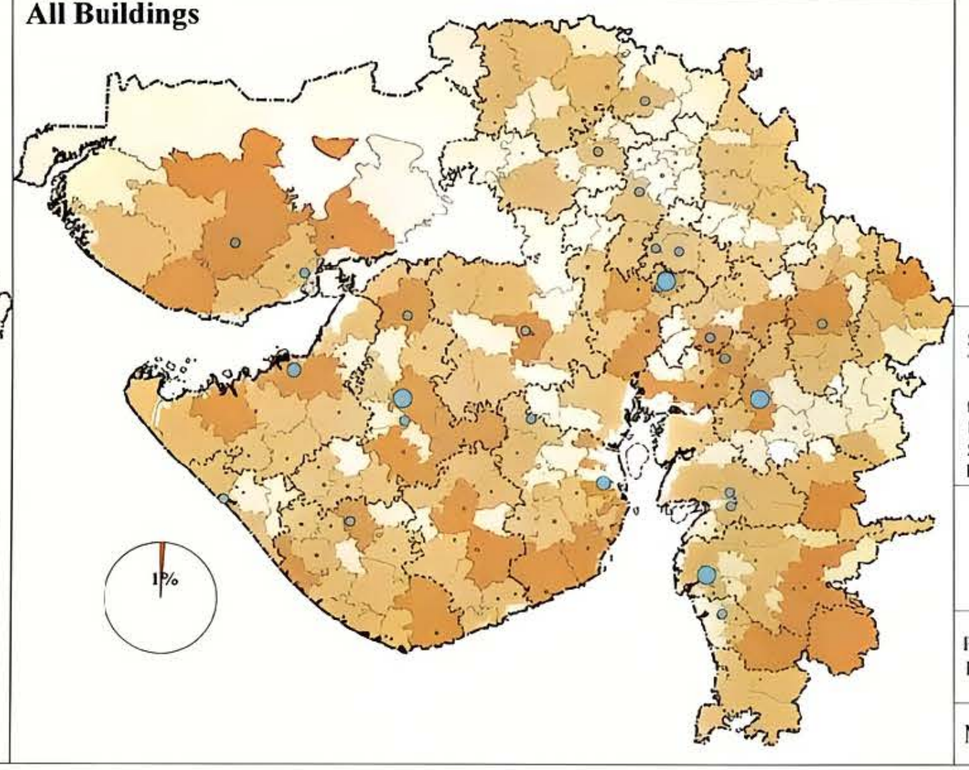




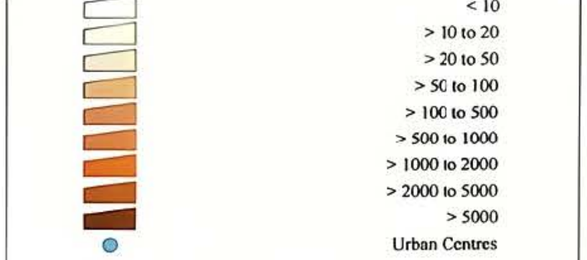
Commercial



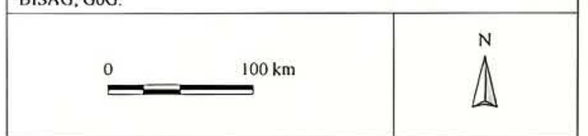
All Buildings



LEGEND



Sizes of the urban centres are varying according to their populations.
The first three main map pie charts show the proportion of loss to buildings in respective category to total loss to all buildings The fourth main map pie chart shows the proportion of loss to all buildings to total cost of all buildings
Source: TARU Studies & Analysis, 1993-2004; Census of India, 2001, BISAG, GoG.



Projection : Lambert Azimuthal Equal Area
Datum : WGS 84

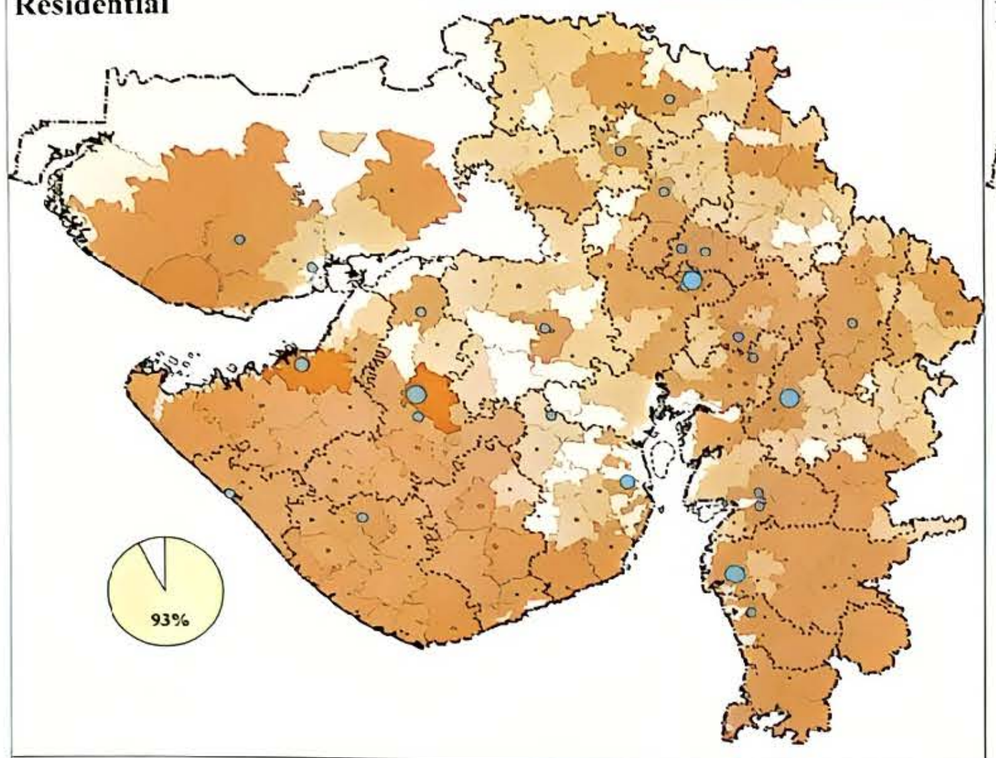
MAP No. : RBLM - 03 OF 05

Date : 16/6/2005

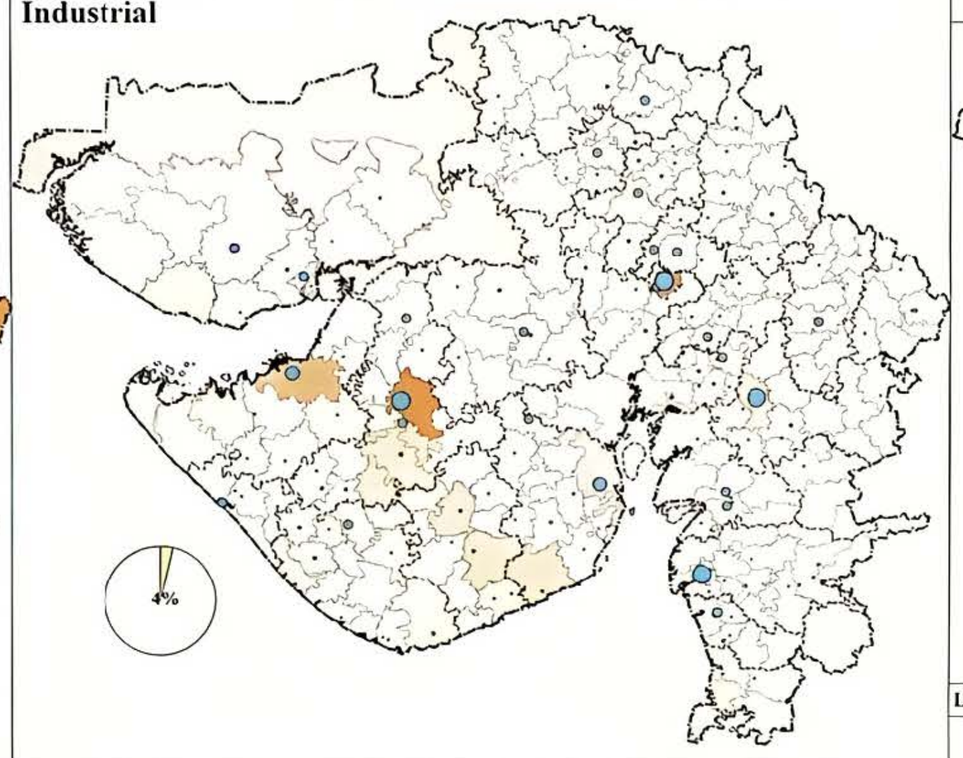
Gujarat Building Risk Zonation: Cyclonic Storms & Wind Loss to Buildings
(100 year return period) (Rs. Million 2002-2003 prices)

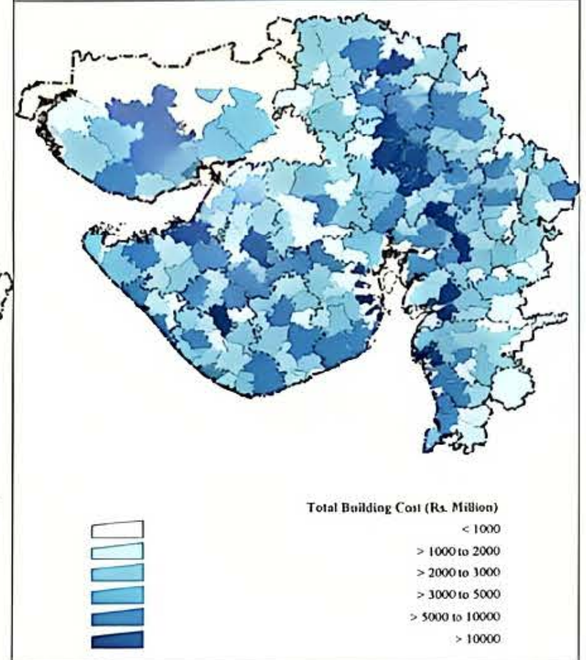
GSDMA

Residential



Industrial

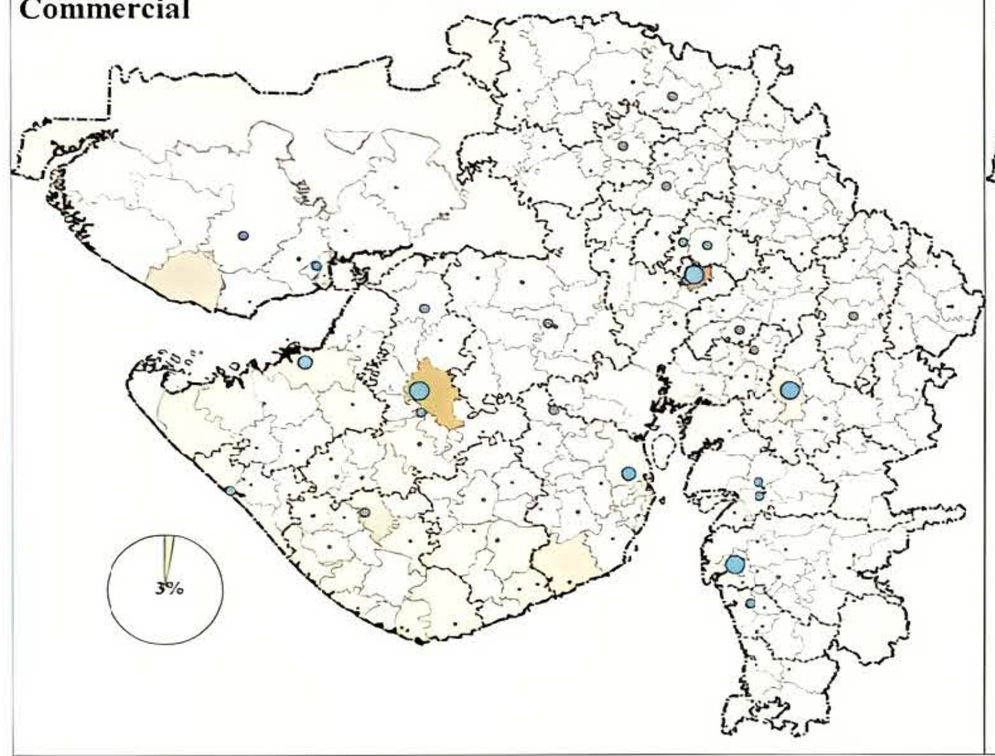




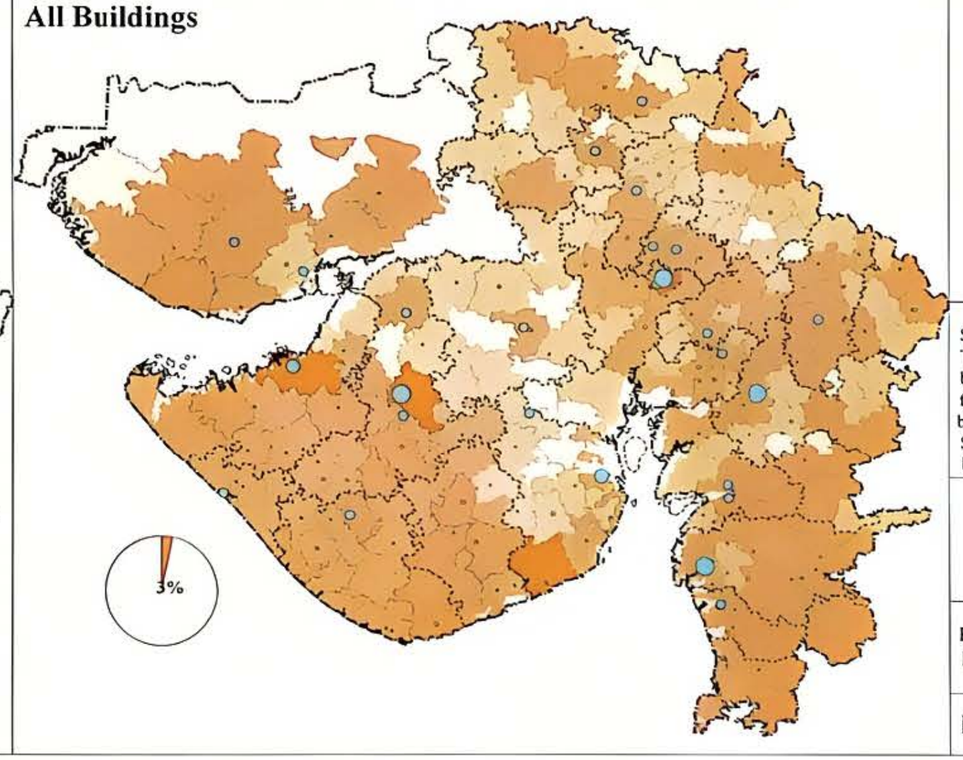
LEGEND

Loss (Rs. Million)
< 10
> 10 to 20
> 20 to 50
> 50 to 100
> 100 to 500
> 500 to 1000
> 1000 to 2000
> 2000 to 5000
> 5000
Urban Centres

Commercial



All Buildings



Sizes of the urban centres are varying according to their populations
The first three main map pie charts show the proportion of loss to buildings in respective category to total loss to all buildings. The fourth main map pie chart shows the proportion of loss to all buildings to total cost of all buildings
Source: TARU Studies & Analysis, 1993-2004; Census of India, 2001, BISAG, GoG

0 100 km

N

Projection : Lambert Azimuthal Equal Area
Datum : WGS 84

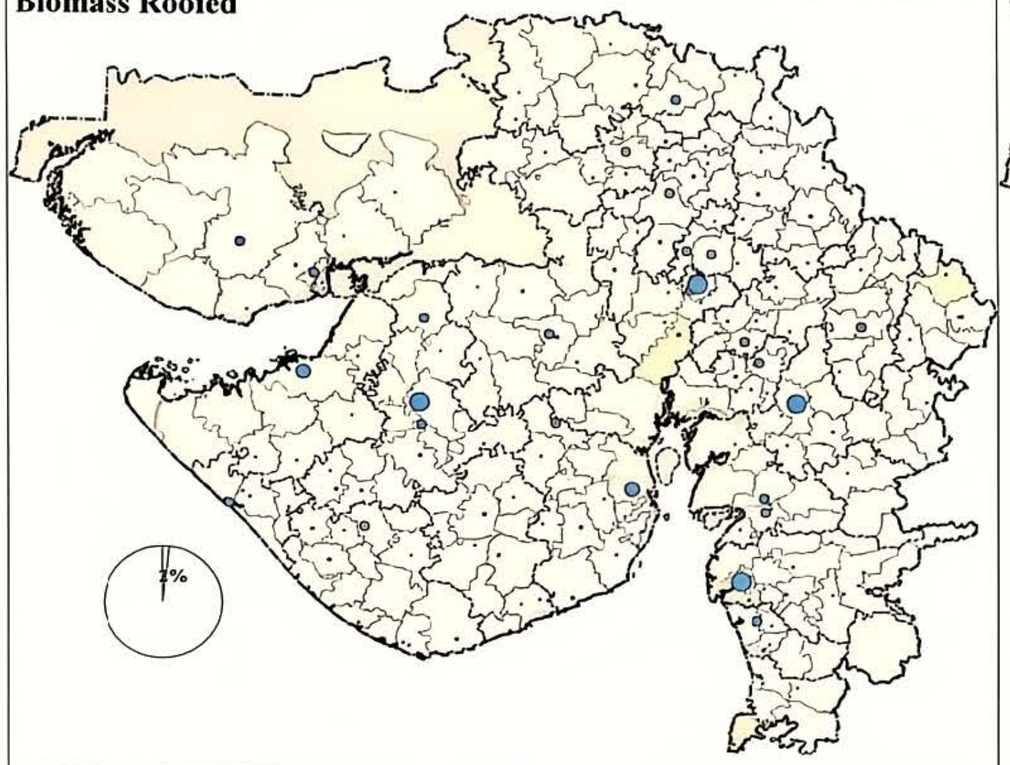
MAP No. : RBLM - 04 OF 05

Date : 17/6/2005

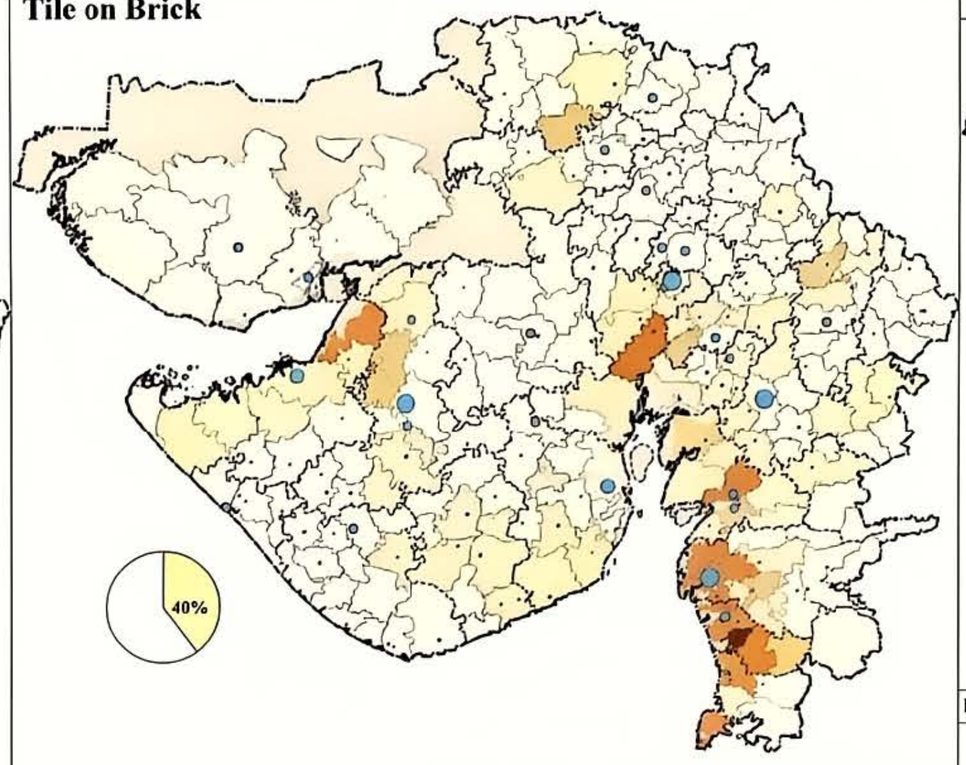
Gujarat Building Risk Zonation: Flood Loss to Buildings
(Rs. Million 2002-2003 prices)

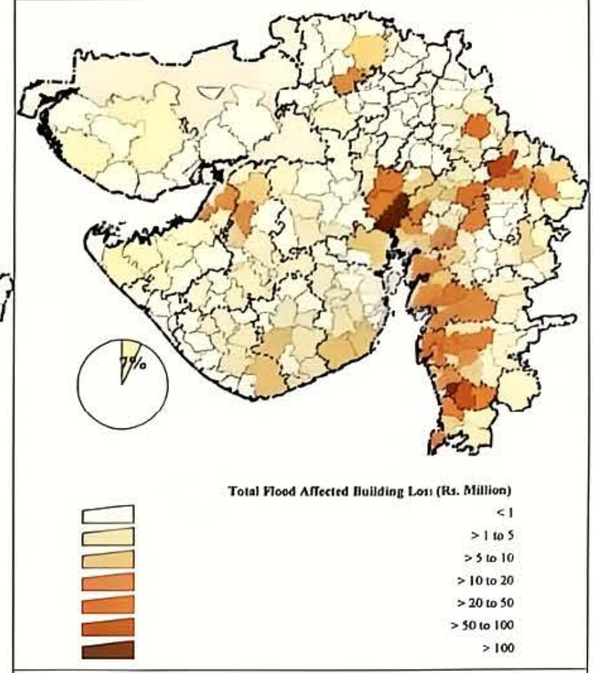
GSDMA

Biomass Roofed

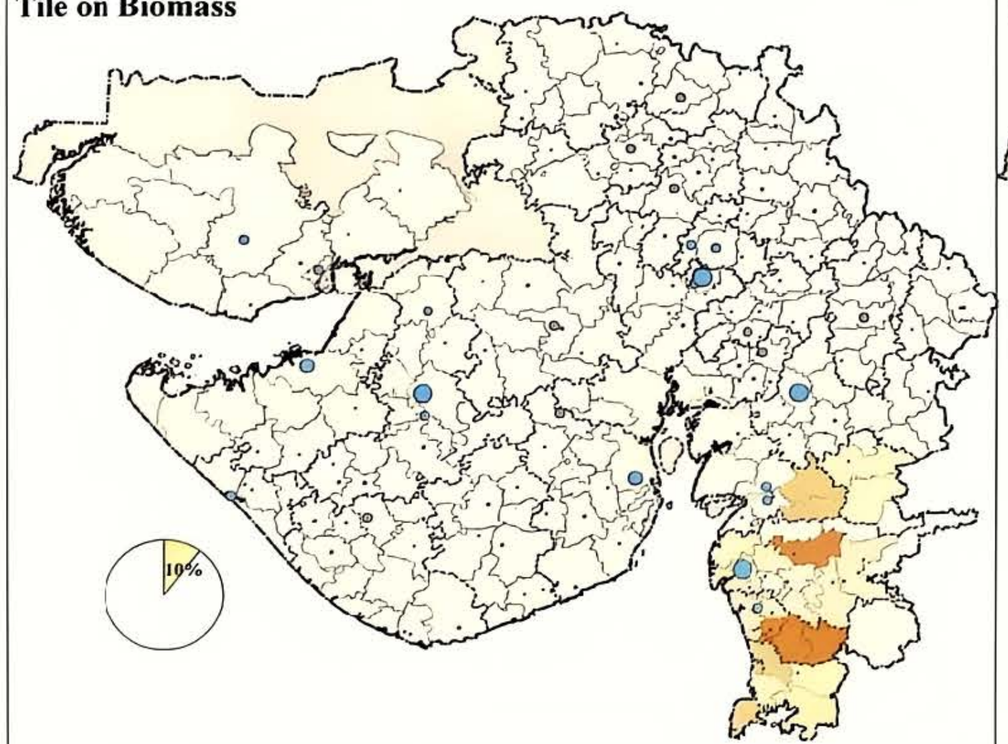


Tile on Brick

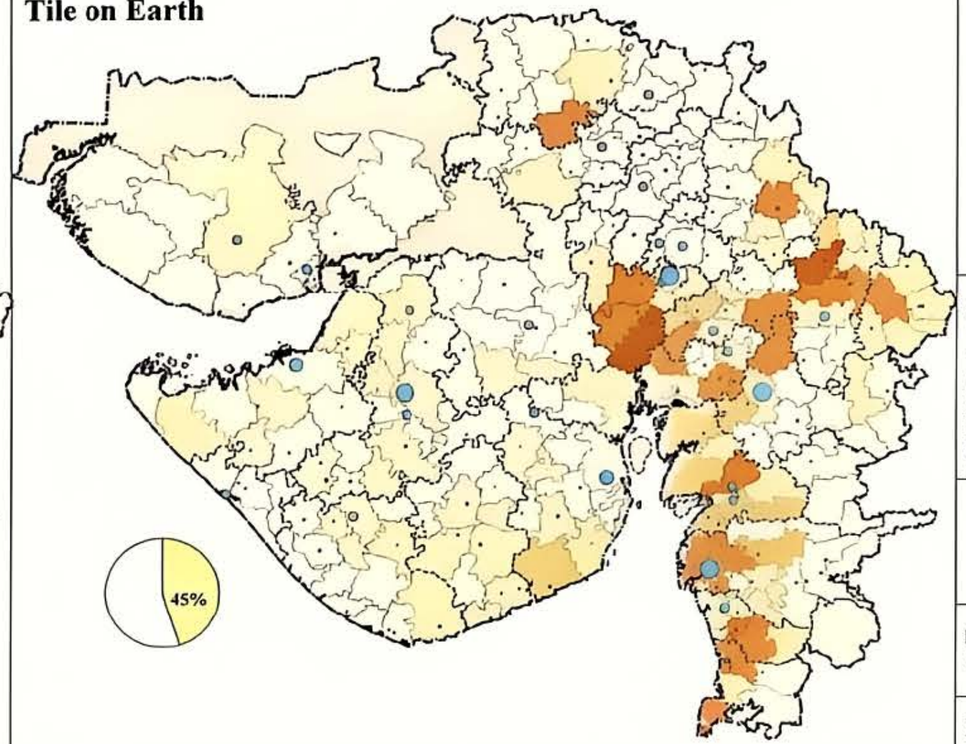




Tile on Biomass



Tile on Earth



LEGEND

Loss (Rs. Million)
< 1
> 1 to 5
> 5 to 10
> 10 to 20
> 20 to 50
> 50 to 100
> 100
Urban Centres

Sizes of the urban centres are varying according to their populations
Inset pie chart shows the proportion of loss of flood affected building to total cost of flood affected buildings
Main map pie charts show the proportion of loss of flood affected buildings in respective category to total loss of flood affected buildings
Source: TARU Studies & Analysis, 2004, Census of India, 2001, Flood Contol Cell, GoG; SWDC; Flood Memorandum, 2003; BISAG, GoG.

0 100 km

N

Projection : Lambert Azimuthal Equal Area
Datum : WGS 84

MAP No. : RBLM - 05 OF 05

Date : 16/6/2005

GUJARAT BUILDING RISK ZONATION: EARTHQUAKE LOSS TO BUILDINGS (100 YEAR RETURN PERIOD)
(Rs. MILLION 2002-2003 PRICES) (BY ENDUSE) Table No. RBLT - 01 of 03

GSDMA

Sr. No	District	Taluka	Residential	Industrial	Commercial	Total Loss	Capital Cost
1	Ahmadabad	Ahmadabad City	12,508.4	1,629.9	1,839.4	16,272	175,921
2	Ahmadabad	Barwala	133.3	6.7	4.0	146	1,106
3	Ahmadabad	Bavla	428.8	14.5	17.1	469	3,629
4	Ahmadabad	Daskroi	1,472.1	39.1	68.4	1,608	16,592
5	Ahmadabad	Detroj-Rampura	233.3	6.7	4.0	250	1,846
6	Ahmadabad	Dhandhuka	379.0	13.0	14.1	415	3,173
7	Ahmadabad	Dholka	648.8	26.9	33.2	722	5,874
8	Ahmadabad	Mandal	241.0	6.5	4.0	257	1,864
9	Ahmadabad	Ranpur	145.0	7.6	2.9	157	1,181
10	Ahmadabad	Sanand	565.8	15.9	8.4	602	4,709
11	Ahmadabad	Viramgam	550.2	19.3	32.3	615	4,663
12	Amreli	Amreli	728.9	59.0	49.3	853	7,864
13	Amreli	Babra	342.9	8.4	13.1	371	2,979
14	Amreli	Bagasara	235.5	11.5	18.1	271	2,335
15	Amreli	Dhari	414.7	11.4	14.5	449	3,545
16	Amreli	Jafrabad	288.0	3.2	9.3	308	2,019
17	Amreli	Khambha	267.0	5.9	8.5	287	2,068
18	Amreli	Kunkavav Vadia	343.0	9.3	10.1	371	3,088
19	Amreli	Lathi	414.9	24.0	18.1	465	4,043
20	Amreli	Lilia	214.7	7.0	4.8	231	1,793
21	Amreli	Rajula	421.0	11.2	27.1	467	3,448
22	Amreli	Savar Kundla	711.6	34.8	35.2	794	6,430
23	Anand	Anand	1,665.4	111.6	149.3	1,970	19,949
24	Anand	Anklav	427.0	9.2	6.9	450	3,429
25	Anand	Borsad	1,056.5	24.4	27.2	1,127	8,941
26	Anand	Khambhat	962.2	51.3	39.5	1,071	9,348
27	Anand	Petlad	807.8	20.8	26.8	871	7,173
28	Anand	Sojitra	324.2	4.3	5.5	339	2,661
29	Anand	Tarapur	260.1	4.6	4.6	275	2,065
30	Anand	Umreth	454.7	13.1	18.7	497	4,170
31	Banas Kantha	Amirgadh	166.4	3.9	2.8	178	1,292
32	Banas Kantha	Bhabhar	163.3	3.2	7.2	178	1,263
33	Banas Kantha	Danta	244.4	6.2	12.2	271	2,200
34	Banas Kantha	Dantiwada	179.6	5.1	3.7	192	1,524
35	Banas Kantha	Deesa	745.4	21.2	26.2	807	6,609
36	Banas Kantha	Deodar	267.7	6.7	7.7	288	2,056
37	Banas Kantha	Dhanera	322.2	7.6	20.9	357	2,866
38	Banas Kantha	Kankrej	358.3	9.0	8.8	386	2,851
39	Banas Kantha	Palanpur	974.3	73.1	72.5	1,143	10,987
40	Banas Kantha	Tharad	327.8	7.5	12.4	356	2,579
41	Banas Kantha	Vadgam	502.4	11.8	8.2	532	4,611
42	Banas Kantha	Vav	290.4	4.1	5.4	308	2,029
43	Bharuch	Amod	319.9	4.8	5.1	338	2,531
44	Bharuch	Anklesvar	877.2	133.9	74.4	1,102	10,461
45	Bharuch	Bharuch	1,269.3	44.1	71.6	1,418	13,406
46	Bharuch	Hansot	232.9	6.3	4.2	250	1,841
47	Bharuch	Jambusar	692.0	17.1	25.6	753	5,808
48	Bharuch	Jhagadia	390.1	5.7	5.1	425	3,251
49	Bharuch	Vagra	321.1	4.4	3.8	341	2,371
50	Bharuch	Valia	309.9	5.5	4.4	336	2,437
51	Bhavnagar	Bhavnagar	1,766.5	197.0	205.7	2,210	22,266
52	Bhavnagar	Botad	573.6	43.8	37.9	664	6,191
53	Bhavnagar	Gadhada	390.0	23.5	15.1	436	3,806
54	Bhavnagar	Gariadhar	284.4	14.2	10.9	315	2,676
55	Bhavnagar	Ghogha	229.9	10.9	6.2	251	1,913
56	Bhavnagar	Mahuva	413.7	13.0	22.4	456	7,596
57	Bhavnagar	Palitana	459.1	21.2	27.3	517	4,448
58	Bhavnagar	Sihor	497.9	46.9	26.6	582	4,957
59	Bhavnagar	Talaja	589.0	20.3	28.3	648	5,066
60	Bhavnagar	Umrala	213.8	19.4	7.2	246	2,147
61	Bhavnagar	Vallabhipur	216.0	16.5	5.2	242	1,911
62	Dohad	Devgadbaria	195.2	2.9	3.5	207	3,047
63	Dohad	Dhanpur	79.3	1.0	0.5	83	1,110
64	Dohad	Dohad	233.6	6.1	12.3	260	5,317
65	Dohad	Fatepura	113.8	0.4	1.0	119	1,647
66	Dohad	Garbada	100.4	0.6	0.9	105	1,446
67	Dohad	Jhalod	187.2	1.4	4.1	200	3,164
68	Dohad	Limkheda	158.6	1.0	1.4	166	2,216
69	Gandhinagar	Dehgam	743.9	27.9	38.9	840	6,949
70	Gandhinagar	Gandhinagar	1,806.2	22.2	61.0	1,922	19,948
71	Gandhinagar	Kalol	403.7	36.2	22.3	469	10,833
72	Gandhinagar	Mansa	623.6	29.4	28.4	693	6,557
73	Jamnagar	Bhanvad	327.5	8.8	20.1	365	2,528
74	Jamnagar	Dhrol	499.4	9.4	21.6	541	2,635
75	Jamnagar	Jamjodhpur	410.0	9.7	24.9	453	3,162
76	Jamnagar	Jamnagar	3,568.1	321.1	258.2	4,213	24,684
77	Jamnagar	Jodiya	623.7	16.1	17.8	672	3,011
78	Jamnagar	Kalavad	571.6	11.6	20.8	615	5,043
79	Jamnagar	Kalyanpur	419.1	13.5	19.7	462	3,400
80	Jamnagar	Khambhalia	622.5	17.6	49.0	703	6,080
81	Jamnagar	Lalpur	329.9	5.6	8.3	351	2,733
82	Jamnagar	Okhamandal	366.8	7.0	22.0	403	3,212
83	Junagadh	Bhesan	227.9	5.8	8.2	247	1,875
84	Junagadh	Junagadh	1,221.2	66.9	139.2	1,456	10,628
85	Junagadh	Keshod	659.4	41.9	58.6	776	5,504
86	Junagadh	Kodinar	588.1	18.3	39.2	659	4,550
87	Junagadh	Malia	416.4	11.9	16.8	454	3,084
88	Junagadh	Manavadar	490.7	10.3	29.4	539	3,749
89	Junagadh	Mangrol	666.5	18.9	30.9	732	4,983
90	Junagadh	Mendarda	209.9	7.9	12.2	235	1,611
91	Junagadh	Patan-Veraval	843.3	32.3	80.3	976	7,136
92	Junagadh	Sutrapada	305.3	5.3	11.8	329	2,254
93	Junagadh	Talala	321.6	8.9	17.9	357	2,460
94	Junagadh	Una	905.0	18.5	29.1	968	6,550
95	Junagadh	Vanthali	367.4	18.9	14.0	407	2,831
96	Junagadh	Visavadar	434.8	11.4	19.2	476	3,616
97	Kachchh	Abdasa	348.2	6.8	10.8	379	2,517
98	Kachchh	Anjar	2,334.5	93.0	181.9	2,670	4,922
99	Kachchh	Bhachau	887.3	23.1	35.8	968	3,942
100	Kachchh	Bhuj	2,423.2	102.3	226.6	2,819	11,670
101	Kachchh	Gandhidham	3,449.3	210.6	336.5	4,053	7,466
102	Kachchh	Lakhpat	238.3	5.3	6.6	262	1,049
103	Kachchh	Mandvi	336.2	7.8	16.1	367	5,847
104	Kachchh	Mundra	674.9	16.0	22.5	732	2,881
105	Kachchh	Nakhatrana	821.6	19.3	28.2	895	3,402
106	Kachchh	Rapar	888.5	15.2	43.1	973	3,529
107	Kheda	Balasinor	157.0	2.9	6.1	171	3,284
108	Kheda	Kapadvanj	631.5	13.4	33.5	697	5,684
109	Kheda	Kathlal	476.3	5.6	7.7	502	3,582
110	Kheda	Kheda	324.9	11.5	15.0	359	2,958
111	Kheda	Mahudha	306.4	4.5	8.2	326	2,473
112	Kheda	Matar	393.8	8.4	6.0	416	3,212
113	Kheda	Mehmedabad	592.9	10.0	15.1	630	4,733
114	Kheda	Nadiad	1,316.1	69.2	102.7	1,530	14,485

GUJARAT BUILDING RISK ZONATION: EARTHQUAKE LOSS TO BUILDINGS (100 YEAR RETURN PERIOD)
(Rs. MILLION 2002-2003 PRICES) (BY ENDUSE) Table No. RBLT - 01 of 03

GSDMA

Sr. No	District	Taluka	Residential	Industrial	Commercial	Total Loss	Capital Cost
115	Kheda	Thasra	759.2	15.3	23.9	817	6,503
116	Kheda	Virpur	95.7	1.6	1.5	103	1,633
117	Mahesana	Becharaji	266.4	3.2	5.5	284	2,249
118	Mahesana	Kadi	1,111.1	53.0	50.9	1,250	10,730
119	Mahesana	Kheralu	365.2	9.8	13.4	396	3,391
120	Mahesana	Mahesana	1,353.6	90.9	134 9	1,608	15,580
121	Mahesana	Satlasana	217.8	5.1	7.3	236	1,998
122	Mahesana	Unjha	612.4	37.7	38.2	701	7,013
123	Mahesana	Vadnagar	375.3	7.2	9.9	401	3,439
124	Mahesana	Vijapur	731.9	18.8	38.6	803	7,587
125	Mahesana	Visnagar	845.2	44.9	74.7	982	9,713
126	Narmada	Dediapada	79.1	1.8	1.1	91	1,337
127	Narmada	Nandod	200.7	4.3	7.4	225	4,285
128	Narmada	Sagbara	51.5	0.8	1.0	59	864
129	Narmada	Tilakwada	50.9	0.6	0.6	56	877
130	Navsari	Bansda	137.7	4.5	2.7	152	2,271
131	Navsari	Chikhli	296.9	14.5	7.1	332	5,277
132	Navsari	Gandevi	677.1	43.6	24.1	762	6,419
133	Navsari	Jalalpore	650.1	25.5	15.1	704	6,260
134	Navsari	Navsari	851.9	64.9	64.8	1,003	9,665
135	Panch Mahals	Ghoghamba	134.4	1.0	1.0	142	1,987
136	Panch Mahals	Godhra	392.8	14.4	20.6	438	9,368
137	Panch Mahals	Halol	194.9	13.2	6.7	221	4,370
138	Panch Mahals	Jambughoda	30.8	0.7	0.3	33	525
139	Panch Mahals	Kadana	110.6	1.1	0.7	116	1,674
140	Panch Mahals	Kalol	201.6	3.2	6.7	216	3,915
141	Panch Mahals	Khanpur	100.9	2.1	1.4	107	1,599
142	Panch Mahals	Lunawada	296.9	11.4	8.4	325	5,784
143	Panch Mahals	Morwa (Hadaf)	107.6	0.6	0.9	112	1,465
144	Panch Mahals	Santrampur	215.9	3.3	4.3	230	3,373
145	Panch Mahals	Shehera	253.3	3.1	2.7	264	3,702
146	Patan	Chanasma	363.5	14.5	10.7	397	3,423
147	Patan	Harij	226.3	6.2	14.5	253	1,969
148	Patan	Patan	885.4	57.6	60.4	1,028	9,602
149	Patan	Radhanpur	262.7	5.1	17.6	294	2,431
150	Patan	Sami	447.9	7.5	9.3	475	3,333
151	Patan	Santalpur	376.9	5.1	10.9	401	1,483
152	Patan	Sidhpur	504.2	17.9	34.4	567	5,368
153	Patan	Vagdod	211.9	3.0	3.2	222	1,730
154	Porbandar	Kutiyana	234.4	10.9	10.4	259	1,786
155	Porbandar	Porbandar	849.0	26.2	62.7	955	6,919
156	Porbandar	Ranavav	262.0	16.1	9.7	292	2,070
157	Rajkot	Dhoraji	548.2	21.6	43.5	624	4,570
158	Rajkot	Gondal	718.6	50 9	69.2	854	7,974
159	Rajkot	Jamkandorna	250.4	9.0	8.4	272	2,099
160	Rajkot	Jasdan	720.6	33.0	34.4	801	6,496
161	Rajkot	Jetpur	675.5	43.2	56.3	789	6,622
162	Rajkot	Kotda Sangani	275.0	44.8	9.0	334	3,026
163	Rajkot	Lodhika	203.2	16.7	4.7	229	1,985
164	Rajkot	Maliya	420.2	12.6	10.5	455	1,874
165	Rajkot	Morvi	1,839.8	169.8	138.3	2,188	12,149
166	Rajkot	Paddhari	555.4	11.5	17.5	597	2,851
167	Rajkot	Rajkot	3,769.4	644.7	449.8	4,945	53,799
168	Rajkot	Tankara	487.9	11.2	11.6	522	2,431
169	Rajkot	Upleta	643.1	23.5	47.0	727	5,355
170	Rajkot	Wankaner	977.0	44 9	48.4	1,094	4,925
171	Sabar Kantha	Bayad	469.8	7.5	12.5	504	4,044
172	Sabar Kantha	Bhiloda	254.7	3.5	3.5	269	4,629
173	Sabar Kantha	Dhansura	229.2	7.2	6.2	252	2,049
174	Sabar Kantha	Himatnagar	747.8	30.1	55.0	854	8,312
175	Sabar Kantha	Idar	757 7	16.7	35.7	832	7,782
176	Sabar Kantha	Khedbrahma	366.9	11.0	16.5	409	3,651
177	Sabar Kantha	Malpur	107.3	1.6	3.9	121	2,054
178	Sabar Kantha	Meghraj	166.2	3.3	4.4	182	2,806
179	Sabar Kantha	Modasa	542.4	10.0	31.0	600	5,351
180	Sabar Kantha	Prantij	391 6	6.9	14.9	423	3,688
181	Sabar Kantha	Talod	377.7	7.8	10.5	405	3,414
182	Sabar Kantha	Vadali	221.6	5.5	6.2	240	2,135
183	Sabar Kantha	Vijaynagar	117.9	2.7	2.3	126	1,879
184	Surat	Bardoli	247.4	8.0	9.7	272	4,994
185	Surat	Chorasi	1,619.0	63.1	74.1	1,782	18,666
186	Surat	Kamrej	378.1	11.3	10.9	409	3,481
187	Surat	Mahuva	118.3	4.2	1.9	130	1,987
188	Surat	Mandvi	138.8	5.4	3.0	155	2,507
189	Surat	Mangrol	356.2	16.8	12.3	397	3,221
190	Surat	Nizar	74.6	1.5	1.4	82	1,189
191	Surat	Olpad	503.4	26.6	11.3	555	4,590
192	Surat	Palsana	310.7	22.9	13.7	356	3,144
193	Surat	Songadh	123.3	2.7	3.5	139	2,165
194	Surat	Surat City	2,630.5	536.3	295.6	3,510	108,149
195	Surat	Uchchhal	35.9	0.9	0.5	41	595
196	Surat	Umarpada	44.0	0.4	0.6	49	704
197	Surat	Valod	80.1	2.6	1.3	89	1,414
198	Surat	Vyara	162.8	5.7	5.2	187	3,148
199	Surendranagar	Chotila	397.6	11.5	18.4	436	3,031
200	Surendranagar	Chuda	206.0	5.1	4.2	218	1,546
201	Surendranagar	Dasada	317.7	6.6	9.3	341	2,444
202	Surendranagar	Dhrangadhra	497.8	12.0	27.4	546	3,823
203	Surendranagar	Halvad	604.3	12.5	26.2	655	2,549
204	Surendranagar	Lakhtar	155.1	7.2	3.0	169	1,208
205	Surendranagar	Limbdi	468.0	16.0	20.3	512	4,050
206	Surendranagar	Muli	195.6	4.9	4.9	209	1,389
207	Surendranagar	Sayla	211.1	3.7	5.7	225	1,475
208	Surendranagar	Wadhwan	915.8	75.5	109.4	1,120	9,785
209	The Dangs	The Dangs	112.4	3.0	2.5	133	1,930
210	Vadodara	Chhota Udaipur	144.4	5.6	4.0	160	2,639
211	Vadodara	Dabhoi	217.2	8.4	10.0	243	4,562
212	Vadodara	Jetpur Pavi	133.2	3.0	2.0	145	2,426
213	Vadodara	Karjan	412.0	5.3	8.9	434	3,657
214	Vadodara	Kavant	64.2	0 6	0.5	70	1,141
215	Vadodara	Nasvadi	79.7	0.6	1.0	87	1,346
216	Vadodara	Padra	647.1	13.0	26.1	697	5,737
217	Vadodara	Sankheda	188.0	3.3	4.4	203	3,534
218	Vadodara	Savli	241.1	7 0	2.3	257	4,204
219	Vadodara	Sinor	80.0	1.0	1.3	84	1,444
220	Vadodara	Vadodara	6,152.6	451.9	481.6	7,225	79,226
221	Vadodara	Vaghodia	134.6	17.3	1.8	158	2,715
222	Valsad	Dharampur	109.1	4.6	4 0	127	1,948
223	Valsad	Kaprada	105.1	2.2	1.4	117	1,632
224	Valsad	Pardi	830.6	125.8	94 2	1,079	9,857
225	Valsad	Umbergaon	430.3	70.3	19.0	536	4,392
226	Valsad	Valsad	404 6	29.3	20 6	468	9,978

GUJARAT BUILDING RISK ZONATION: CYCLONIC STORM & WIND LOSS TO BUILDINGS (100 YEAR RETURN PERIOD)
(Rs. MILLION 2002-2003 PRICES) (BY ENDUSE) Table No. RBLT - 02 of 03

GSDMA

Sr. No	District	Taluka	Residential	Industrial	Commercial	Total Loss	Capital Cost
1	Ahmadabad	Ahmadabad City	773.1	136.6	111.9	1,035	175,921
2	Ahmadabad	Barwala	31.2	1.1	0.6	33	1,106
3	Ahmadabad	Bavla	85.7	1.9	1.7	91	3,629
4	Ahmadabad	Daskroi	139.1	3.9	4.3	149	16,592
5	Ahmadabad	Detroj-Rampura	55.5	1.0	0.6	58	1,846
6	Ahmadabad	Dhandhuka	93.7	2.5	1.9	100	3,173
7	Ahmadabad	Dholka	121.4	3.8	3.4	130	5,874
8	Ahmadabad	Mandal	48.6	1.0	0.7	51	1,864
9	Ahmadabad	Ranpur	36.9	1.4	0.6	39	1,181
10	Ahmadabad	Sanand	121.0	1.9	1.3	126	4,709
11	Ahmadabad	Viramgam	112.9	2.9	3.7	121	4,663
12	Amreli	Amreli	593.6	40.6	19.8	664	7,864
13	Amreli	Babra	377.0	8.3	9.6	400	2,979
14	Amreli	Bagasara	227.5	8.9	9.3	250	2,335
15	Amreli	Dhari	471.9	9.6	12.4	501	3,545
16	Amreli	Jafrabad	332.6	3.1	7.1	348	2,019
17	Amreli	Khambha	338.9	7.3	8.7	359	2,068
18	Amreli	Kunkavav Vadia	347.0	10.0	8.3	371	3,088
19	Amreli	Lathi	66.8	2.6	2.0	72	4,043
20	Amreli	Lilia	245.2	7.0	4.1	260	1,793
21	Amreli	Rajula	467.4	10.8	15.1	498	3,448
22	Amreli	Savar Kundla	778.9	32.4	20.0	841	6,430
23	Anand	Anand	178.4	11.4	8.4	201	19,949
24	Anand	Anklav	86.4	1.2	0.7	89	3,429
25	Anand	Borsad	201.3	2.9	2.3	209	8,941
26	Anand	Khambhat	166.4	6.4	3.1	178	9,348
27	Anand	Petlad	146.9	2.5	2.4	153	7,173
28	Anand	Sojitra	62.4	0.6	0.6	64	2,661
29	Anand	Tarapur	56.3	0.6	0.4	58	2,065
30	Anand	Umreth	75.7	1.5	2.0	80	4,170
31	Banas Kantha	Amirgadh	43.9	0.6	0.4	45	1,292
32	Banas Kantha	Bhabhar	43.3	0.5	0.9	45	1,263
33	Banas Kantha	Danta	73.8	0.9	1.0	76	2,200
34	Banas Kantha	Dantiwada	41.2	0.8	0.3	43	1,524
35	Banas Kantha	Deesa	148.3	2.2	2.1	154	6,609
36	Banas Kantha	Deodar	68.7	1.0	1.0	72	2,056
37	Banas Kantha	Dhanera	68.3	1.1	1.9	72	2,866
38	Banas Kantha	Kankrej	86.6	1.1	1.1	90	2,851
39	Banas Kantha	Palanpur	121.6	4.9	4.0	132	10,987
40	Banas Kantha	Tharad	98.0	1.2	1.3	102	2,579
41	Banas Kantha	Vadgam	79.1	1.5	0.6	82	4,611
42	Banas Kantha	Vav	90.4	0.9	1.0	94	2,029
43	Bharuch	Amod	64.6	0.6	0.6	67	2,531
44	Bharuch	Anklesvar	128.9	16.0	3.9	151	10,461
45	Bharuch	Bharuch	175.3	4.3	5.0	188	13,406
46	Bharuch	Hansot	55.3	0.8	0.6	58	1,841
47	Bharuch	Jambusar	129.3	2.4	2.5	136	5,808
48	Bharuch	Jhagadia	210.2	0.9	0.9	215	3,251
49	Bharuch	Vagra	74.8	0.8	0.6	78	2,371
50	Bharuch	Valia	188.3	1.2	1.2	193	2,437
51	Bhavnagar	Bhavnagar	180.9	21.1	14.0	220	22,266
52	Bhavnagar	Botad	81.7	4.7	2.7	90	6,191
53	Bhavnagar	Gadhada	66.8	2.6	1.5	72	3,806
54	Bhavnagar	Gariadhar	49.9	1.6	1.0	53	2,676
55	Bhavnagar	Ghogha	49.4	1.9	1.1	53	1,913
56	Bhavnagar	Mahuva	962.4	28.3	32.5	1,033	7,596
57	Bhavnagar	Palitana	83.8	2.3	2.2	89	4,448
58	Bhavnagar	Sihor	85.1	6.7	2.6	96	4,957
59	Bhavnagar	Talaja	116.2	2.6	3.2	123	5,066
60	Bhavnagar	Umrala	39.8	2.6	0.9	44	2,147
61	Bhavnagar	Vallabhipur	40.0	2.8	0.8	44	1,911
62	Dohad	Devgadbaria	100.2	1.2	1.2	104	3,047
63	Dohad	Dhanpur	53.6	0.5	0.2	55	1,110
64	Dohad	Dohad	123.5	1.6	2.5	129	5,317
65	Dohad	Fatepura	85.3	0.2	0.4	87	1,647
66	Dohad	Garbada	55.5	0.3	0.2	57	1,446
67	Dohad	Jhalod	196.8	0.7	1.1	200	3,164
68	Dohad	Limkheda	91.7	0.5	0.5	94	2,216
69	Gandhinagar	Dehgam	128.6	3.5	4.2	140	6,949
70	Gandhinagar	Gandhinagar	166.3	2.2	3.8	174	19,948
71	Gandhinagar	Kalol	104.9	7.3	3.7	117	10,833
72	Gandhinagar	Mansa	77.3	3.1	2.0	83	6,557
73	Jamnagar	Bhanvad	283.0	6.6	8.3	301	2,528
74	Jamnagar	Dhrol	254.2	6.1	5.6	270	2,635
75	Jamnagar	Jamjodhpur	302.8	5.6	9.8	321	3,162
76	Jamnagar	Jamnagar	1,123.5	78.9	38.4	1,254	24,684
77	Jamnagar	Jodiya	61.0	1.5	1.5	65	3,011
78	Jamnagar	Kalavad	491.0	11.3	12.1	521	5,043
79	Jamnagar	Kalyanpur	337.4	7.6	10.3	359	3,400
80	Jamnagar	Khambhalia	531.4	15.7	15.7	570	6,080
81	Jamnagar	Lalpur	314.2	4.7	6.3	329	2,733
82	Jamnagar	Okhamandal	229.5	2.5	8.6	243	3,212
83	Junagadh	Bhesan	216.6	4.9	7.2	232	1,875
84	Junagadh	Junagadh	574.8	12.6	21.3	614	10,628
85	Junagadh	Keshod	402.2	10.4	13.5	432	5,504
86	Junagadh	Kodinar	444.6	7.7	12.4	471	4,550
87	Junagadh	Malia	353.5	8.2	11.8	378	3,084
88	Junagadh	Manavadar	348.4	5.9	13.7	372	3,749
89	Junagadh	Mangrol	554.7	11.5	14.6	588	4,983
90	Junagadh	Mendarda	167.8	4.8	7.8	182	1,611
91	Junagadh	Patan-Veraval	363.9	8.5	12.2	388	7,136
92	Junagadh	Sutrapada	253.8	3.4	6.1	266	2,254
93	Junagadh	Talala	245.4	4.5	8.1	261	2,460
94	Junagadh	Una	805.0	13.0	15.3	840	6,550
95	Junagadh	Vanthali	258.0	11.3	6.7	279	2,831
96	Junagadh	Visavadar	433.6	10.9	10.6	462	3,616
97	Kachchh	Abdasa	374.7	7.0	9.2	397	2,517
98	Kachchh	Anjar	84.9	3.0	3.1	92	4,922
99	Kachchh	Bhachau	99.5	2.1	2.5	105	3,942
100	Kachchh	Bhuj	196.3	4.4	6.1	209	11,670
101	Kachchh	Gandhidham	45.3	2.1	3.1	51	7,466
102	Kachchh	Lakhpat	32.7	0.5	0.5	34	1,049
103	Kachchh	Mandvi	630.3	14.1	21.3	674	5,847
104	Kachchh	Mundra	372.0	8.4	9.7	394	2,881
105	Kachchh	Nakhatrana	397.0	7.2	8.9	416	3,402
106	Kachchh	Rapar	117.3	1.6	3.6	124	3,529
107	Kheda	Balasinor	66.4	0.9	1.0	70	3,284
108	Kheda	Kapadvanj	114.3	1.6	2.8	121	5,684
109	Kheda	Kathlal	107.9	0.8	1.0	112	3,582
110	Kheda	Kheda	62.5	1.4	1.3	66	2,958
111	Kheda	Mahudha	64.2	0.6	0.9	67	2,473
112	Kheda	Matar	81.8	1.1	0.7	84	3,212
113	Kheda	Mehmedabad	123.3	1.5	1.8	128	4,733
114	Kheda	Nadiad	187.5	7.1	6.0	204	14,485

GUJARAT BUILDING RISK ZONATION: CYCLONIC STORM & WIND LOSS TO BUILDINGS (100 YEAR RETURN PERIOD)
(Rs. MILLION 2002-2003 PRICES) (BY ENDUSE) Table No. RBLT - 02 of 03

GSDMA

Sr. No	District	Taluka	Residential	Industrial	Commercial	Total Loss	Capital Cost
115	Kheda	Thasra	144.0	1.7	2.0	150	6,503
116	Kheda	Virpur	46.8	0.7	0.4	49	1,633
117	Mahesana	Becharaji	49.5	0.4	0.7	52	2,249
118	Mahesana	Kadi	176.9	6.5	4.4	192	10,730
119	Mahesana	Kheralu	55.0	1.2	1.4	58	3,391
120	Mahesana	Mahesana	164.2	10.3	7.9	185	15,580
121	Mahesana	Satlasana	39.4	0.4	0.5	41	1,998
122	Mahesana	Unjha	61.6	3.2	2.2	68	7,013
123	Mahesana	Vadnagar	59.4	0.8	1.1	62	3,439
124	Mahesana	Vijapur	89.1	2.3	3.4	96	7,587
125	Mahesana	Visnagar	89.9	3.3	4.1	98	9,713
126	Narmada	Dediapada	301.4	3.1	1.9	310	1,337
127	Narmada	Nandod	228.6	1.4	2.4	236	4,285
128	Narmada	Sagbara	62.8	0.3	0.5	64	864
129	Narmada	Tilakwada	32.9	0.2	0.2	34	877
130	Navsari	Bansda	302.0	6.1	3.1	314	2,271
131	Navsari	Chikhli	310.6	7.1	3.4	326	5,277
132	Navsari	Gandevi	178.4	6.4	2.7	190	6,419
133	Navsari	Jalalpore	130.3	2.3	1.3	135	6,260
134	Navsari	Navsari	143.0	6.0	4.1	155	9,665
135	Panch Mahals	Ghoghamba	103.7	0.5	0.5	106	1,987
136	Panch Mahals	Godhra	151.9	2.5	3.1	160	9,368
137	Panch Mahals	Halol	116.6	3.2	1.2	122	4,370
138	Panch Mahals	Jambughoda	18.8	0.2	0.1	19	525
139	Panch Mahals	Kadana	60.9	0.5	0.3	62	1,674
140	Panch Mahals	Kalol	100.5	0.8	1.5	104	3,915
141	Panch Mahals	Khanpur	50.2	0.6	0.4	52	1,599
142	Panch Mahals	Lunawada	125.4	2.5	1.5	131	5,784
143	Panch Mahals	Morwa (Hadaf)	55.0	0.3	0.3	56	1,465
144	Panch Mahals	Santrampur	109.1	1.2	0.9	113	3,373
145	Panch Mahals	Shehera	123.1	1.3	0.7	126	3,702
146	Patan	Chanasma	54.2	1.8	1.2	58	3,423
147	Patan	Harij	50.1	1.0	1.5	54	1,969
148	Patan	Patan	113.1	5.1	4.1	125	9,602
149	Patan	Radhanpur	64.5	0.6	1.5	68	2,431
150	Patan	Sami	103.7	1.4	1.6	108	3,333
151	Patan	Santalpur	56.6	0.5	1.1	59	1,483
152	Patan	Sidhpur	59.4	1.7	2.9	65	5,368
153	Patan	Vagdod	39.9	0.5	0.5	41	1,730
154	Porbandar	Kutiyana	180.6	5.7	4.5	193	1,786
155	Porbandar	Porbandar	447.5	8.3	11.0	470	6,919
156	Porbandar	Ranavav	169.7	3.1	4.2	179	2,070
157	Rajkot	Dhoraji	298.3	7.6	9.5	318	4,570
158	Rajkot	Gondal	540.1	39.2	18.7	605	7,974
159	Rajkot	Jamkandorna	199.3	5.7	5.5	213	2,099
160	Rajkot	Jasdan	121.3	3.9	3.3	130	6,496
161	Rajkot	Jetpur	475.5	34.0	17.1	532	6,622
162	Rajkot	Kotda Sangani	234.2	26.6	5.5	269	3,026
163	Rajkot	Lodhika	195.6	10.6	3.9	212	1,985
164	Rajkot	Maliya	49.5	1.2	1.0	53	1,874
165	Rajkot	Morvi	125.7	7.7	3.7	139	12,149
166	Rajkot	Paddhari	296.5	6.1	6.2	312	2,851
167	Rajkot	Rajkot	1,430.9	328.2	77.7	1,854	53,799
168	Rajkot	Tankara	44.3	1.0	0.7	47	2,431
169	Rajkot	Upleta	384.4	8.0	14.3	410	5,355
170	Rajkot	Wankaner	84.5	3.2	2.2	91	4,925
171	Sabar Kantha	Bayad	89.7	0.8	1.2	93	4,044
172	Sabar Kantha	Bhiloda	129.2	1.2	0.9	133	4,629
173	Sabar Kantha	Dhansura	44.8	0.8	0.6	47	2,049
174	Sabar Kantha	Himatnagar	92.5	2.9	2.3	99	8,312
175	Sabar Kantha	Idar	108.9	1.6	2.1	114	7,782
176	Sabar Kantha	Khedbrahma	136.6	1.3	1.5	140	3,651
177	Sabar Kantha	Malpur	49.6	0.5	0.7	53	2,054
178	Sabar Kantha	Meghraj	88.3	0.9	1.0	92	2,806
179	Sabar Kantha	Modasa	91.2	1.1	2.0	96	5,351
180	Sabar Kantha	Prantij	59.9	0.9	1.6	63	3,688
181	Sabar Kantha	Talod	67.0	1.0	0.7	69	3,414
182	Sabar Kantha	Vadali	37.2	0.7	0.5	39	2,135
183	Sabar Kantha	Vijaynagar	66.1	1.0	0.8	69	1,879
184	Surat	Bardoli	149.3	2.6	1.9	156	4,994
185	Surat	Chorasi	162.6	4.9	4.2	174	18,666
186	Surat	Kamrej	75.5	1.1	0.9	79	3,481
187	Surat	Mahuva	171.0	2.0	1.2	176	1,987
188	Surat	Mandvi	263.4	1.6	1.4	269	2,507
189	Surat	Mangrol	154.2	1.9	1.3	159	3,221
190	Surat	Nizar	57.8	0.7	0.5	59	1,189
191	Surat	Olpad	117.9	2.0	1.1	123	4,590
192	Surat	Palsana	62.2	1.8	0.8	66	3,144
193	Surat	Songadh	330.6	3.4	2.5	340	2,165
194	Surat	Surat City	371.6	61.2	34.3	473	108,149
195	Surat	Uchchhal	102.4	1.1	0.9	106	595
196	Surat	Umarpada	120.3	0.9	1.0	124	704
197	Surat	Valod	100.1	1.2	0.6	104	1,414
198	Surat	Vyara	375.8	5.1	3.2	389	3,148
199	Surendranagar	Chotila	73.5	1.7	2.0	78	3,031
200	Surendranagar	Chuda	40.8	0.9	0.8	43	1,546
201	Surendranagar	Dasada	86.5	1.2	2.0	91	2,444
202	Surendranagar	Dhrangadhra	73.0	1.4	2.0	77	3,823
203	Surendranagar	Halvad	61.3	1.2	1.7	65	2,549
204	Surendranagar	Lakhtar	34.3	1.3	0.6	37	1,208
205	Surendranagar	Limbdi	89.1	2.3	1.9	94	4,050
206	Surendranagar	Muli	42.8	0.8	0.9	45	1,389
207	Surendranagar	Sayla	48.4	0.7	1.1	51	1,475
208	Surendranagar	Wadhwan	105.1	6.4	5.8	119	9,785
209	The Dangs	The Dangs	367.0	5.9	3.5	382	1,930
210	Vadodara	Chhota Udaipur	72.5	1.9	1.0	77	2,639
211	Vadodara	Dabhoi	66.5	2.0	2.2	72	4,562
212	Vadodara	Jetpur Pavi	82.5	1.1	0.6	86	2,426
213	Vadodara	Karjan	67.4	0.6	0.7	70	3,657
214	Vadodara	Kavant	98.7	0.3	0.4	101	1,141
215	Vadodara	Nasvadi	133.3	0.5	0.6	136	1,346
216	Vadodara	Padra	114.3	1.4	2.2	119	5,737
217	Vadodara	Sankheda	98.4	0.9	0.9	102	3,534
218	Vadodara	Savli	116.5	1.7	0.7	121	4,204
219	Vadodara	Sinor	24.5	0.2	0.3	26	1,444
220	Vadodara	Vadodara	377.9	45.9	25.2	456	79,226
221	Vadodara	Vaghodia	66.4	4.5	0.5	73	2,715
222	Valsad	Dharampur	236.9	4.4	2.6	248	1,948
223	Valsad	Kaprada	256.9	2.6	1.7	264	1,632
224	Valsad	Pardi	238.3	16.7	7.0	266	9,857
225	Valsad	Umbergaon	154.7	9.5	2.3	169	4,392
226	Valsad	Valsad	228.4	8.7	4.0	245	9,978

GUJARAT BUILDING RISK ZONATION: FLOOD LOSS TO BUILDINGS
(Rs. MILLION 2002-2003 PRICES) (BY ROOFWALL TYPE) Table No. RBLT - 03 of 03

GSDMA

Sr. No	District	Taluka	Tile on Biomass	Tile on Earth	Biomass	Tile on Brick	Total Loss	Capital Cost
1	Ahmadabad	Ahmadabad City	0 0	0 0	0.1	0 1	0	175,921
2	Ahmadabad	Barwala	0 0	0.0	0.0	0.0	0	1,106
3	Ahmadabad	Bavla	0 1	21.8	0.3	4.3	27	3,629
4	Ahmadabad	Daskroi	0.1	3.9	0.4	1.4	6	16,592
5	Ahmadabad	Detroj-Rampura	0.0	0 0	0.0	0.0	0	1,846
6	Ahmadabad	Dhandhuka	0.0	3.4	0.5	2.7	7	3,173
7	Ahmadabad	Dholka	0.9	94 9	2.4	31.6	130	5,874
8	Ahmadabad	Mandal	0.0	0.9	0.0	0.6	2	1,864
9	Ahmadabad	Ranpur	0.0	0.0	0 0	0.0	0	1,181
10	Ahmadabad	Sanand	0.1	27.0	0.9	4.2	32	4,709
11	Ahmadabad	Viramgam	0.0	2.0	0.1	0 6	3	4,663
12	Amreli	Amreli	0 0	1.7	0.1	2.4	4	7,864
13	Amreli	Babra	0.0	0.0	0 0	0.0	0	2,979
14	Amreli	Bagasara	0.0	0.3	0 0	0.6	1	2,335
15	Amreli	Dhari	0.0	2.9	0.1	4.4	7	3,545
16	Amreli	Jafrabad	0.0	1.3	0.0	0.8	2	2,019
17	Amreli	Khambha	0.0	0.0	0.0	0.0	0	2,068
18	Amreli	Kunkavav Vadia	0 0	0.0	0.0	0.0	0	3,088
19	Amreli	Lathi	0 0	0.0	0.0	0.0	0	4,043
20	Amreli	Lilia	0.0	2.2	0.0	1.6	4	1,793
21	Amreli	Rajula	0.0	2.3	0.1	1.3	4	3,448
22	Amreli	Savar Kundla	0.0	1.6	0.0	1.6	3	6,430
23	Anand	Anand	0.0	1.6	0.1	1.2	3	19,949
24	Anand	Anklav	0.2	12.7	0.2	3.9	17	3,429
25	Anand	Borsad	0.1	10.0	0.3	3.1	13	8,941
26	Anand	Khambhat	0.1	4.3	0.1	1.6	6	9,348
27	Anand	Petlad	0.0	0.0	0.0	0.0	0	7,173
28	Anand	Sojitra	0.0	0.0	0.0	0 0	0	2,661
29	Anand	Tarapur	0.1	10.9	0.2	2.6	14	2,065
30	Anand	Umreth	0.0	0.3	0.0	0.3	1	4,170
31	Banas Kantha	Amirgadh	0.0	0 0	0.0	0.0	0	1,292
32	Banas Kantha	Bhabhar	0.0	0.0	0.0	0 0	0	1,263
33	Banas Kantha	Danta	0 0	0.0	0.0	0 0	0	2,200
34	Banas Kantha	Dantiwada	0.0	0.5	0.1	0.8	1	1,524
35	Banas Kantha	Deesa	0.1	4.7	0.3	3.1	8	6,609
36	Banas Kantha	Deodar	0.0	0.0	0.0	0.0	0	2,056
37	Banas Kantha	Dhanera	0.0	0.0	0.0	0.0	0	2,866
38	Banas Kantha	Kankrej	0.1	11.3	0.8	6.9	19	2,851
39	Banas Kantha	Palanpur	0.0	0.0	0.0	0.0	0	10,987
40	Banas Kantha	Tharad	0.0	0.0	0.0	0.0	0	2,579
41	Banas Kantha	Vadgam	0.0	0.2	0.0	0.5	1	4,611
42	Banas Kantha	Vav	0.0	0.0	0.0	0.0	0	2,029
43	Bharuch	Amod	0.2	4.9	0.1	3.1	8	2,531
44	Bharuch	Anklesvar	0.7	9.9	0.4	5.3	15	10,461
45	Bharuch	Bharuch	0.9	21.8	0.3	11.7	34	13,406
46	Bharuch	Hansot	0.3	8.0	0.1	3.0	12	1,841
47	Bharuch	Jambusar	0.1	8.1	0.1	6.1	14	5,808
48	Bharuch	Jhagadia	5.7	4.2	0.3	2.4	13	3,251
49	Bharuch	Vagra	0.1	9.1	0.1	2.2	12	2,371
50	Bharuch	Valia	7.0	6.5	0.2	3.8	18	2,437
51	Bhavnagar	Bhavnagar	0 0	0.2	0.0	0.3	0	22,266
52	Bhavnagar	Botad	0.0	0.3	0.0	0.1	0	6,191
53	Bhavnagar	Gadhada	0.0	1.5	0.1	0.9	2	3,806
54	Bhavnagar	Gariadhar	0.0	0.6	0.0	0.4	1	2,676
55	Bhavnagar	Ghogha	0.0	0.0	0.0	0.0	0	1,913
56	Bhavnagar	Mahuva	0.0	6.2	0.2	3.2	10	7,596
57	Bhavnagar	Palitana	0.0	1.8	0.1	1.5	3	4,448
58	Bhavnagar	Sihor	0.0	0.5	0 0	0.6	1	4,957
59	Bhavnagar	Talaja	0 0	2 6	0.1	3.7	6	5,066
60	Bhavnagar	Umrala	0.0	1 7	0.2	2.2	4	2,147
61	Bhavnagar	Vallabhipur	0 0	0.1	0 0	0.1	0	1,911
62	Dohad	Devgadbaria	0.1	1.4	0.0	0.8	2	3,047
63	Dohad	Dhanpur	0.1	1.6	0.1	0.5	2	1,110
64	Dohad	Dohad	0.1	1.3	0.2	0.3	2	5,317
65	Dohad	Fatepura	0 0	0.0	0.0	0.0	0	1,647
66	Dohad	Garbada	0.1	1.2	0.0	0.2	2	1,446
67	Dohad	Jhalod	0.1	4.5	2.1	0.7	7	3,164
68	Dohad	Limkheda	0.3	12.9	0.1	0.6	14	2,216
69	Gandhinagar	Dehgam	0.0	0.0	0.0	0.0	0	6,949
70	Gandhinagar	Gandhinagar	0.0	0.2	0 0	0.1	0	19,948
71	Gandhinagar	Kalol	0 0	0.0	0.0	0.0	0	10,833
72	Gandhinagar	Mansa	0.0	0.0	0.0	0.0	0	6,557
73	Jamnagar	Bhanvad	0.0	3.4	0.1	0.8	4	2,528
74	Jamnagar	Dhrol	0.0	1.1	0.0	3.3	5	2,635
75	Jamnagar	Jamjodhpur	0.0	0.2	0.0	0 1	0	3,162
76	Jamnagar	Jamnagar	0.0	0.8	0.1	1.9	3	24,684
77	Jamnagar	Jodiya	0.0	3.1	0.2	13.9	17	3,011
78	Jamnagar	Kalavad	0.0	0.2	0.0	0.4	1	5,043
79	Jamnagar	Kalyanpur	0.0	1.1	0.1	1.6	3	3,400
80	Jamnagar	Khambhalia	0.0	0.6	0.0	1.2	2	6,080
81	Jamnagar	Lalpur	0.0	1.3	0.1	2.3	4	2,733
82	Jamnagar	Okhamandal	0.0	0.0	0.0	0.0	0	3,212
83	Junagadh	Bhesan	0.0	0.0	0.0	0.0	0	1,875
84	Junagadh	Junagadh	0.0	1.0	0.1	0.2	1	10,628
85	Junagadh	Keshod	0.0	0.4	0.0	0.0	0	5,504
86	Junagadh	Kodinar	0.0	0.6	0.0	0.2	1	4,550
87	Junagadh	Malia	0.0	0.1	0.0	0 0	0	3,084
88	Junagadh	Manavadar	0.0	0.1	0 0	0.0	0	3,749
89	Junagadh	Mangrol	0.0	0.6	0.0	0.1	1	4,983
90	Junagadh	Mendarda	0.0	1.7	0.0	0.2	2	1,611
91	Junagadh	Patan-Veraval	0.0	0.4	0.0	0.1	1	7,136
92	Junagadh	Sutrapada	0.0	0.2	0.0	0.1	0	2,254
93	Junagadh	Talala	0.2	0.9	0.1	0.1	2	2,460
94	Junagadh	Una	0.1	4.5	0.2	0.4	6	6,550
95	Junagadh	Vanthali	0.0	1.5	0.0	0.3	2	2,831
96	Junagadh	Visavadar	0.0	1.7	0.0	3.0	5	3,616
97	Kachchh	Abdasa	0.0	0.5	0.1	0.3	1	2,517
98	Kachchh	Anjar	0.0	0.1	0.0	0.1	0	4,922
99	Kachchh	Bhachau	0.0	0 0	0.0	0.0	0	3,942
100	Kachchh	Bhuj	0.0	1.5	0.9	0.4	3	11,670
101	Kachchh	Gandhidham	0.0	0 0	0 0	0 0	0	7,466
102	Kachchh	Lakhpat	0.0	0.4	0.3	0.2	1	1,049
103	Kachchh	Mandvi	0.0	0.1	0.0	0.1	0	5,847
104	Kachchh	Mundra	0.0	0.4	0.0	0.4	1	2,881
105	Kachchh	Nakhatrana	0.0	0 5	0.1	0.2	1	3,402
106	Kachchh	Rapar	0.0	0.3	0.1	0.1	1	3,529
107	Kheda	Balasinor	0.0	0.0	0.0	0.0	0	3,284
108	Kheda	Kapadvanj	0.0	0.9	0.0	0.2	1	5,684
109	Kheda	Kathlal	0.0	1.6	0.1	0.5	2	3,582
110	Kheda	Kheda	0.1	6.0	0.6	2.3	9	2,958
111	Kheda	Mahudha	0.1	4.0	0.2	1.1	5	2,473
112	Kheda	Matar	0.3	18.2	0.5	6 1	25	3,212
113	Kheda	Mehmedabad	0.1	5.3	0.1	1.2	7	4,733
114	Kheda	Nadiad	0 0	1.6	0.1	0.5	2	14,485

GUJARAT BUILDING RISK ZONATION: FLOOD LOSS TO BUILDINGS
(Rs. MILLION 2002-2003 PRICES) (BY ROOFWALL TYPE) Table No. RBLT - 03 of 03

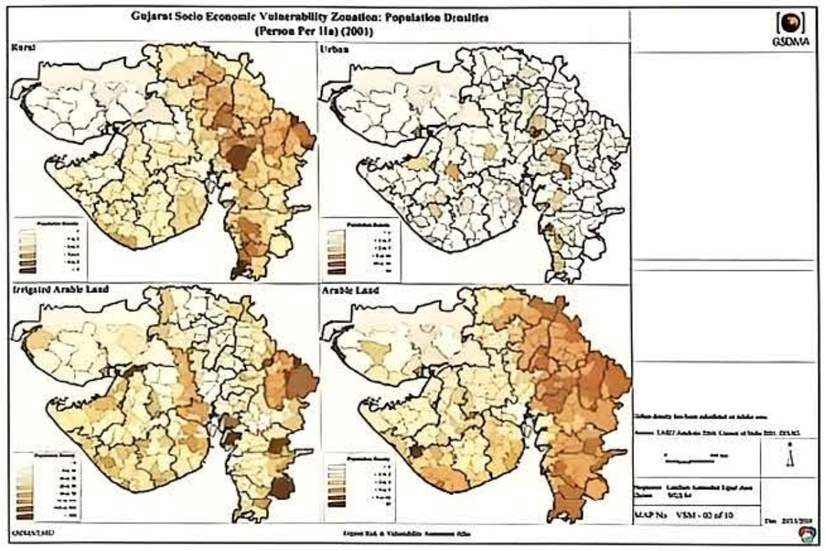
GSDMA

Sr. No	District	Taluka	Tile on Biomass	Tile on Earth	Biomass	Tile on Brick	Total Loss	Capital Cost
115	Kheda	Thasra	0.2	17.3	0.4	4.9	23	6,503
116	Kheda	Virpur	0.0	0.0	0.0	0.0	0	1,633
117	Mahesana	Becharaji	0.0	0.0	0.0	0.0	0	2,249
118	Mahesana	Kadi	0.0	0.0	0.0	0.0	0	10,730
119	Mahesana	Kheralu	0.0	0.0	0.0	0.0	0	3,391
120	Mahesana	Mahesana	0.0	0.0	0.0	0.0	0	15,580
121	Mahesana	Satlasana	0.0	0.0	0.0	0.0	0	1,998
122	Mahesana	Unjha	0.0	0.0	0.0	0.0	0	7,013
123	Mahesana	Vadnagar	0.0	0.0	0.0	0.0	0	3,439
124	Mahesana	Vijapur	0.0	0.0	0.0	0.0	0	7,587
125	Mahesana	Visnagar	0.0	0.0	0.0	0.0	0	9,713
126	Narmada	Dediapada	3.2	0.1	0.0	0.2	3	1,337
127	Narmada	Nandod	2.2	0.6	0.3	1.0	4	4,285
128	Narmada	Sagbara	0.0	0.0	0.0	0.0	0	864
129	Narmada	Tilakwada	0.1	0.1	0.0	0.0	0	877
130	Navsari	Bansda	24.4	2.8	0.5	9.6	37	2,271
131	Navsari	Chikhli	22.5	17.1	0.6	30.3	71	5,277
132	Navsari	Gandevi	30.4	39.3	0.9	261.5	385	6,419
133	Navsari	Jalalpore	2.1	4.6	0.3	12.7	20	6,260
134	Navsari	Navsari	2.2	3.8	0.4	11.3	18	9,665
135	Panch Mahals	Ghoghamba	0.0	0.5	0.1	0.2	1	1,987
136	Panch Mahals	Godhra	0.1	2.1	0.1	0.5	3	9,368
137	Panch Mahals	Halol	0.1	0.3	0.0	0.2	1	4,370
138	Panch Mahals	Jambughoda	0.0	0.0	0.0	0.0	0	525
139	Panch Mahals	Kadana	0.1	3.5	0.1	0.2	4	1,674
140	Panch Mahals	Kalol	0.0	0.0	0.0	0.0	0	3,915
141	Panch Mahals	Khanpur	0.1	7.3	0.1	1.0	9	1,599
142	Panch Mahals	Lunawada	0.5	53.5	0.4	6.4	61	5,784
143	Panch Mahals	Morwa (Hadaf)	0.1	17.7	0.1	0.6	19	1,465
144	Panch Mahals	Santrampur	0.0	1.2	0.0	1.7	2	3,373
145	Panch Mahals	Shehera	0.2	23.2	0.1	1.7	25	3,702
146	Patan	Chanasma	0.0	0.3	0.0	0.5	1	3,423
147	Patan	Harij	0.0	0.0	0.0	0.0	0	1,969
148	Patan	Patan	0.0	0.1	0.0	0.1	0	9,602
149	Patan	Radhanpur	0.0	0.0	0.0	0.0	0	2,431
150	Patan	Sami	0.0	2.5	0.1	1.7	4	3,333
151	Patan	Santalpur	0.0	0.0	0.0	0.0	0	1,483
152	Patan	Sidhpur	0.0	0.4	0.0	0.3	1	5,368
153	Patan	Vagdod	0.0	0.0	0.0	0.0	0	1,730
154	Porbandar	Kutiyana	0.0	0.3	0.0	0.0	0	1,786
155	Porbandar	Porbandar	0.0	0.2	0.0	0.1	0	6,919
156	Porbandar	Ranavav	0.0	0.1	0.0	0.0	0	2,070
157	Rajkot	Dhoraji	0.0	0.1	0.0	0.1	0	4,570
158	Rajkot	Gondal	0.0	1.7	0.0	2.6	4	7,974
159	Rajkot	Jamkandorna	0.0	0.2	0.0	0.2	0	2,099
160	Rajkot	Jasdan	0.0	0.7	0.0	0.3	1	6,496
161	Rajkot	Jetpur	0.0	1.5	0.0	1.8	3	6,622
162	Rajkot	Kotda Sangani	0.0	0.4	0.0	1.1	2	3,026
163	Rajkot	Lodhika	0.0	0.2	0.0	0.6	1	1,985
164	Rajkot	Maliya	0.0	0.9	0.1	1.4	2	1,874
165	Rajkot	Morvi	0.0	2.7	0.1	4.5	7	12,149
166	Rajkot	Paddhari	0.0	3.7	0.0	5.7	9	2,851
167	Rajkot	Rajkot	0.0	1.1	0.1	0.9	2	53,799
168	Rajkot	Tankara	0.0	3.0	0.0	7.5	11	2,431
169	Rajkot	Upleta	0.0	1.1	0.1	0.5	2	5,355
170	Rajkot	Wankaner	0.0	0.4	0.0	0.3	1	4,925
171	Sabar Kantha	Bayad	0.0	1.6	0.0	0.4	2	4,044
172	Sabar Kantha	Bhiloda	0.0	1.4	0.1	0.5	2	4,629
173	Sabar Kantha	Dhansura	0.0	1.9	0.1	0.6	3	2,049
174	Sabar Kantha	Himatnagar	0.0	0.9	0.0	0.3	1	8,312
175	Sabar Kantha	Idar	0.0	0.0	0.0	0.0	0	7,782
176	Sabar Kantha	Khedbrahma	0.0	0.5	0.3	0.1	1	3,651
177	Sabar Kantha	Malpur	0.0	0.4	0.0	0.1	0	2,054
178	Sabar Kantha	Meghraj	0.0	1.0	0.0	0.1	1	2,806
179	Sabar Kantha	Modasa	0.1	17.6	0.6	3.0	21	5,351
180	Sabar Kantha	Prantij	0.0	0.0	0.0	0.0	0	3,688
181	Sabar Kantha	Talod	0.0	0.0	0.0	0.0	0	3,414
182	Sabar Kantha	Vadali	0.0	0.0	0.0	0.0	0	2,135
183	Sabar Kantha	Vijaynagar	0.0	0.5	0.0	0.1	1	1,879
184	Surat	Bardoli	1.8	2.0	0.3	6.1	10	4,994
185	Surat	Chorasi	2.7	11.4	1.6	19.1	36	18,666
186	Surat	Kamrej	2.2	13.2	0.5	13.6	31	3,481
187	Surat	Mahuva	2.4	1.4	0.1	1.8	6	1,987
188	Surat	Mandvi	17.6	6.3	0.6	5.0	30	2,507
189	Surat	Mangrol	0.6	0.9	0.0	0.6	2	3,221
190	Surat	Nizar	0.8	0.3	0.1	0.1	1	1,189
191	Surat	Olpad	2.0	17.4	0.9	14.0	35	4,590
192	Surat	Palsana	0.1	0.3	0.0	1.3	2	3,144
193	Surat	Songadh	2.8	0.2	0.1	0.3	3	2,165
194	Surat	Surat City	0.0	0.1	0.7	0.2	15	108,149
195	Surat	Uchchhal	0.0	0.0	0.0	0.0	0	595
196	Surat	Umarpada	0.7	0.0	0.0	0.2	1	704
197	Surat	Valod	3.0	1.1	0.1	2.8	7	1,414
198	Surat	Vyara	1.1	0.2	0.0	0.3	2	3,148
199	Surendranagar	Chotila	0.0	0.1	0.0	0.0	0	3,031
200	Surendranagar	Chuda	0.0	2.4	0.0	0.7	3	1,546
201	Surendranagar	Dasada	0.0	0.0	0.0	0.0	0	2,444
202	Surendranagar	Dhrangadhra	0.0	0.3	0.0	0.0	0	3,823
203	Surendranagar	Halvad	0.0	0.7	0.1	0.2	1	2,549
204	Surendranagar	Lakhtar	0.0	0.0	0.0	0.0	0	1,208
205	Surendranagar	Limbdi	0.0	0.4	0.0	0.2	1	4,050
206	Surendranagar	Muli	0.0	0.7	0.1	0.1	1	1,389
207	Surendranagar	Sayla	0.0	1.2	0.0	0.1	1	1,475
208	Surendranagar	Wadhwan	0.0	0.8	0.1	0.1	1	9,785
209	The Dangs	The Dangs	1.0	0.1	0.0	0.1	1	1,930
210	Vadodara	Chhota Udaipur	0.0	0.4	0.0	2.1	2	2,639
211	Vadodara	Dabhoi	0.0	0.2	0.1	0.1	0	4,562
212	Vadodara	Jetpur Pavi	0.6	2.5	0.4	2.3	6	2,426
213	Vadodara	Karjan	0.0	0.9	0.0	1.5	2	3,657
214	Vadodara	Kavant	0.2	0.2	0.3	0.3	1	1,141
215	Vadodara	Nasvadi	0.1	0.0	0.0	0.0	0	1,346
216	Vadodara	Padra	0.1	7.1	0.3	2.1	9	5,737
217	Vadodara	Sankheda	0.0	0.8	0.0	2.0	2	3,534
218	Vadodara	Savli	1.0	14.0	0.7	3.1	19	4,204
219	Vadodara	Sinor	0.0	0.0	0.0	0.0	0	1,444
220	Vadodara	Vadodara	0.1	2.9	0.8	0.7	4	79,226
221	Vadodara	Vaghodia	0.0	0.0	0.0	0.0	0	2,715
222	Valsad	Dharampur	1.5	0.2	0.1	0.5	2	1,948
223	Valsad	Kaprada	2.5	0.9	0.1	0.5	4	1,632
224	Valsad	Pardi	1.7	1.4	0.1	2.4	6	9,857
225	Valsad	Umbergaon	8.6	10.2	1.2	11.9	33	4,392
226	Valsad	Valsad	7.8	11.4	0.3	16.2	33	9,978

SOCIO-ECONOMIC VULNERABILITY

SOCIO-ECONOMIC VULNERABILITY ASSESSMENT

The state of Gujarat is exposed to multiple natural hazards especially drought, earthquake, cyclone, storm surge and flood (World Bank/ADB, 2001). In addition, due to its large area and population size along with a high level of industrial development – the state is also exposed to multiple man-made hazards, particularly industrial and chemical hazards. Gujarat has a unique socio-economic profile as one of India's most urbanised and economically developed states. Nevertheless, there are a number of population groups and sub-regions that are especially disadvantaged.



The plains of south and central Gujarat, and the western coastal belt of Porbandar and Junagadh districts contain the highest densities of rural population in the state. The lowest densities are in Kachchh and in the tribal belts of The Dangs, Narmada and Valsad districts. The highest densities are observed in central Gujarat, especially in and around Anand district.

Central and south Gujarat, which attracted 92 percent of the industrial investment in large and medium industries in the 1980s, has been called the "Golden corridor". With increased emphasis on industrial development in coastal Saurashtra and Kachchh, the investment in this area has declined to 70 percent of the overall share after the mid 1980s. With a shift in these investment patterns, coastal Saurashtra and Kachchh are now called the "Silver corridor". This development of coastal Saurashtra has been linked to several factors including: new industrial environment encouraging the use of local raw material (mainly minerals); and ease of export from the new ports in the region; incentives and subsidies to industrially backward coastal talukas; and the new mineral policy of the government which provides extra incentives for utilizing regional mineral resources. (Hirvey. I and Mahadevya D, 1999).

SOCIO-ECONOMIC PROFILE OF GUJARAT

The geography of Gujarat coupled with its history and economy enable it to be divided into five major socio-cultural regions: Kachchh, Saurasthra, North Gujarat, Central Gujarat and South Gujarat. These regions have considerable local variations in economics, allocation of resources, production and social context. Each region has its own dialect and is largely congruent to the physical divisions that the state was carved into during its formation in 1960 on linguistic grounds (Sanghavi 1996).

A overview of the cultural traits of each region based on their historical legacy can be got from the analysis of Joshi (2000).

TABLE (1.1): CULTURAL ATTRIBUTES OF SOCIO - CULTURAL REGIONS IN GUJARAT

	Saurashtra and Kachchh	Central Belt	Eastern Belt
Terrain	Mostly plain	Plain	Undulating
Landholding system (Prior to independence)	Zamindari (Girasdari, Barkhalidari and Inamdari)	Ryotwari	Community ownership
Political system (Prior to independence)	202 feudal states	Some kingdoms and British Rule	Some kingdoms and tribal chiefs under British tutelage
Dominant value	Conflict	Cooperation	Subjugation
Political culture	Semi-feudal	Democratic	Semi-tribal
View on human nature	Godly, saintly / humanitarian	Interests and goals – means relationship	Reform
Social organisation	Charity oriented	Development oriented	Liberation oriented

Source Joshi (2000), EPW, August 26-September 2, 2000

SOCIO-ECONOMIC VULNERABILITY

Vulnerability Assessment (VA) seeks to analyze, model or quantify what may happen to an identifiable population under conditions of specific risks and hazards. Because of its predictive nature VA is expected to contribute to directing development aid interventions, risk reduction and disaster mitigation strategies.

Social Vulnerability is the impact a particular event has on populations that are at different levels of preparedness. Disasters impact not only their homes but also their livelihoods and social relations. The impact of a disaster is also determined by these factors. Social vulnerability is the complex outcome of a set of characteristics. Data was collected on the following factors to assess current status.

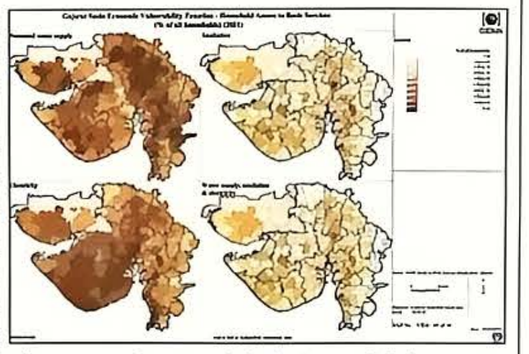
THE APPROACH

The most common framework for social vulnerability uses three broad sets of parameters – social (community, networks), physical (location, housing and infrastructure) and psychological (ability to cope with loss) status of households (Anderson & Woodrow, 1989). This approach is inadequate to capture the range of factors that result in differential vulnerability to multiple hazards – hydrological, geotectonic and agricultural.

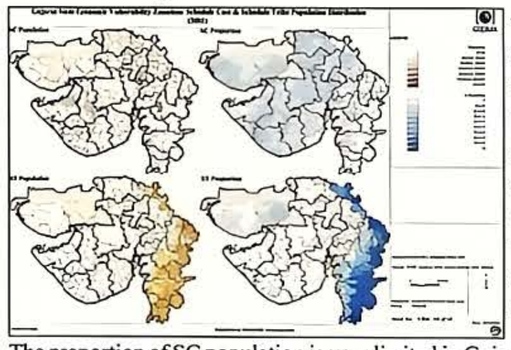
The Sustainable Rural Livelihoods (SRL) approach provides a framework for analysis of household capabilities from a more holistic perspective. A livelihood comprises the capabilities, assets (both material and social resources) and activities required for a means of living. The ability of a livelihood to cope with and recover from stresses and shocks (arising also from natural hazards) and maintain or enhance its asset base and capabilities, determines the extent of its vulnerability. The Capital Assets of a livelihood comprise natural, social, human, physical and financial assets and capabilities.

This framework has been developed in response to DFID's commitment to promoting sustainable rural livelihoods and has been used by different donors to develop poverty eradication strategies, but has not been used as a tool for vulnerability assessment. It recognizes that household vulnerability arises from the trends, shocks and cultural context within which they use their Capital Assets and which lead to changes in their capital stocks. However, the relationship between factors that form the vulnerability context and the resultant livelihoods of the households, mediated through their Capital Assets and transforming structures and processes is not well developed either in the theory or empirical studies. The SRL framework was therefore adapted for this task. The utility of using such a framework is the comprehensive picture of household entitlements and capacities it enables, each component of which has a specific bearing on the differential vulnerability of households to the various hazards this project seeks to address.

ACCESS TO BASIC SERVICES

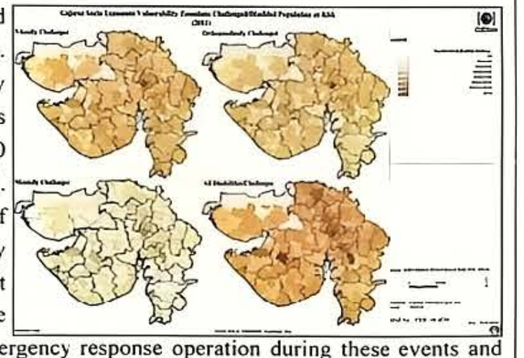


There is a wide disparity in the access to all three basic services (protected water supply, sanitation and electricity) in Gujarat. Protected water supply is available to the bulk of the population in Gujarat except for small pockets in Bhavnagar, Surendranagar, Jamnagar, Kachchh and Panchmahals districts where there are water source and access challenges. Sanitation coverage however, is limited, especially in western, northern, many parts of central Gujarat and Saurashtra. The differential impact of natural hazards is accentuated by poor access to basic services, especially in the aftermath of events where public health challenges become even more severe. Disaster mitigation and planning activities will need to take these challenges into account in reducing overall long term vulnerability.



The most vulnerable populations in the aftermath of natural disasters include socially and economically backward groups (like SC and ST), the disabled, children and the elderly. Gujarat presents a unique distribution of these populations who need to be planned for in emergency and long-term mitigation activities.

The proportion of SC population is very limited in Gujarat (7 percent) and their population is by and large dispersed across the state except for some concentrations in urban pockets like Ahmedabad, Baroda and Rajkot. The ST population, however, is moderately large (at 15 percent) and relatively highly concentrated along the western tribal fringe that runs all the way from Mehsana through Dahod, Vadodara, Narmada, The Dangs to Valsad districts.

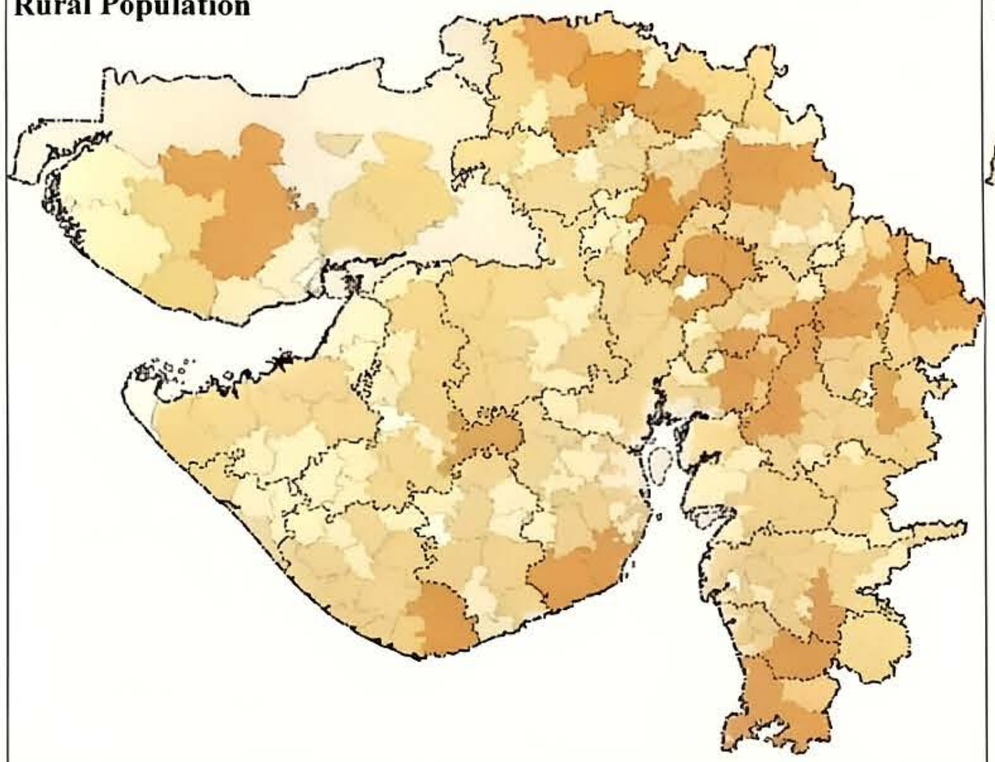


The total proportion of disabled population in Gujarat is 2 percent. Of this, 47 percent is visually challenged, 30 percent is orthopaedically challenged and 10 percent is mentally challenged. These populations will be of considerable concern especially during evacuation operations that will be necessary during cyclone and storm surge, flood and emergency response operation during these events and earthquake. Special plans will need to be developed in each district to address the needs of these groups.

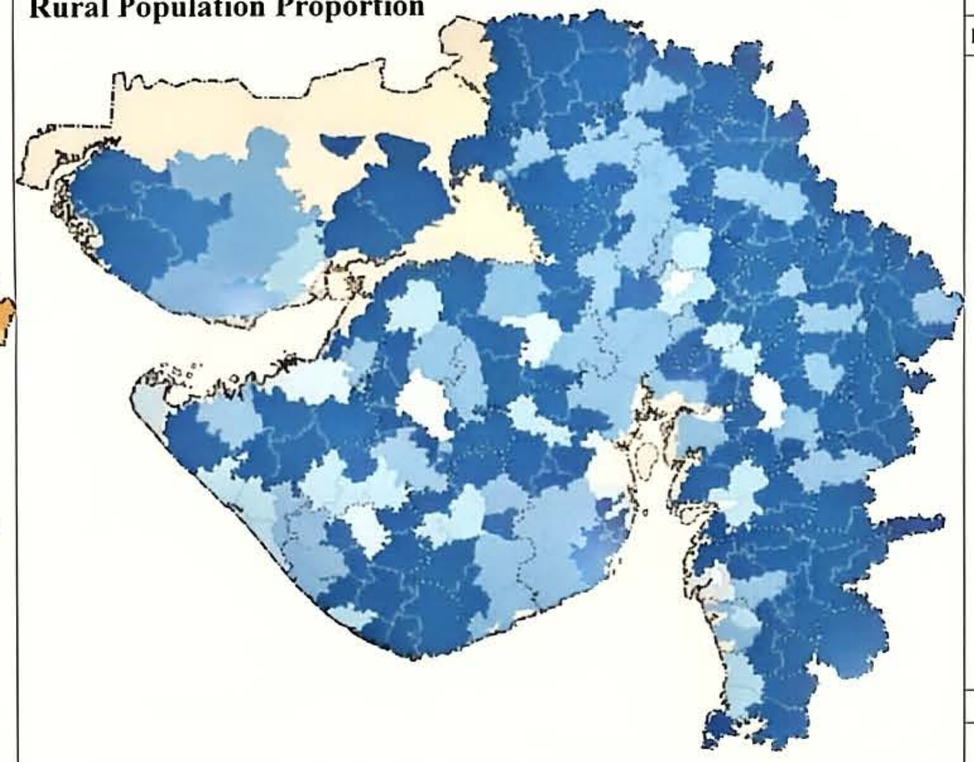
Gujarat Socio Economic Vulnerability Zonation: Rural & Urban Population Distribution (2001)

GSDMA

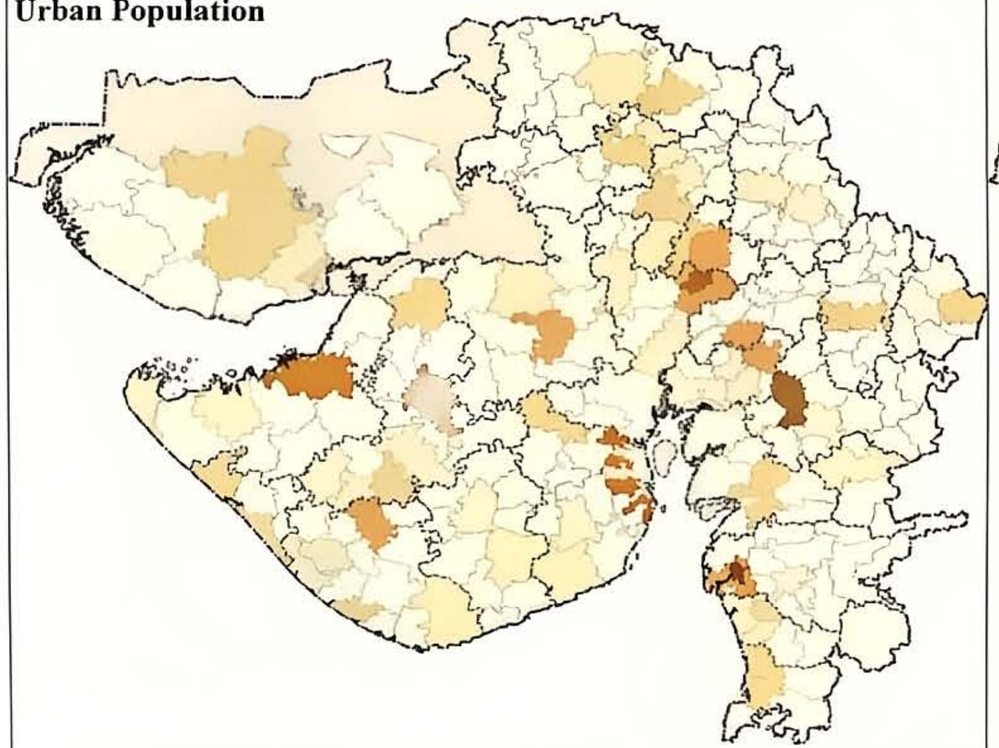
Rural Population



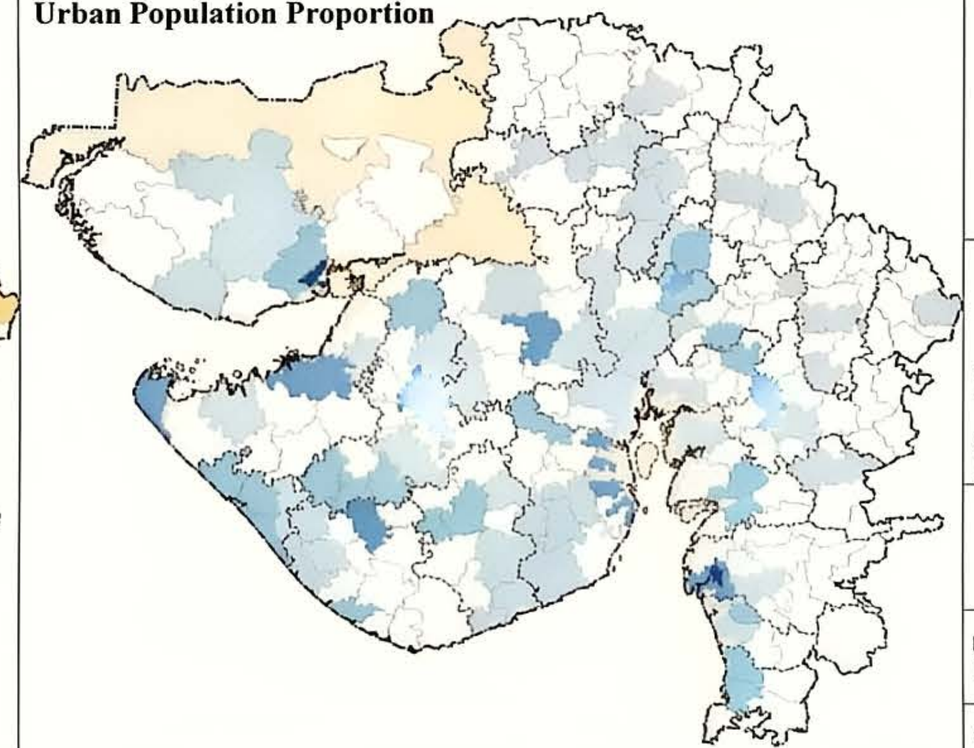
Rural Population Proportion



Urban Population



Urban Population Proportion



LEGEND

Population
- < 50,000
- > 50,000 to 100,000
- > 100,000 to 200,000
- > 200,000 to 300,000
- > 300,000 to 500,000
- > 500,000 to 1,000,000
- > 1,000,000

% Population
- < 20
- > 20 to 40
- > 40 to 60
- > 60 to 80
- > 80

The rural and urban population proporations are a percentage share of total Taluka population.

Source: TARU Analysis, 2004; Census of India, 2001; BISAG, GoG.

0 100 km

N

Projection : Lambert Azimuthal Equal Area
Datum : WGS 84

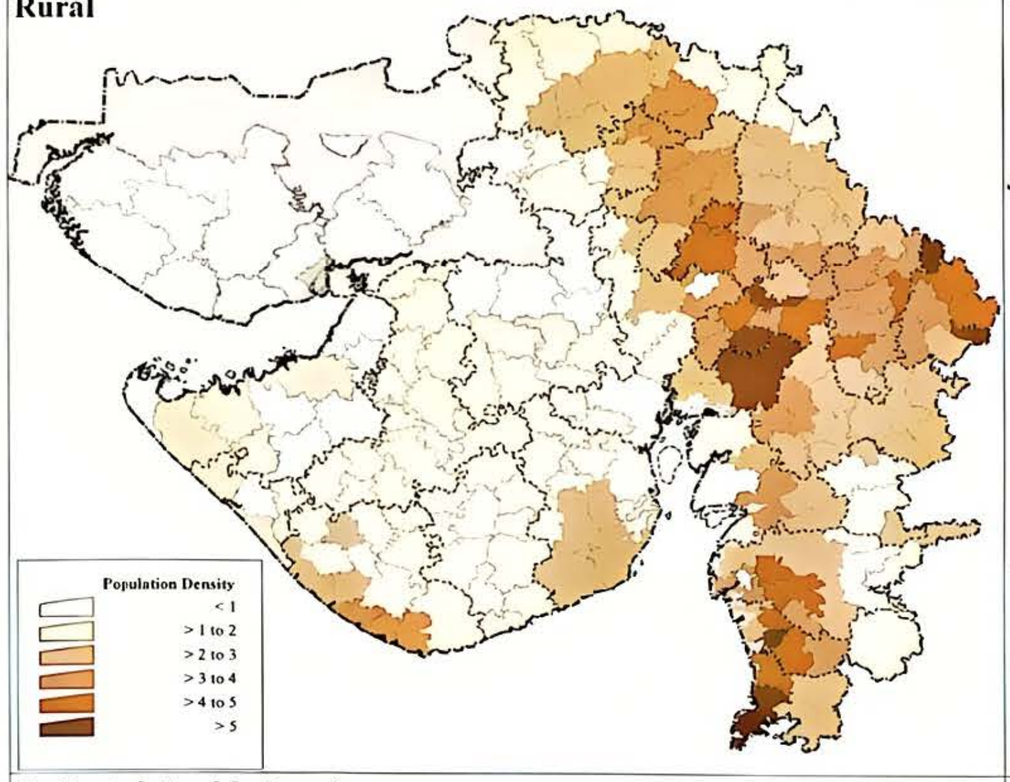
MAP No. : VSEM - 01 OF 11

Date : 16/6/2005

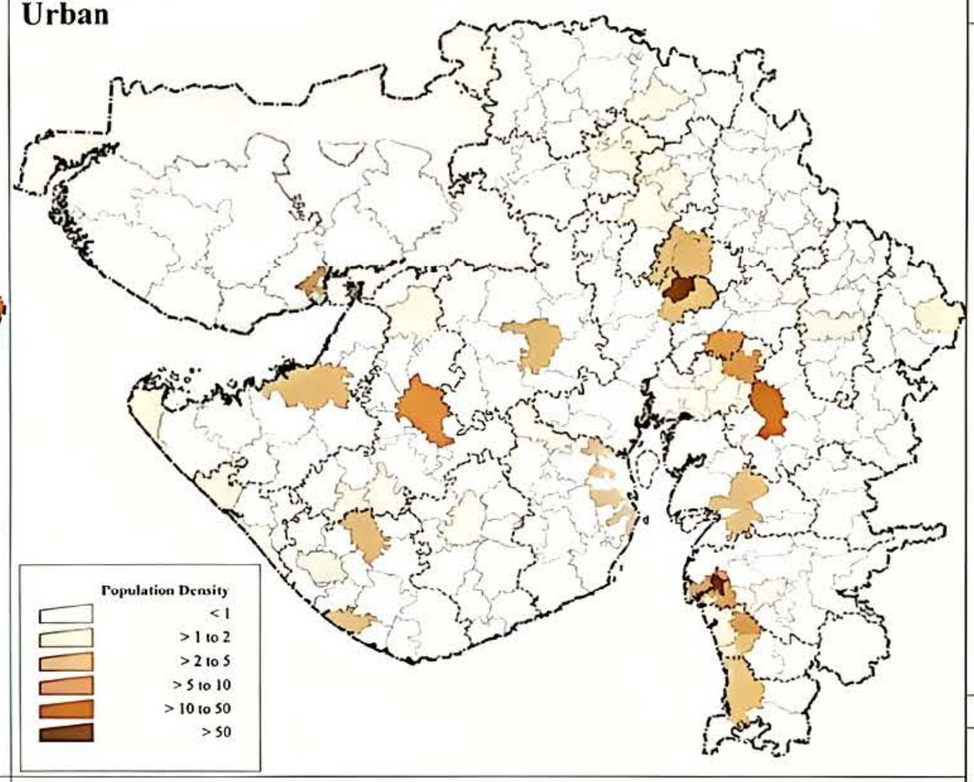
Gujarat Socio Economic Vulnerability Zonation: Population Densities (Person Per Ha) (2001)

GSDMA

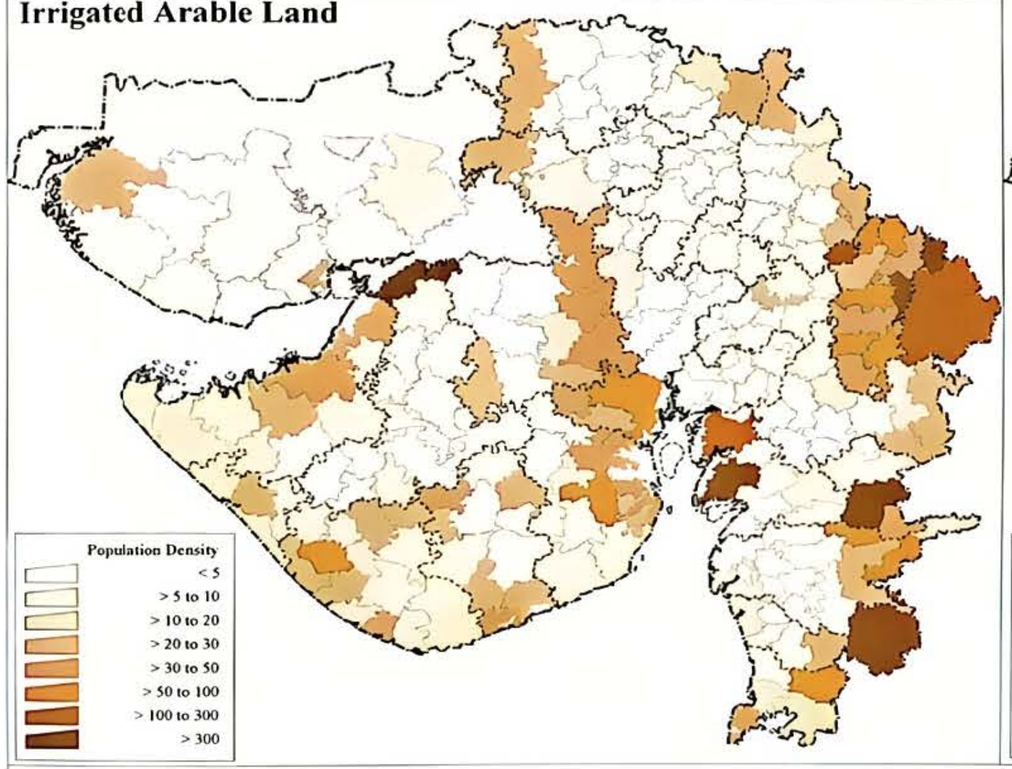
Rural



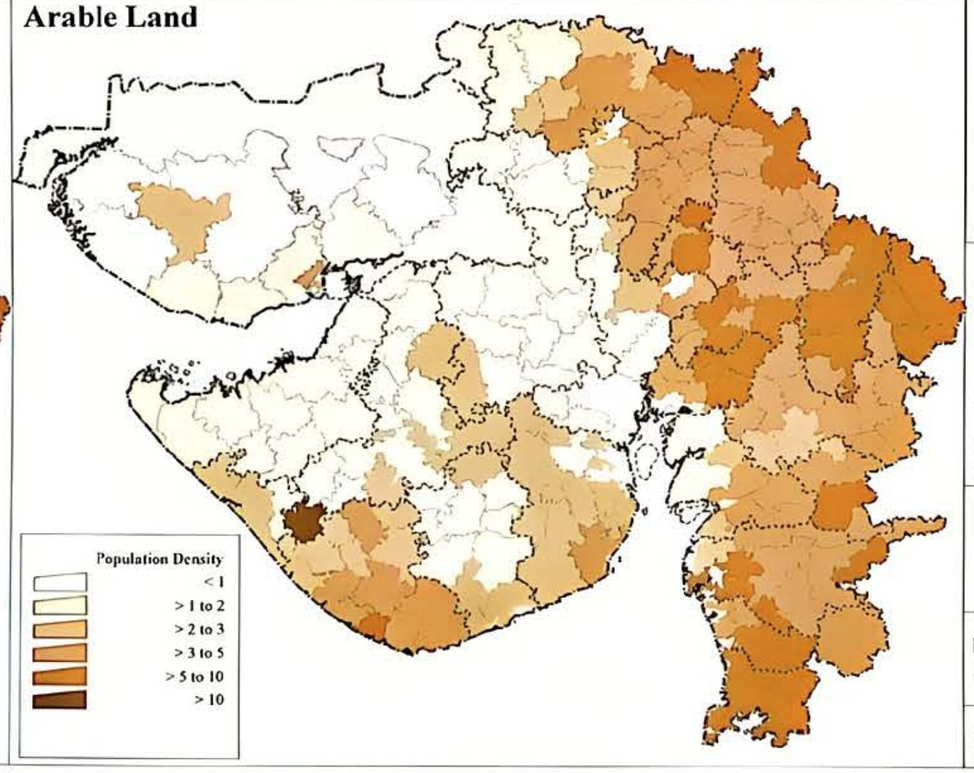
Urban



Irrigated Arable Land



Arable Land



Urban density has been calculated on total Taluka area.

Source: TARU Analysis, 2004; Census of India, 2001; BISAG, GoG.

0 100 km

N

Projection : Lambert Azimuthal Equal Area
Datum : WGS 84

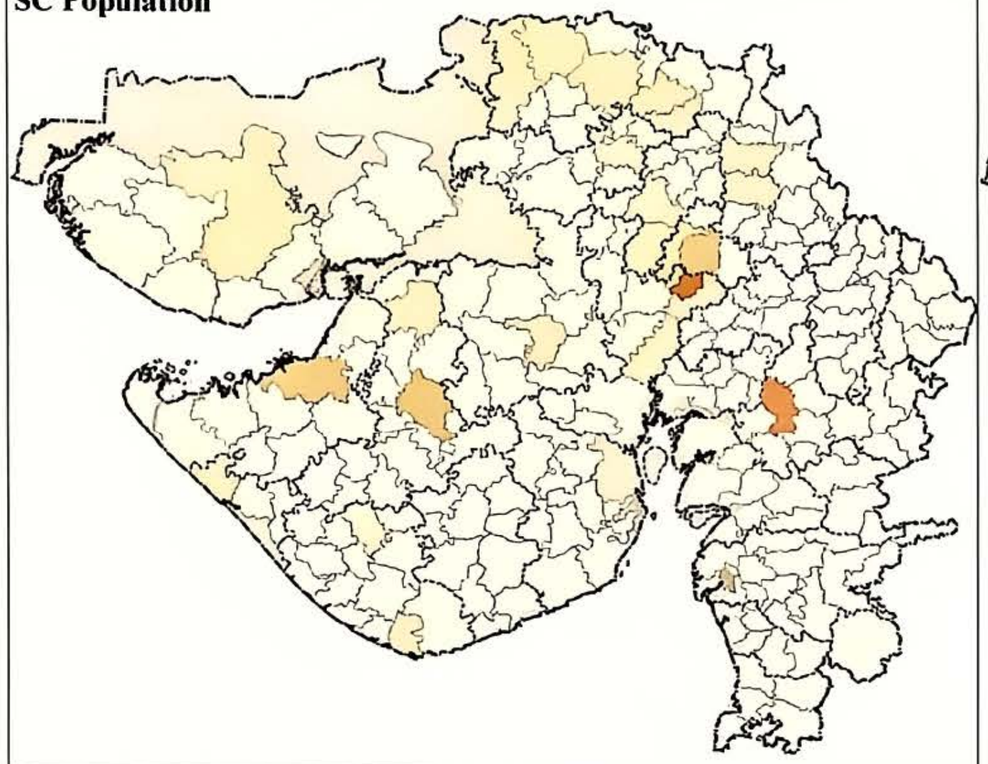
MAP No. : VSEM - 02 OF 11

Date : 16/6/2005

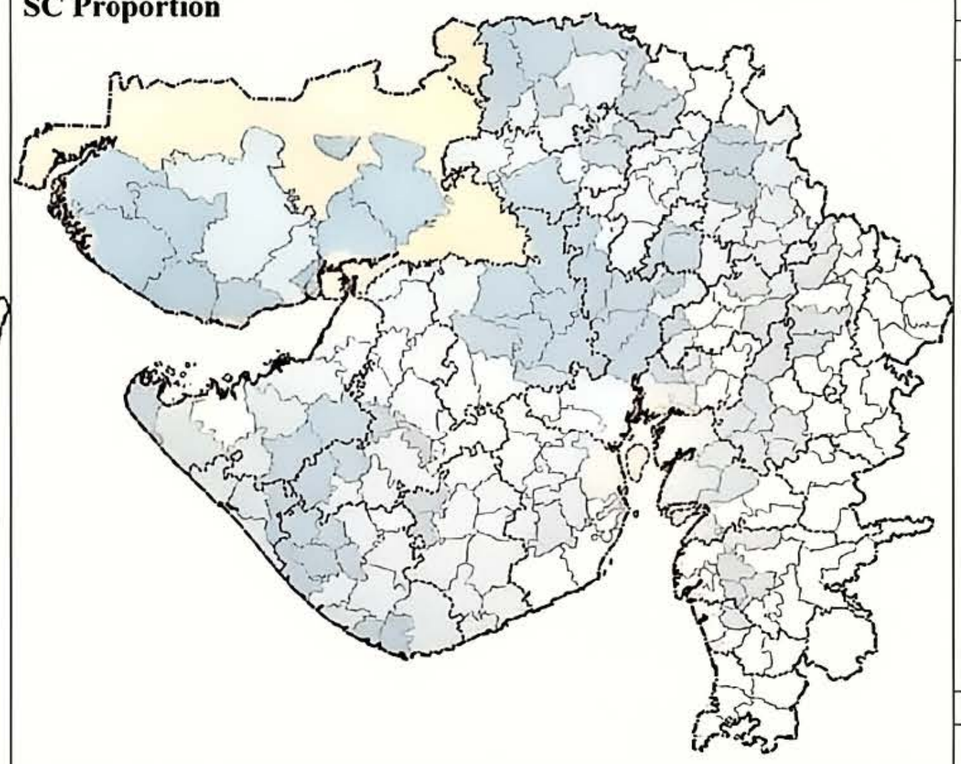
Gujarat Socio Economic Vulnerability Zonation: Scheduled Caste (SC) & Scheduled Tribe (ST) Population Distribution (2001)

GSDMA

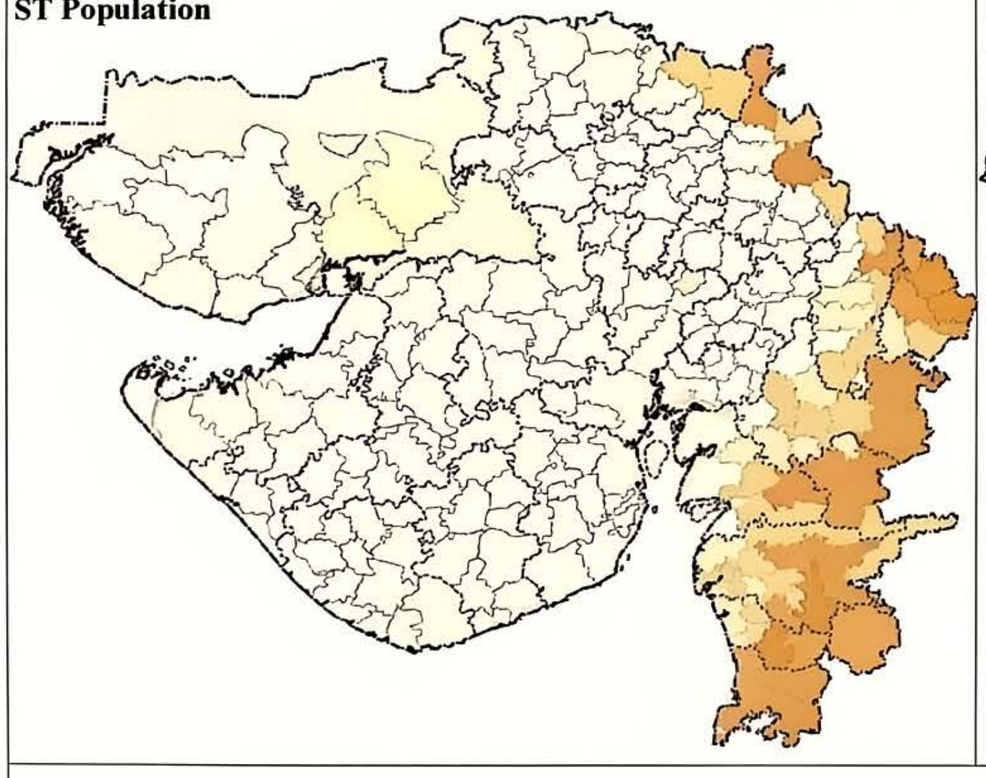
SC Population



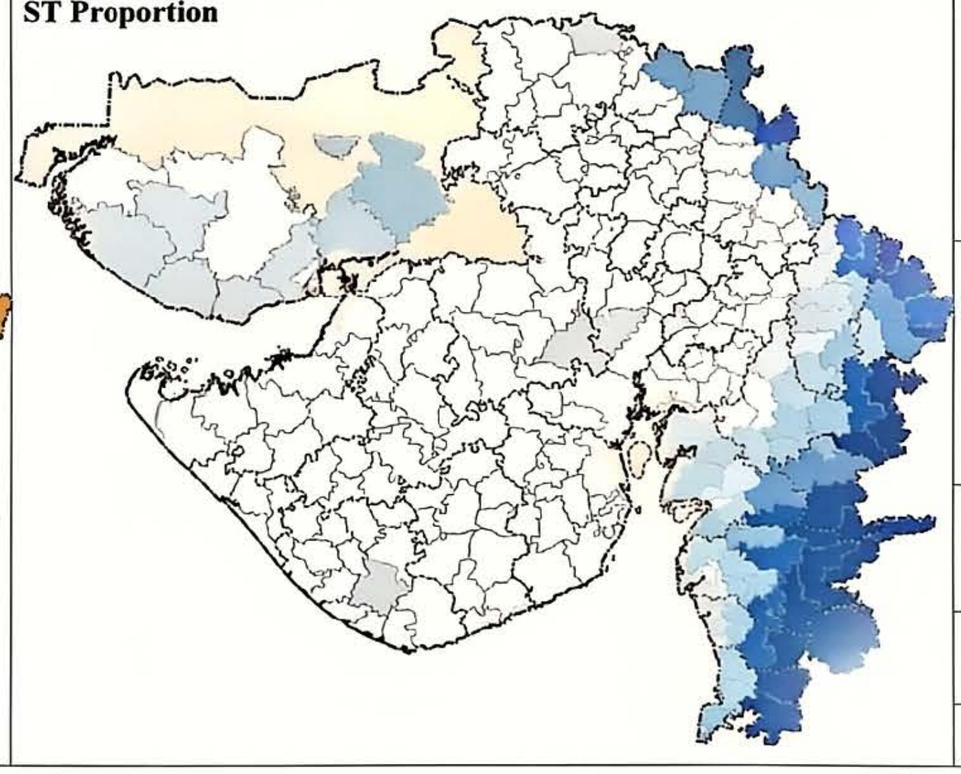
SC Proportion



ST Population



ST Proportion



LEGEND

Population
- < 25,000
- > 25,000 to 50,000
- > 50,000 to 100,000
- > 100,000 to 200,000
- > 200,000 to 500,000
- > 500,000 to 1,000,000
- > 1,000,000

% Population
- < 5
- > 5 to 10
- > 10 to 20
- > 20 to 30
- > 30 to 40
- > 40 to 50
- > 50 to 60
- > 60 to 70
- > 70 to 80
- > 80

Source: TARU Analysis, 2004; Census of India, 2001; BISAG, GoG.

0 100 km

N

Projection : Lambert Azimuthal Equal Area
Datum : WGS 84

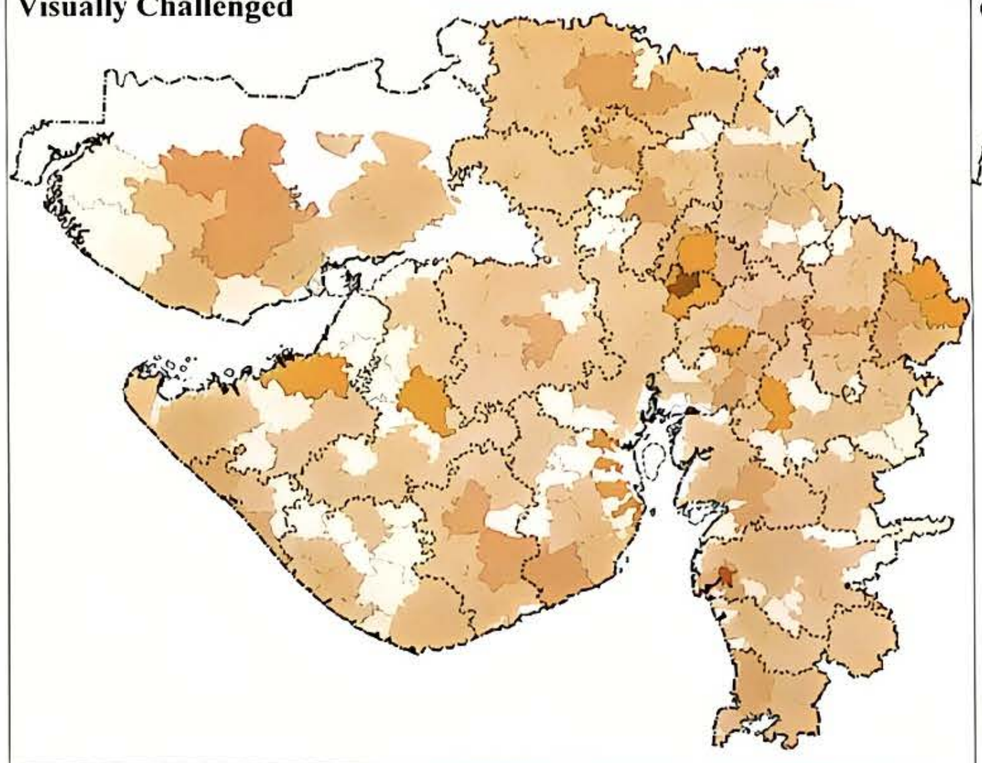
MAP No. : VSEM - 03 OF 11

Date : 16/6/2005

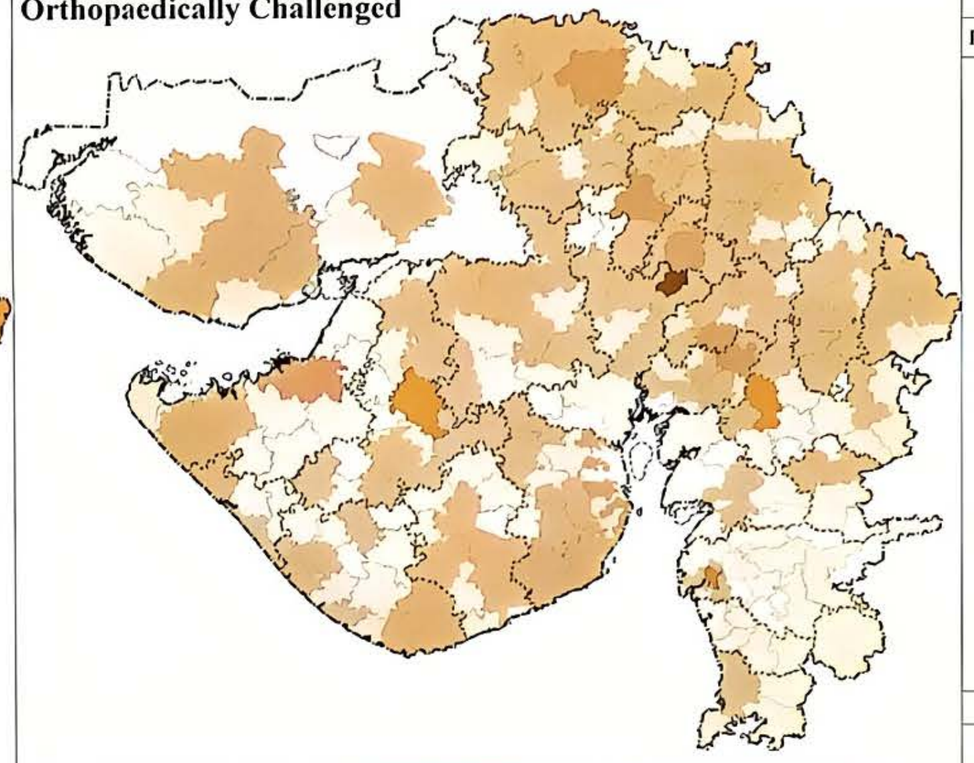
Gujarat Socio Economic Vulnerability Zonation: Challenged/Disabled Population at Risk (2001)

GSDMA

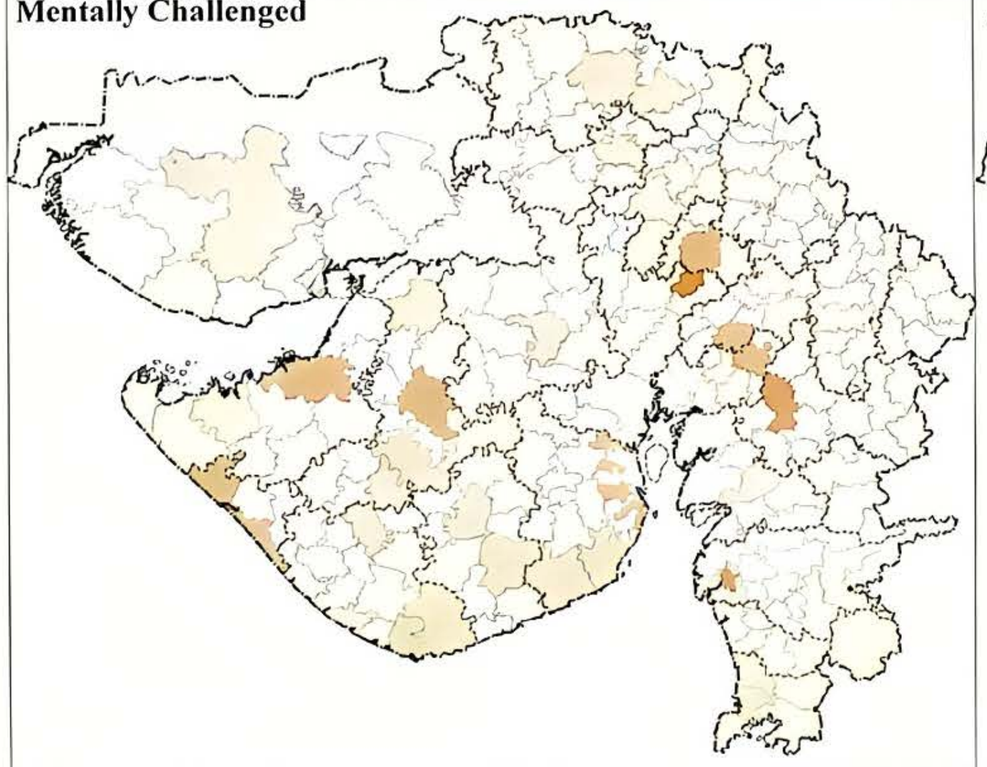
Visually Challenged



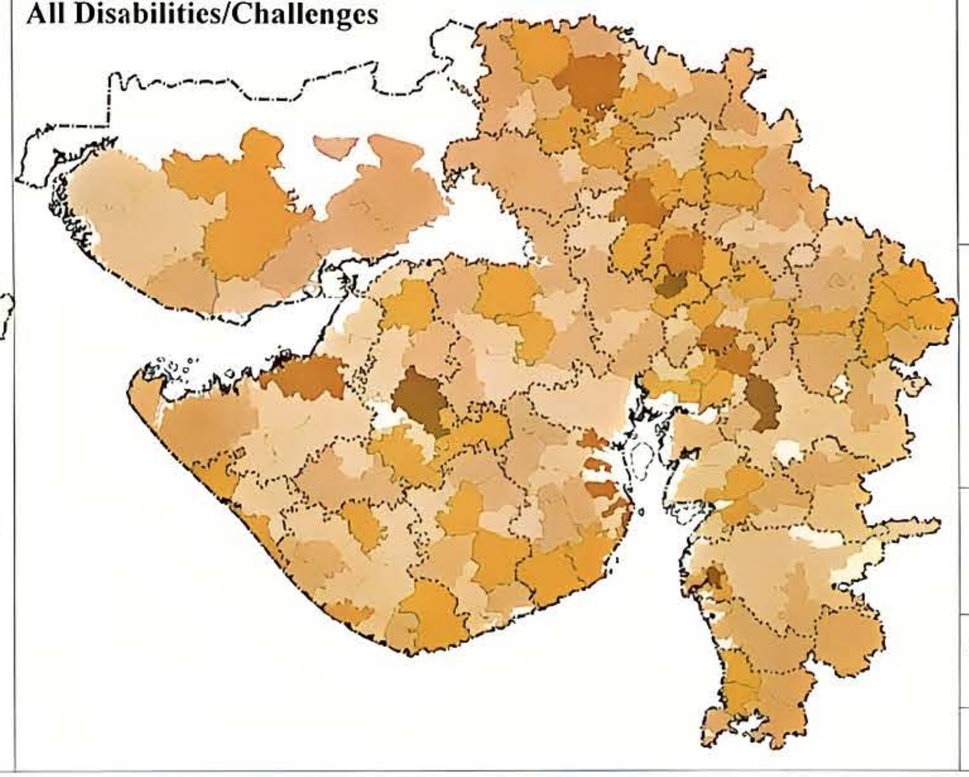
Orthopaedically Challenged



Mentally Challenged



All Disabilities/Challenges



LEGEND

Population with Disability/Challenge

- < 250
- > 250 to 500
- > 500 to 1,000
- > 1,000 to 3,000
- > 3,000 to 5,000
- > 5,000 to 10,000
- > 10,000 to 20,000
- > 20,000

Source: TARU Analysis, 2004; Census of India, 2001; BISAG, GoG.

0 100 km

N

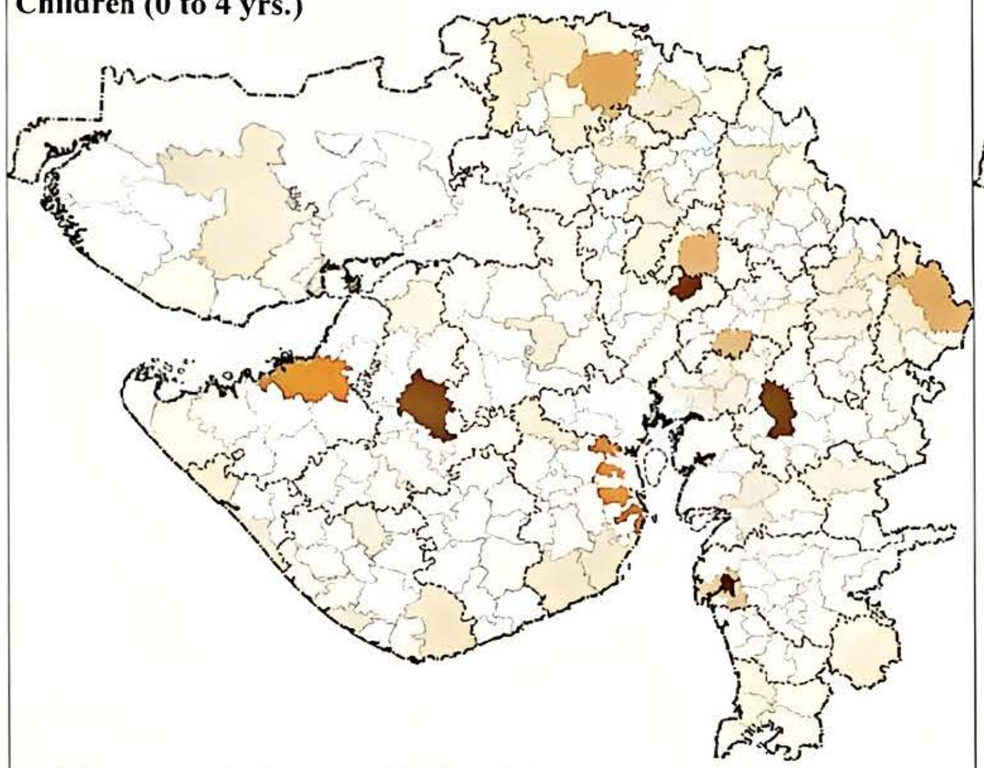
Projection : Lambert Azimuthal Equal Area
Datum : WGS 84

MAP No. : VSEM - 04 OF 11

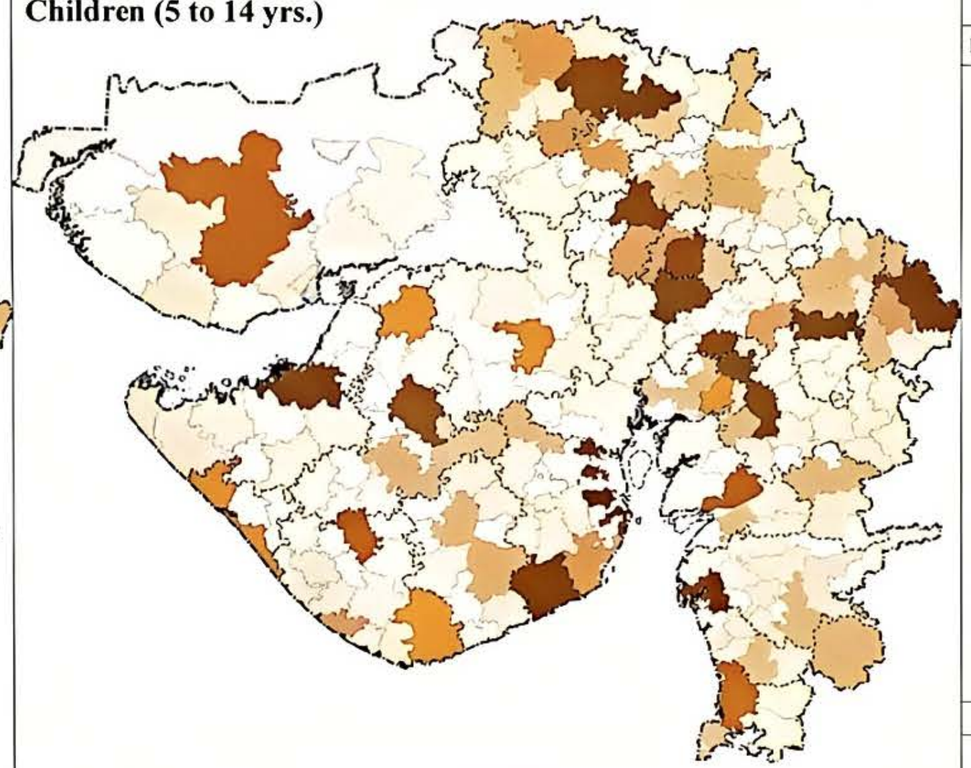
Date : 16/6/2005

Gujarat Socio Economic Vulnerability Zonation: Population of Children & Aged at Risk (2001)

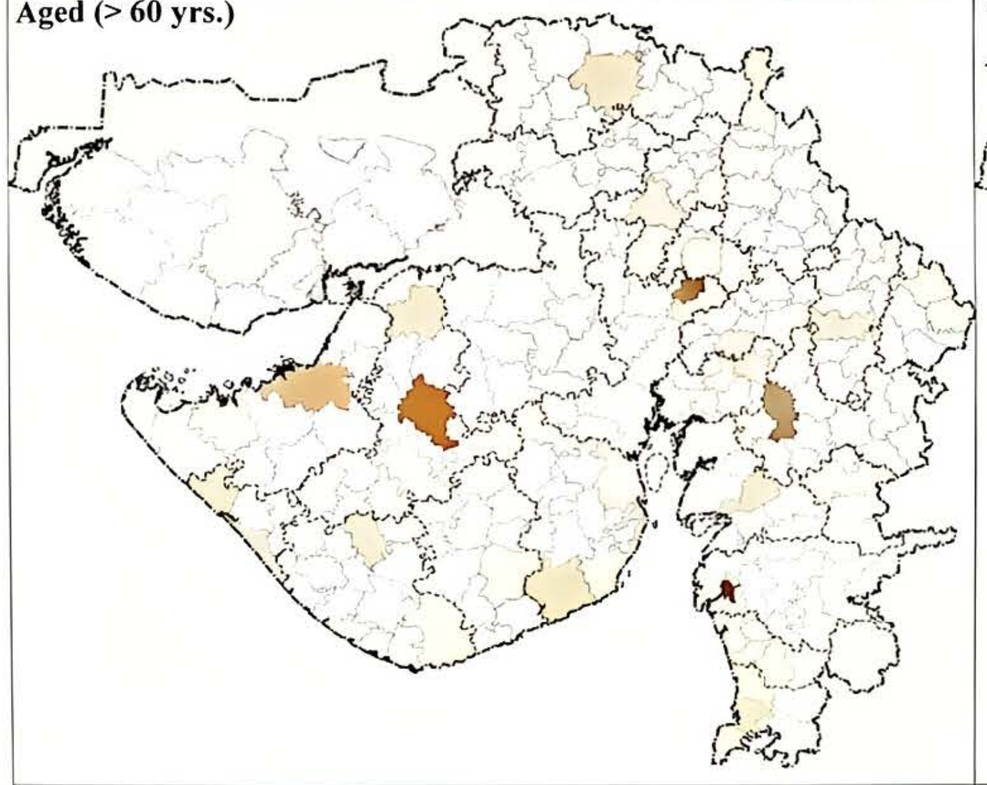
Children (0 to 4 yrs.)



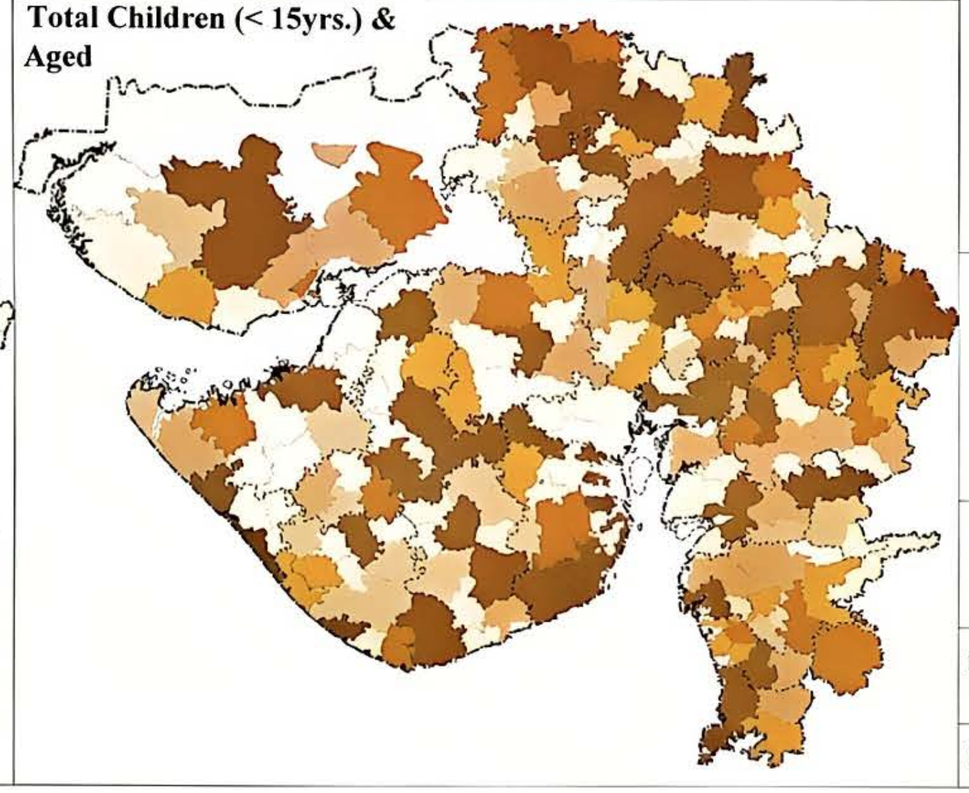
Children (5 to 14 yrs.)



Aged (> 60 yrs.)



Total Children (< 15yrs.) & Aged



GSDMA

LEGEND

Population
< 15,000
> 15,000 to 25,000
> 25,000 to 50,000
> 50,000 to 60,000
> 60,000 to 70,000
> 70,000 to 80,000
> 80,000 to 90,000
> 90,000

Source: TARU Analysis, 2004; Census of India, 2001; BISAG, GoG.

0 100 km

N

Projection : Lambert Azimuthal Equal Area
Datum : WGS 84

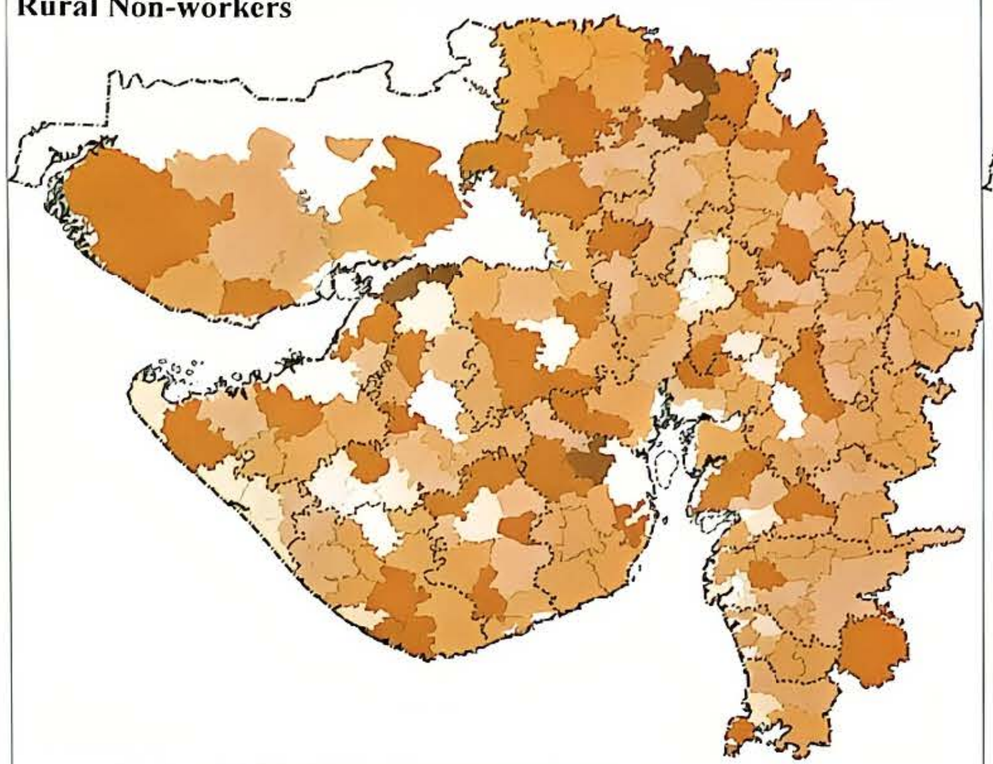
MAP No. : VSEM - 05 OF 11

Date : 16/6/2005

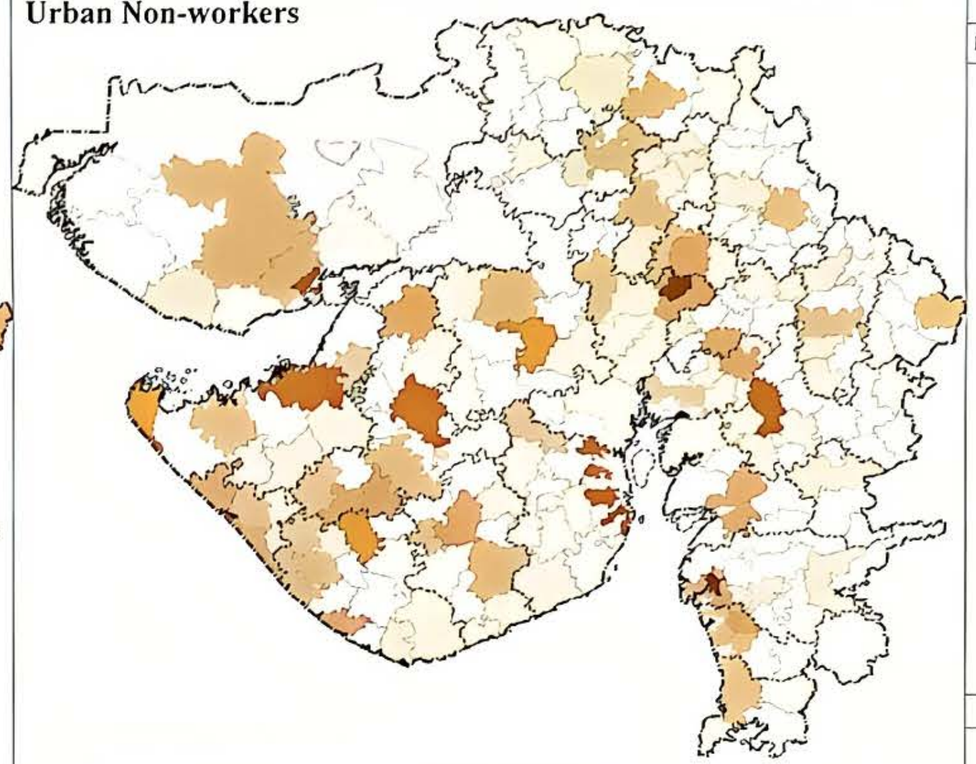
Gujarat Socio Economic Vulnerability Zonation: Workers & Non-workers

GSDMA

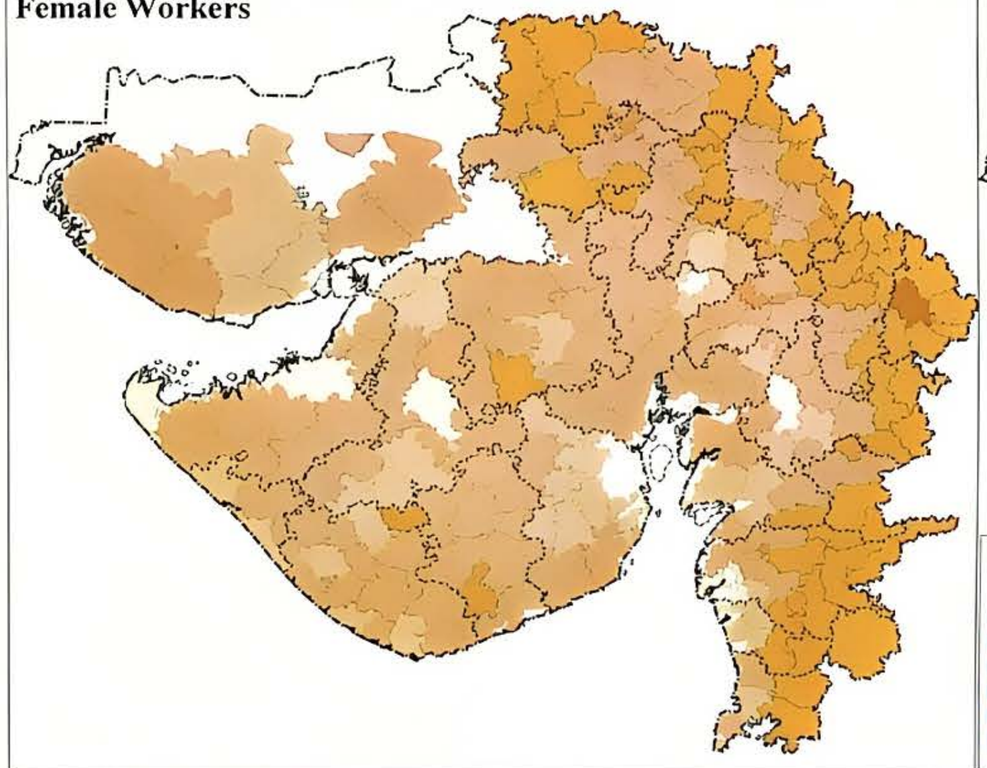
Rural Non-workers



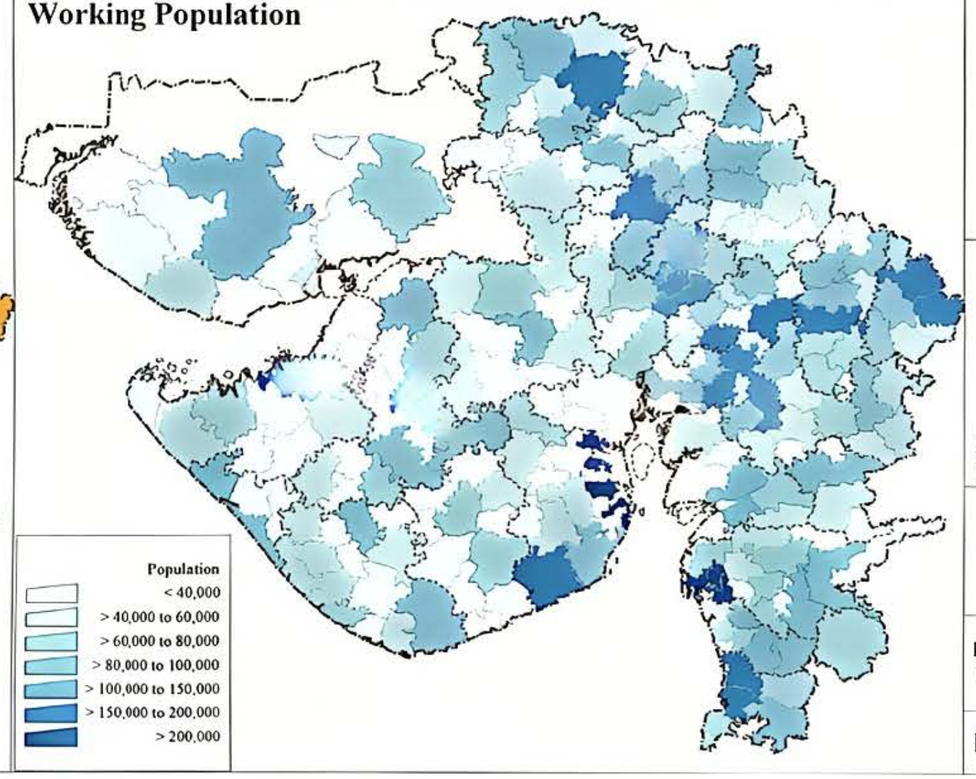
Urban Non-workers



Female Workers



Working Population



LEGEND



% Population
- < 5
- > 5 to 10
- > 10 to 20
- > 20 to 30
- > 30 to 40
- > 40 to 50
- > 50 to 60
- > 60

Population
- < 40,000
- > 40,000 to 60,000
- > 60,000 to 80,000
- > 80,000 to 100,000
- > 100,000 to 150,000
- > 150,000 to 200,000
- > 200,000

Source:TARU Analysis, 2004; Census of India, 2001; BISAG, GoG.

0 100 km

N

Projection : Lambert Azimuthal Equal Area
Datum : WGS 84

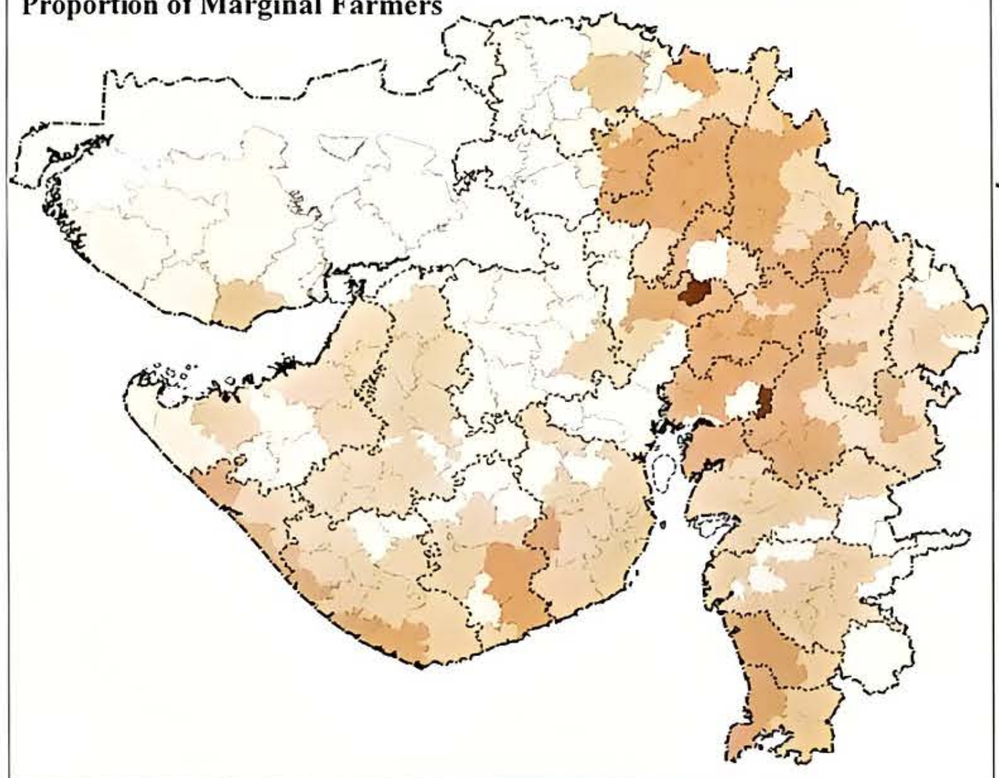
MAP No. : VSEM - 06 OF 11

Date : 16/6/2005

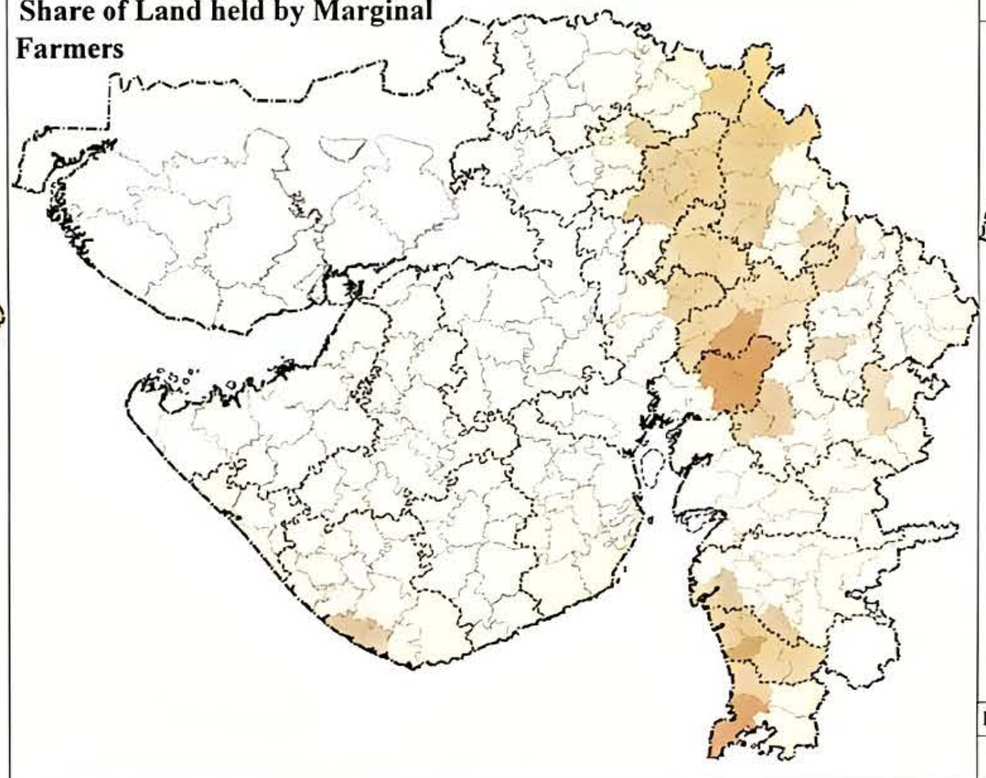
Gujarat Socio Economic Vulnerability Zonation : Proportion & Share of Land held by Marginal & Small Farmers (1995-1996)

GSDMA

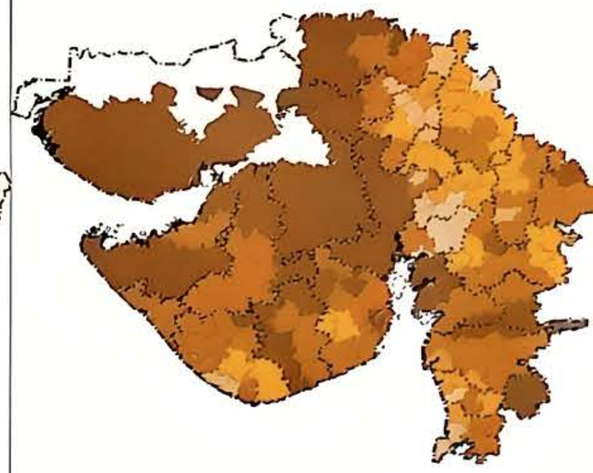
Proportion of Marginal Farmers



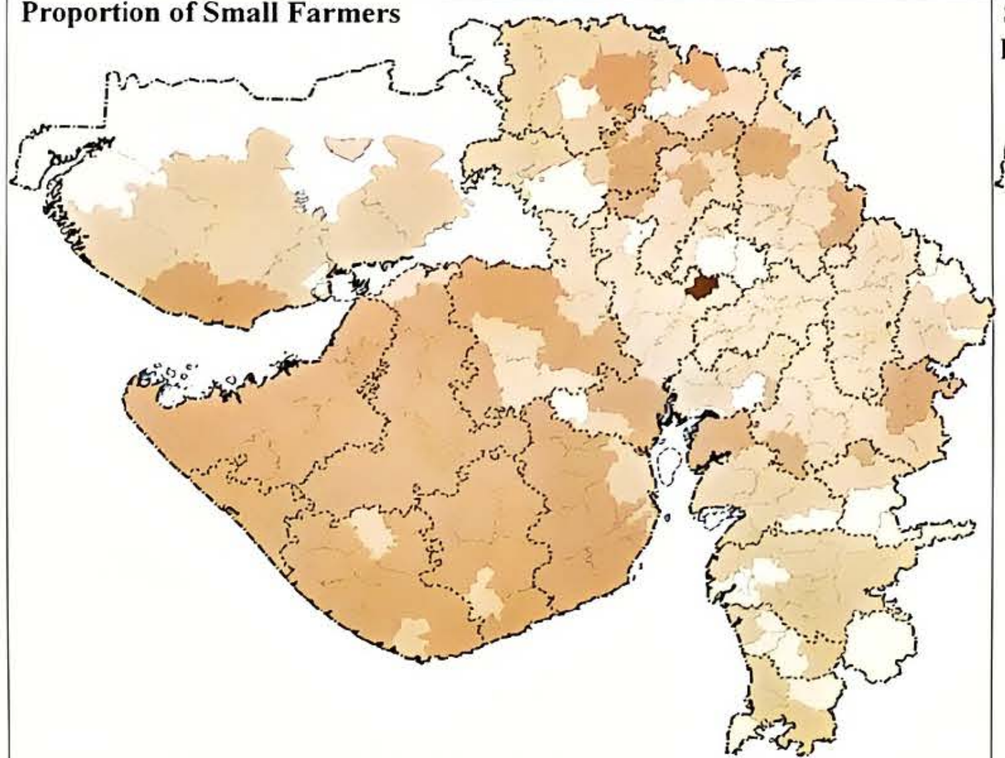
Share of Land held by Marginal Farmers



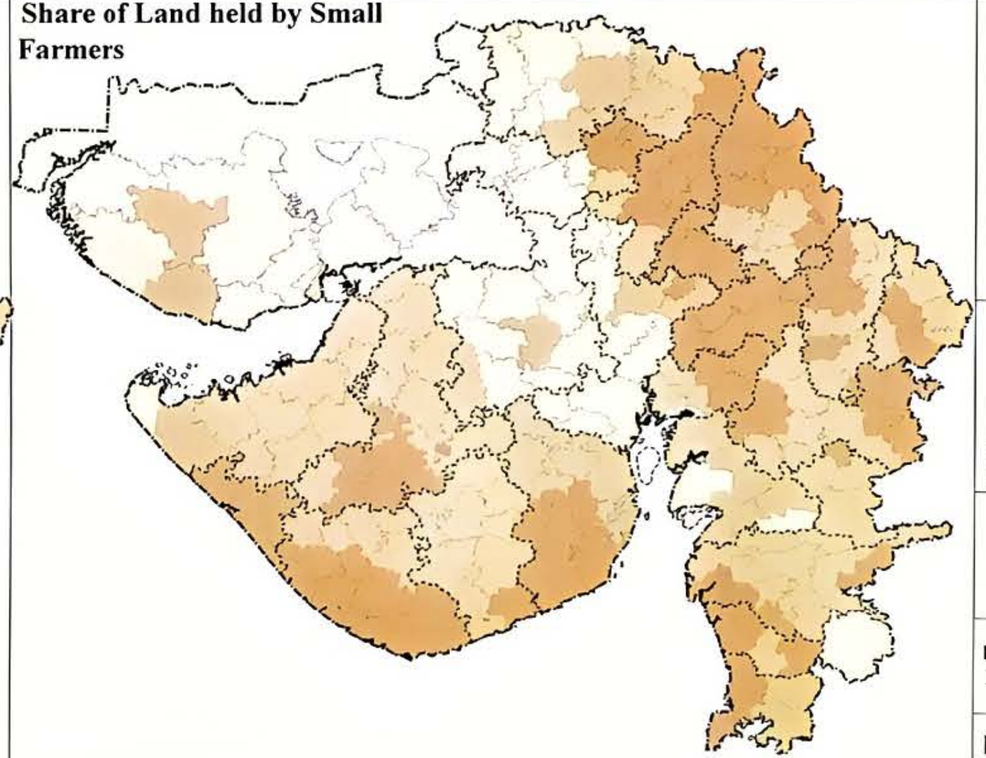
Share of Land held by Large Farmers



Proportion of Small Farmers



Share of Land held by Small Farmers



LEGEND

% of total farmers/total land held by farmers

- < 2
- > 2 to 5
- > 5 to 10
- > 10 to 20
- > 20 to 50
- > 50 to 60
- > 60 to 70
- > 70 to 80
- > 80

Source: TARU Analysis, 2004; Agriculture Census, 1995-1996; BISAG, GoG.

0 100 km

N

Projection : Lambert Azimuthal Equal Area
Datum : WGS 84

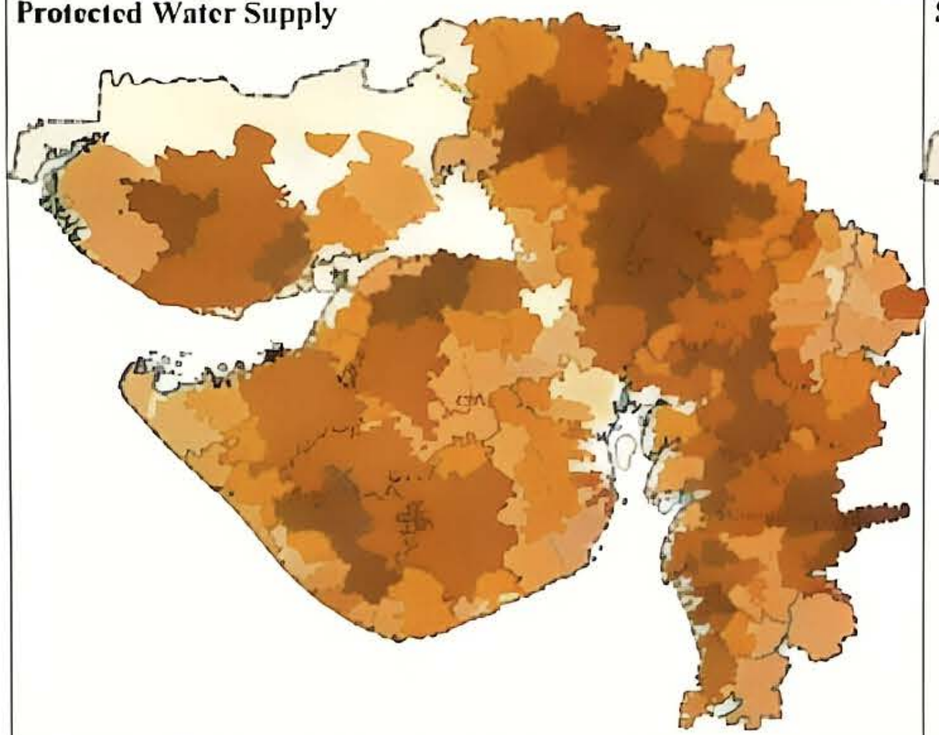
MAP No. : VSEM - 07 OF 11

Date : 18/6/2005

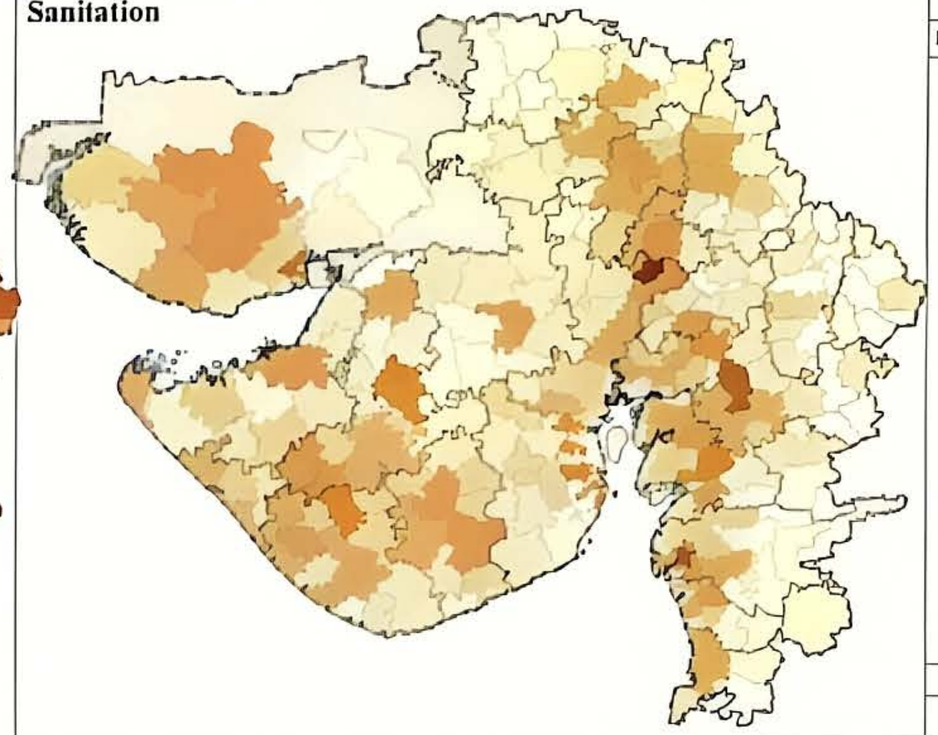
Gujarat Socio Economic Vulnerability Zonation : Household Access to Basic Services (% of all households) (2001)

GSDMA

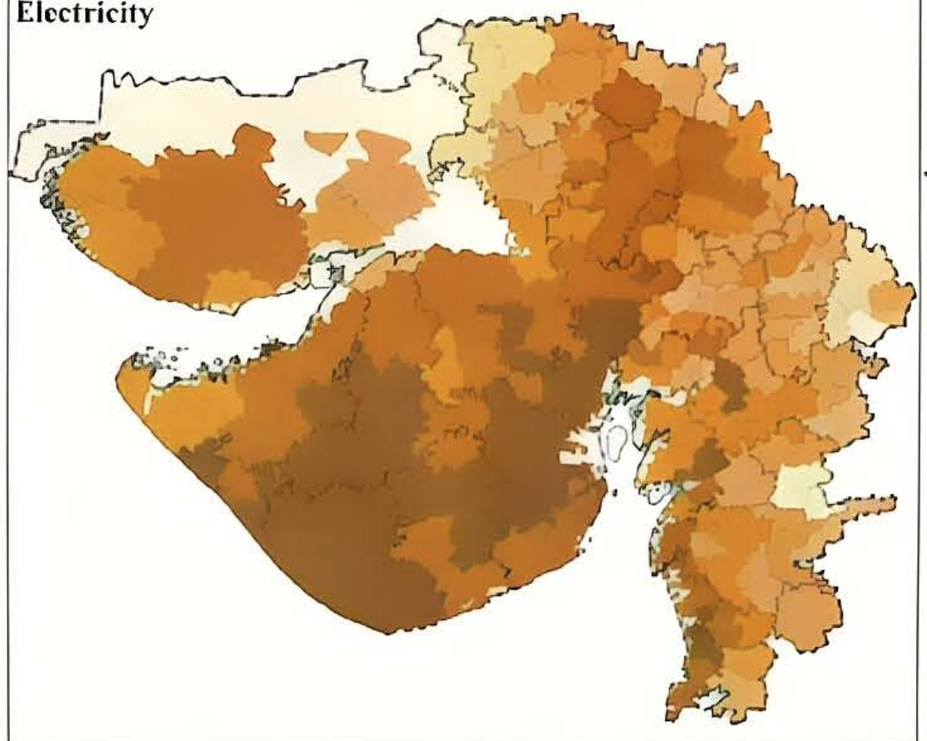
Protected Water Supply



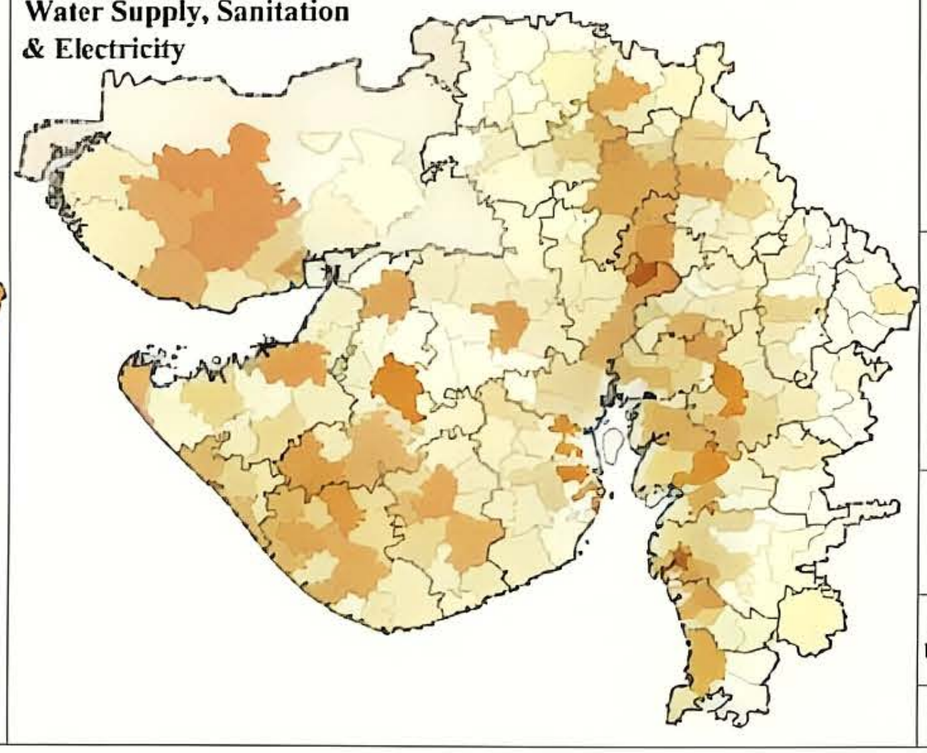
Sanitation



Electricity



Water Supply, Sanitation & Electricity



LEGEND

% of all households
< 10
> 10 to 20
> 20 to 30
> 30 to 40
> 40 to 50
> 50 to 60
> 60 to 70
> 70 to 80
> 80 to 90
> 90

Source: TARU Analysis, 2004; Census of India, 2001, BISAG, GoG.

0 100 km

N

Projection : Lambert Azimuthal Equal Area
Datum : WGS 84

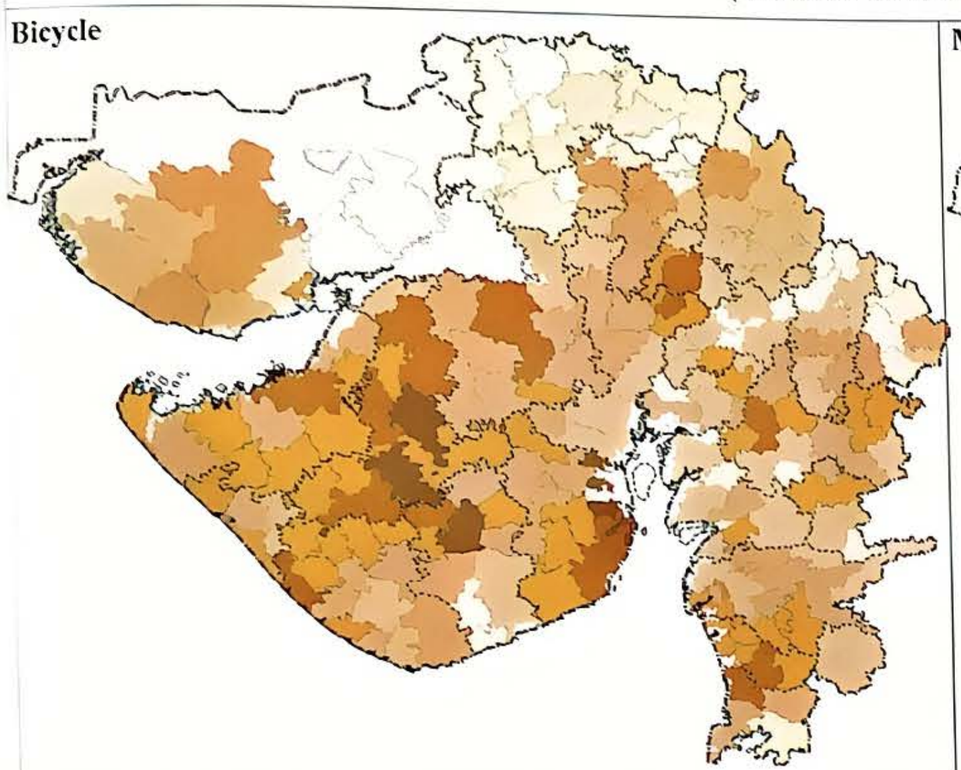
MAP No. : VSEM - 08 OF 11

Date : 18/6/2005

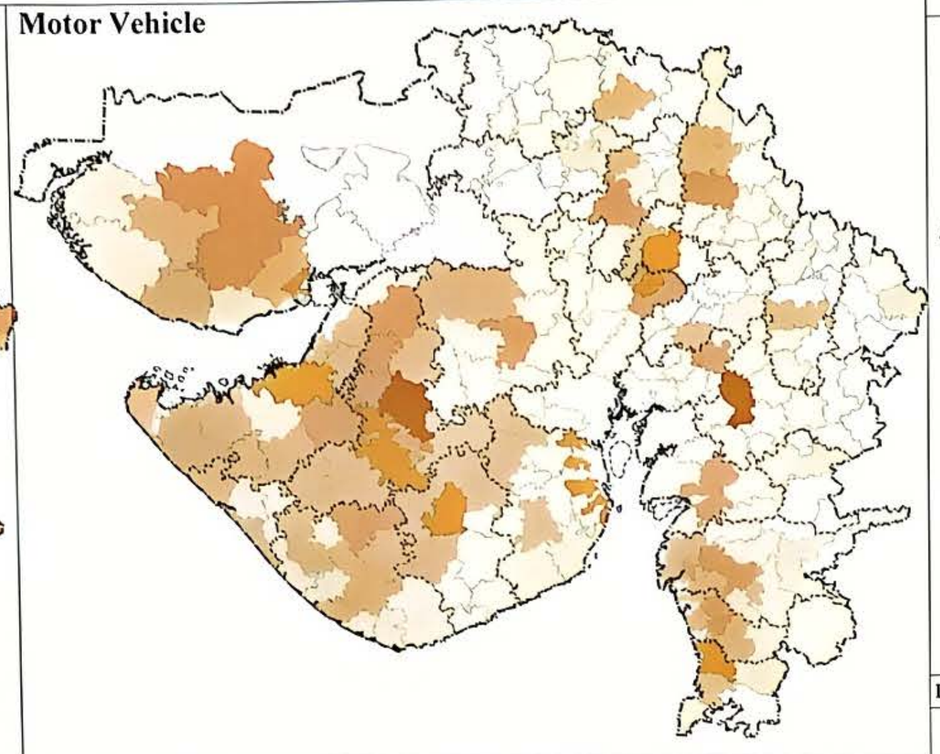
Gujarat Socio Economic Vulnerability Zonation : Household Asset Ownership (% of all households) (2001)

GSDMA

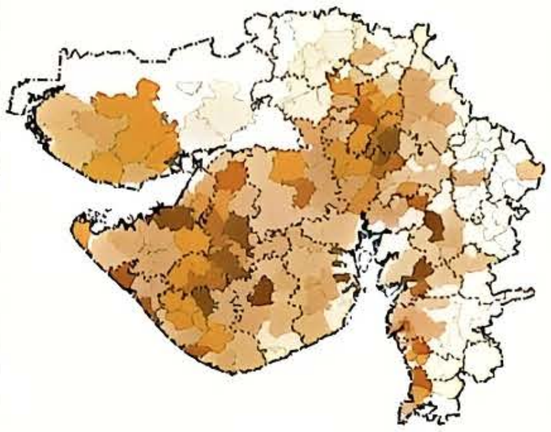
Bicycle



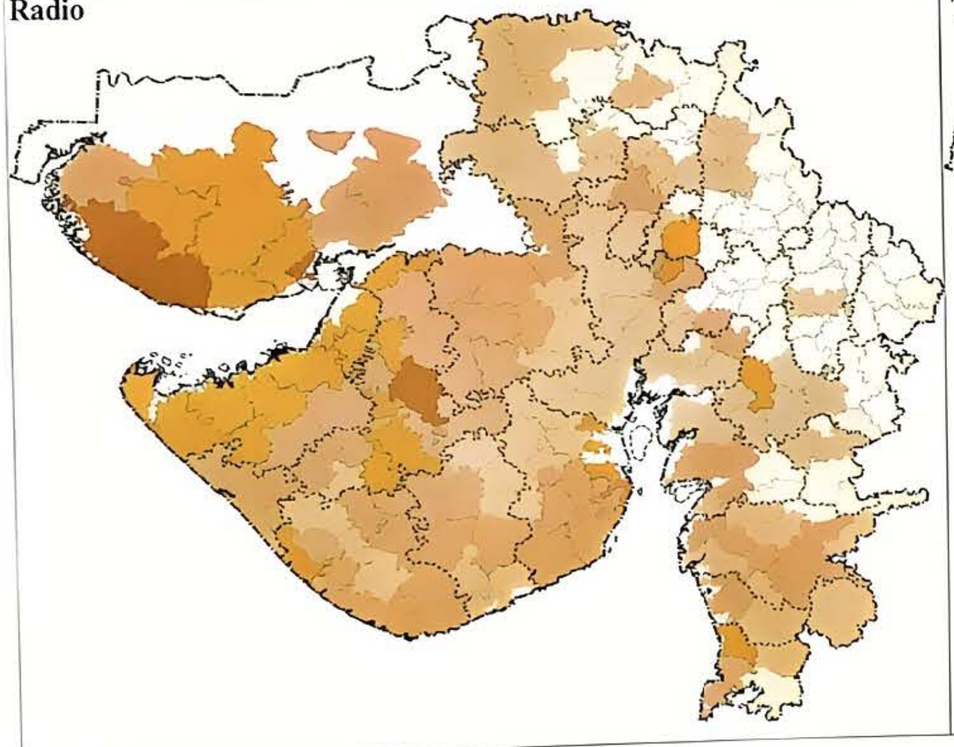
Motor Vehicle



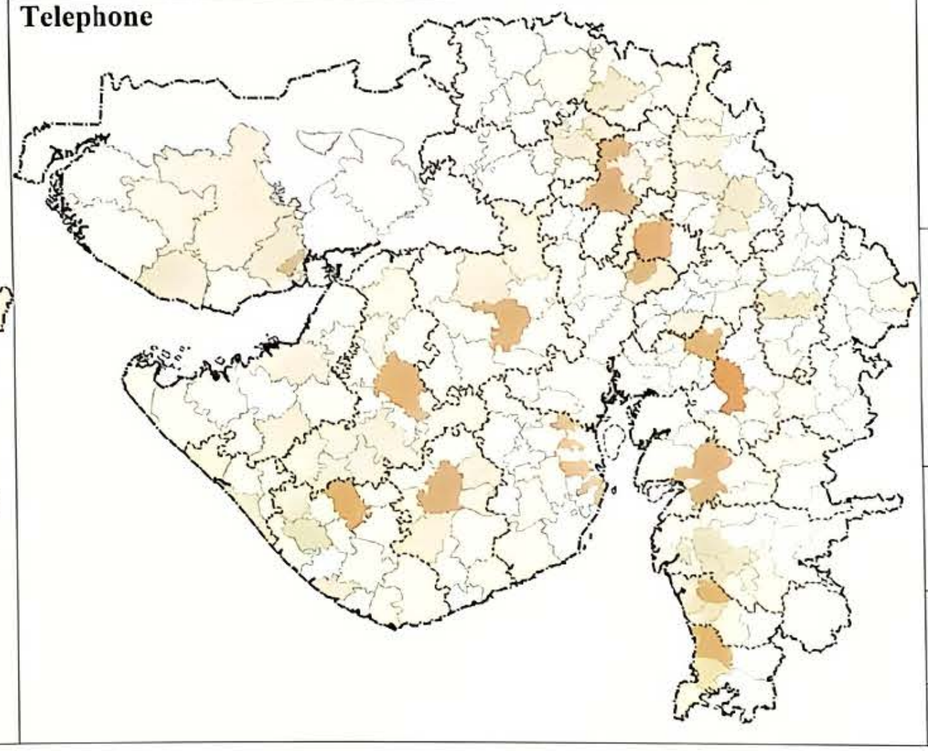
Television



Radio



Telephone



LEGEND

% of all households

- < 5
- > 5 to 10
- > 10 to 20
- > 20 to 30
- > 30 to 40
- > 40 to 50
- > 50 to 60
- > 60

Source: TARU Analysis, 2004; Census of India, 2001; BISAG, GoG.

0 100 km

N

Projection : Lambert Azimuthal Equal Area
Datum : WGS 84

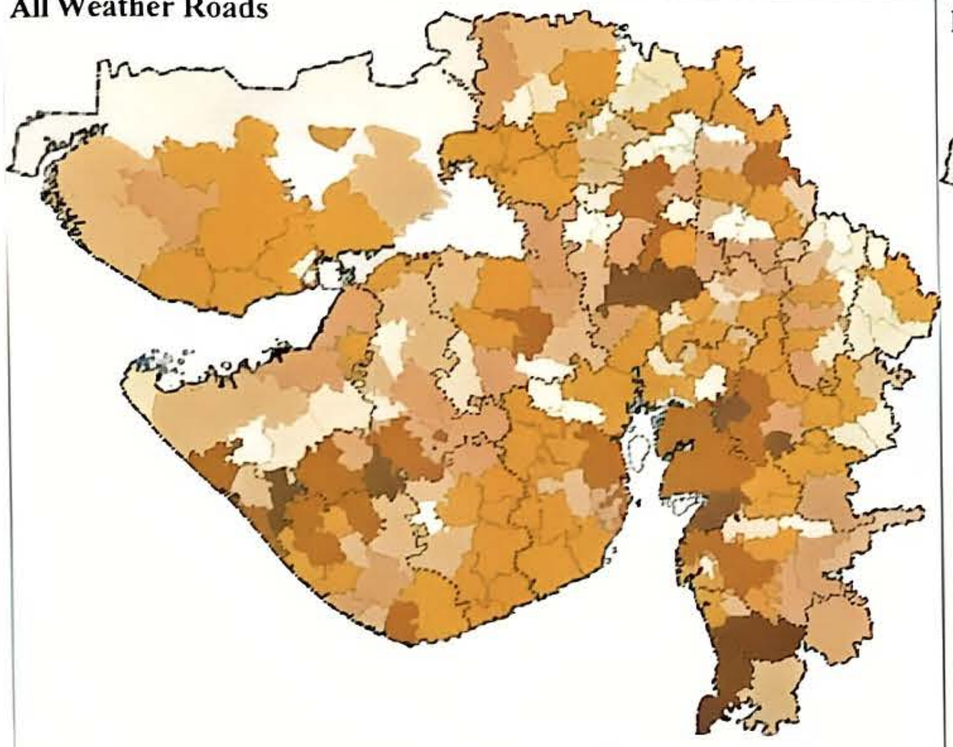
MAP No. : VSEM - 09 OF 11

Date : 18/6/2005

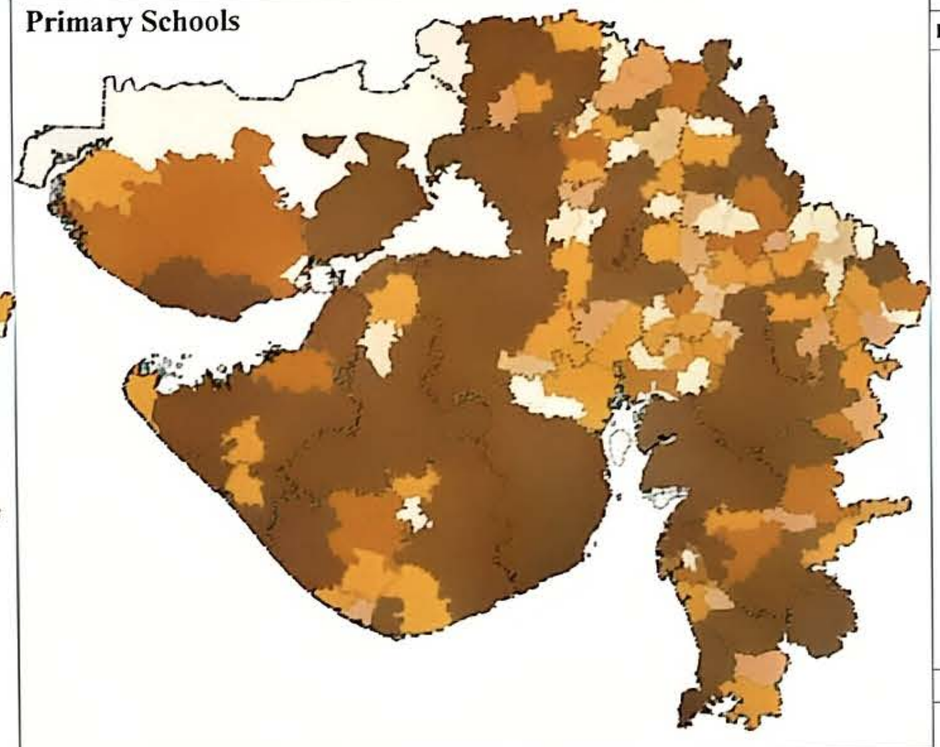
Gujarat Socio Economic Vulnerability Zonation : Infrastructure Access (% of Settlements) (2001)

GSDMA

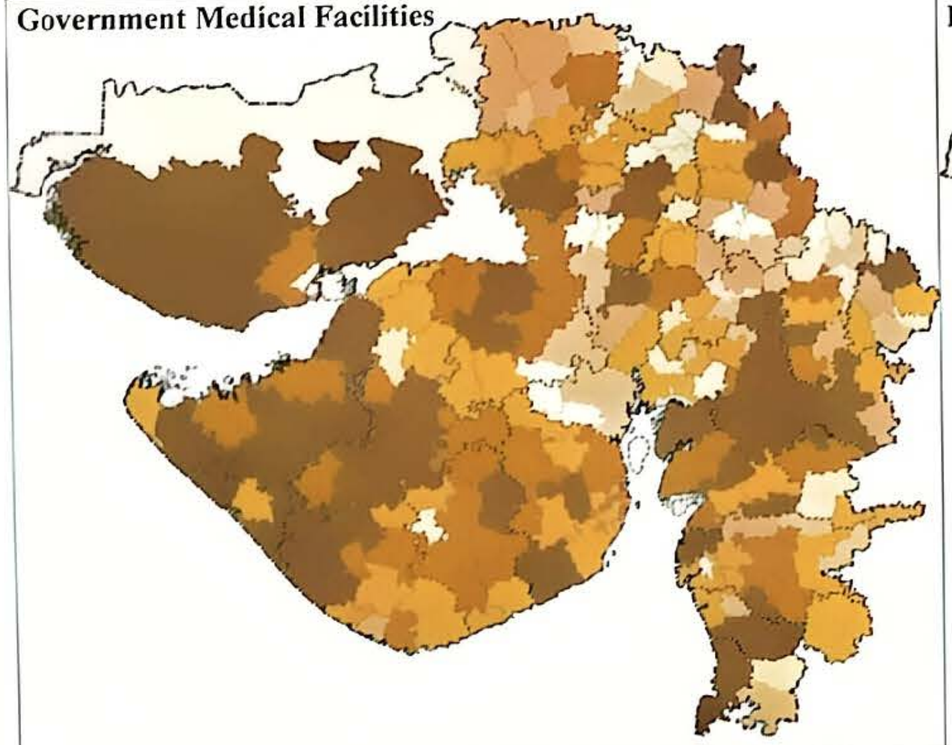
All Weather Roads



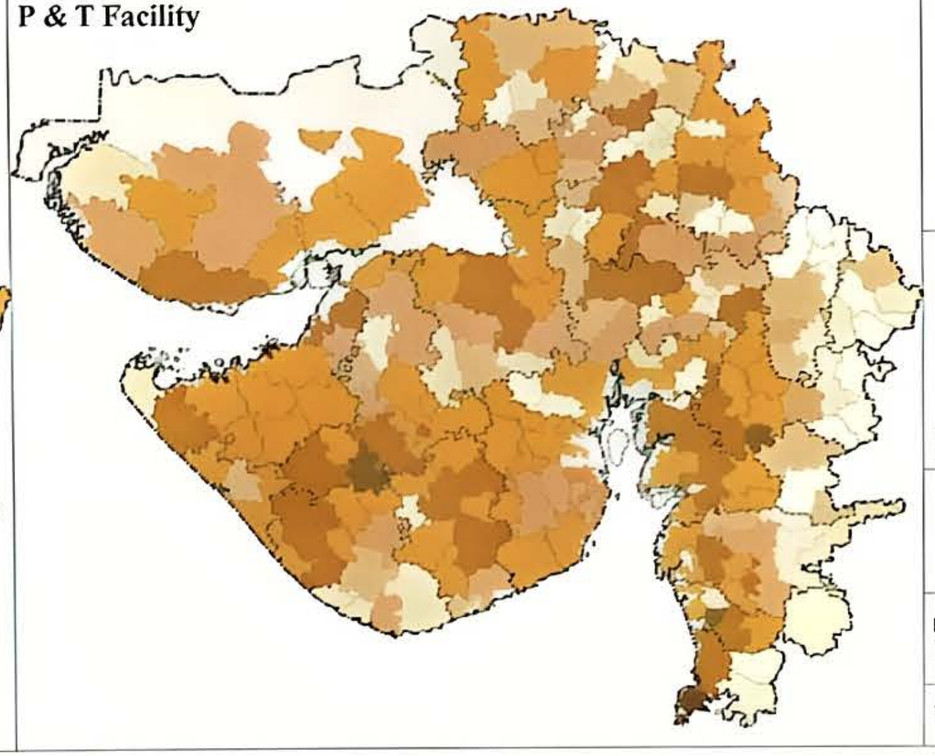
Primary Schools



Government Medical Facilities



P & T Facility



LEGEND

% of all settlements
- < 10
- > 10 to 20
- > 20 to 30
- > 30 to 40
- > 40 to 50
- > 50 to 70
- > 70 to 90
- > 90

Source: TARU Analysis, 2004; Census of India, 2001; BISAG, GoG.

0 100 km

N

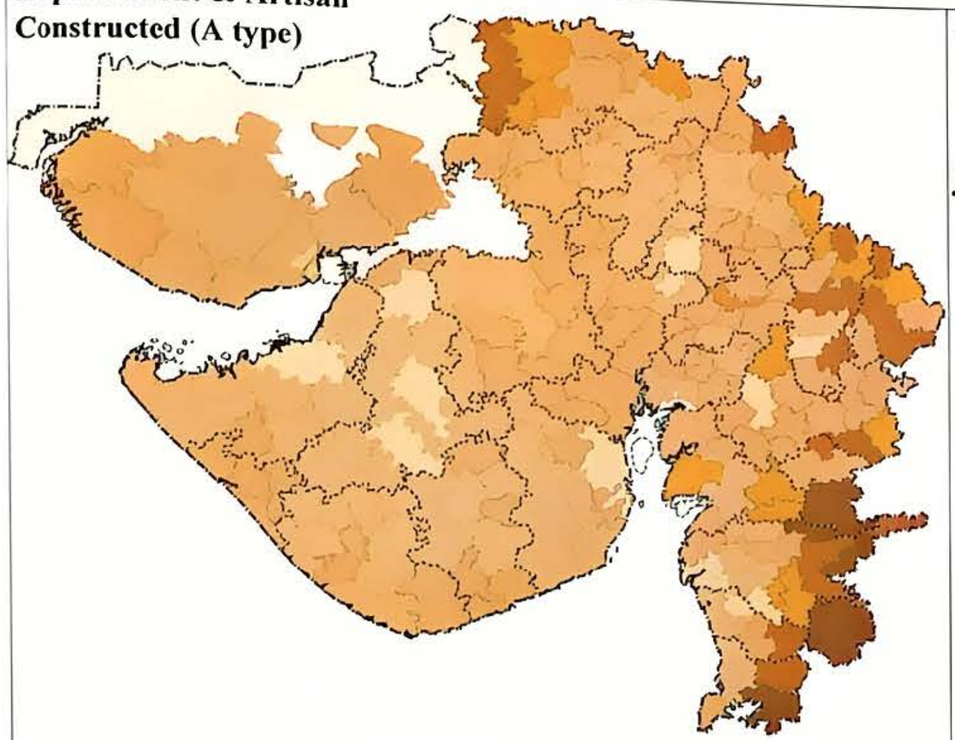
Projection : Lambert Azimuthal Equal Area
Datum : WGS 84

MAP No. : VSEM - 10 OF 11

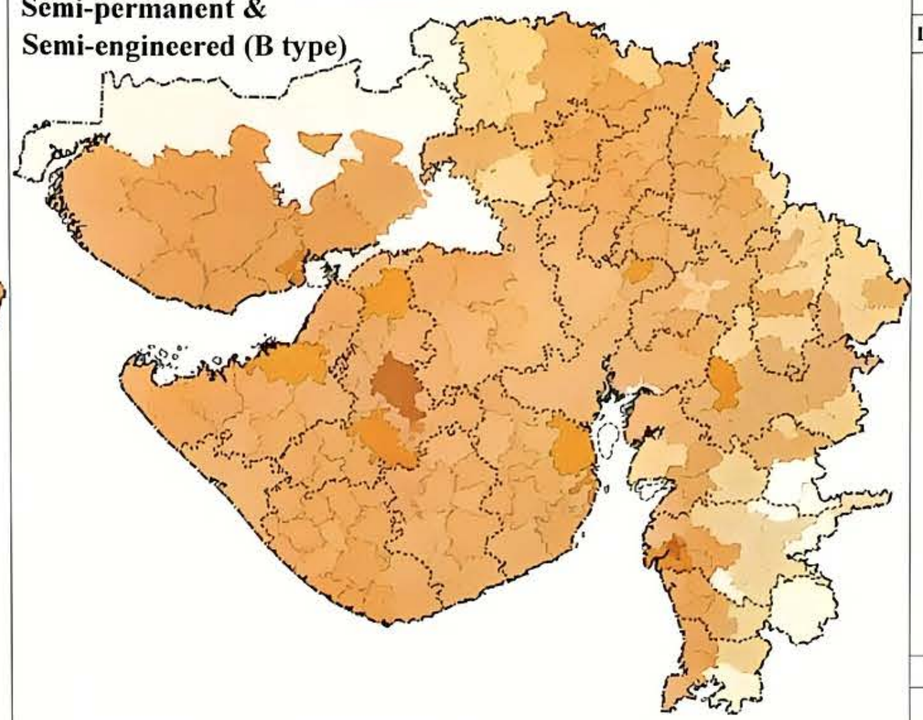
Date . 18/6/2005

Gujarat Socio Economic Vulnerability Zonation : Proportion of Buildings by MSK type (2001)

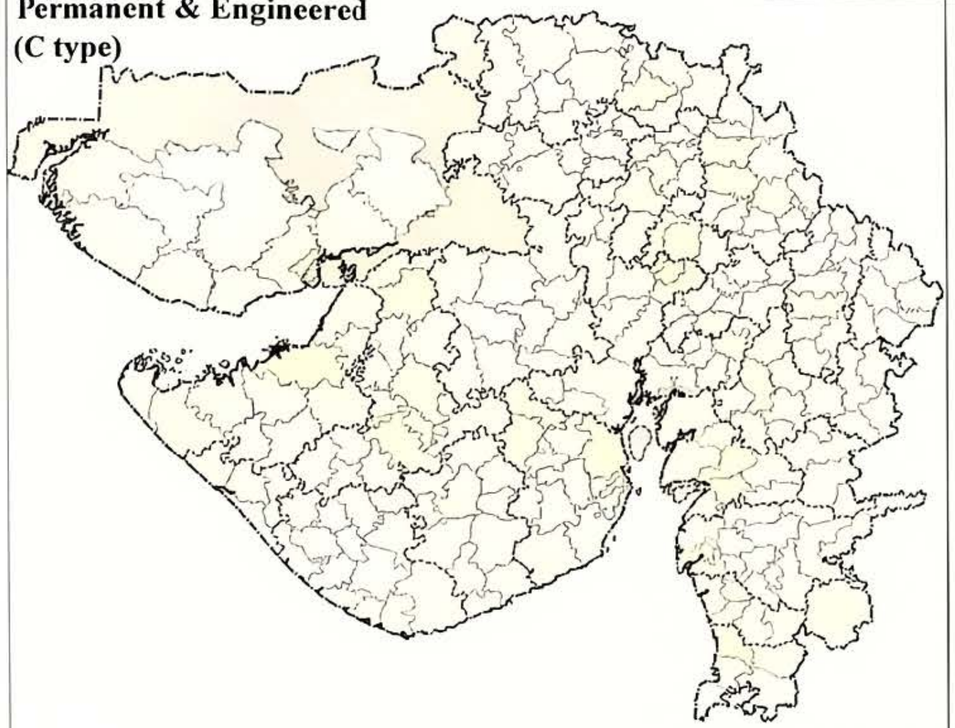
Impermanent & Artisan Constructed (A type)

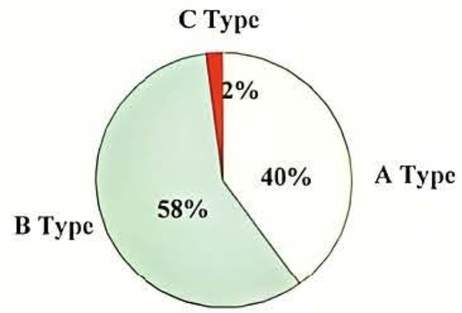


Semi-permanent & Semi-engineered (B type)



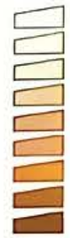
Permanent & Engineered (C type)





GSDMA

LEGEND



% of buildings
- < 2
- > 2 to 5
- > 5 to 10
- > 10 to 30
- > 30 to 50
- > 50 to 70
- > 70 to 80
- > 80 to 90
- >90

Source: TARU Study & Analysis, 1991-2004; Census of India 2001; MSK Scale BIS IS 1893 (Part 1) : 2002; BISAG, GoG.

0 100 km

N

Projection : Lambert Azimuthal Equal Area
Datum : WGS 84

MAP No. : VSEM - 11 OF 11

Date : 18/6/2005

GUJARAT SOCIO ECONOMIC VULNERABILITY ZONATION: RURAL, URBAN, SC & ST POPULATION DISTRIBUTION
(2001) Table No. VSET - 01 of 01

GSDMA

Sr. No	District	Taluka	Rural	Urban	S.C.	S.T.	Rural %	Urban %	S.C. %	S.T. %
1	Ahmadabad	Ahmadabad City	4,551	4,215,497	461,864	39,791	0 1	99.9	10.9	0 9
2	Ahmadabad	Barwala	67,301	-	5,317	89	100 0	-	7.9	0.1
3	Ahmadabad	Bavla	104,226	30,871	14,786	7,725	77.1	22.9	10 9	5 7
4	Ahmadabad	Daskroi	218,670	240,513	29,650	4,469	47.6	52.4	6 5	1 0
5	Ahmadabad	Detroj-Rampura	77,778	-	6,140	84	100.0	-	7.9	0.1
6	Ahmadabad	Dhandhuka	105,090	29,572	12,701	296	78.0	22.0	9 4	0.2
7	Ahmadabad	Dholka	153,267	61,569	30,401	1,907	71.3	28.7	14.2	0.9
8	Ahmadabad	Mandal	65,751	-	8,171	161	100.0	-	12.4	0.2
9	Ahmadabad	Ranpur	76,128	-	5,726	79	100 0	-	7.5	0.1
10	Ahmadabad	Sanand	160,918	32,417	23,683	609	83.2	16.8	12.2	0.3
11	Ahmadabad	Viramgam	119,306	53,094	22,326	2,825	69 2	30.8	13.0	1.6
12	Amreli	Amreli	122,194	95,307	18,208	838	56.2	43.8	8.4	0.4
13	Amreli	Babra	122,983	-	8,615	303	100.0	-	7.0	0.2
14	Amreli	Bagasara	46,518	31,796	8,159	181	59.4	40.6	10.4	0.2
15	Amreli	Dhari	119,338	16,915	13,241	375	87.6	12.4	9.7	0 3
16	Amreli	Jafrabad	65,646	25,086	5,414	248	72.4	27.6	6 0	0.3
17	Amreli	Khambha	84,529	-	6,641	67	100.0	-	7.9	0.1
18	Amreli	Kunkavav Vadia	95,872	-	11,770	91	100.0	-	12.3	0.1
19	Amreli	Lathi	94,454	37,685	10,333	451	71.5	28.5	7.8	0.3
20	Amreli	Lilia	60,722	-	4,970	30	100.0	-	8.2	0.0
21	Amreli	Rajula	113,233	32,395	10,880	233	77.8	22.2	7.5	0.2
22	Amreli	Savar Kundla	155,471	73,774	17,259	439	67.8	32.2	7.5	0.2
23	Anand	Anand	259,150	254,750	20,775	12,733	50.4	49.6	4.0	2.5
24	Anand	Anklav	114,877	19,803	5,355	880	85.3	14.7	4.0	0.7
25	Anand	Borsad	290,523	56,886	15,785	2,315	83.6	16.4	4.5	0.7
26	Anand	Khambhat	167,818	93,194	19,663	1,736	64.3	35.7	7.5	0.7
27	Anand	Petlad	214,308	51,147	17,582	2,583	80.7	19.3	6.6	1.0
28	Anand	Sojitra	96,138	-	5,770	437	100.0	-	6.0	0.5
29	Anand	Tarapur	75,850	-	8,573	451	100.0	-	11.3	0.6
30	Anand	Umreth	130,237	32,191	4,982	1,700	80.2	19.8	3.1	1.0
31	Banas Kantha	Amirgadh	101,133	-	3,223	53,808	100.0	-	3.2	53.2
32	Banas Kantha	Bhabhar	97,582	-	6,917	122	100.0	-	7.1	0.1
33	Banas Kantha	Danta	159,664	13,702	6,033	91,468	92.1	7.9	3.5	52.8
34	Banas Kantha	Dantiwada	87,500	-	9,360	3,963	100.0	-	10.7	4.5
35	Banas Kantha	Deesa	374,921	83,382	44,876	11,589	81.8	18.2	9.8	2.5
36	Banas Kantha	Deodar	146,393	-	14,854	2,926	100.0	-	10.1	2.0
37	Banas Kantha	Dhanera	159,002	22,172	23,387	14,674	87.8	12.2	12.9	8.1
38	Banas Kantha	Kankrej	225,723	-	17,107	528	100 0	-	7 6	0.2
39	Banas Kantha	Palanpur	247,277	133,430	42,724	14,510	65.0	35.0	11.2	3.8
40	Banas Kantha	Tharad	230,296	22,815	35,310	6,028	91.0	9.0	14.0	2.4
41	Banas Kantha	Vadgam	205,992	-	34,232	4,928	100.0	-	16.6	2.4
42	Banas Kantha	Vav	193,260	-	33,461	1,360	100.0	-	17.3	0.7
43	Bharuch	Amod	92,921	-	4,897	27,339	100.0	-	5.3	29.4
44	Bharuch	Anklesvar	136,712	126,149	10,309	69,869	52.0	48.0	3.9	26.6
45	Bharuch	Bharuch	196,113	187,633	21,803	71,781	51.1	48.9	5.7	18.7
46	Bharuch	Hansot	68,782	-	3,868	24,303	100.0	-	5.6	35.3
47	Bharuch	Jambusar	137,781	38,778	10,719	17,838	78.0	22.0	6.1	10.1
48	Bharuch	Jhagadia	172,553	-	4,353	115,458	100.0	-	2.5	66.9
49	Bharuch	Vagra	82,647	-	4,459	21,276	100.0	-	5.4	25.7
50	Bharuch	Valia	130,587	-	1,083	96,179	100.0	-	0.8	73.7
51	Bhavnagar	Bhavnagar	135,267	527,413	35,640	4,028	20.4	79.6	5.4	0.6
52	Bhavnagar	Botad	128,297	100,194	15,848	523	56.1	43.9	6.9	0.2
53	Bhavnagar	Gadhada	148,893	26,754	11,480	275	84.8	15.2	6.5	0.2
54	Bhavnagar	Gariadhar	84,927	30,526	10,353	260	73.6	26 4	9.0	0.2
55	Bhavnagar	Ghogha	74,776	10,848	2,297	135	87.3	12.7	2 7	0.2
56	Bhavnagar	Mahuva	288,039	87,770	14,748	523	76.6	23.4	3.9	0.1
57	Bhavnagar	Palitana	147,394	51,944	13,548	478	73.9	26.1	6 8	0.2
58	Bhavnagar	Sihor	145,779	46,960	16,569	519	75.6	24.4	8.6	0.3
59	Bhavnagar	Talaja	225,407	44,579	9,149	362	83.5	16.5	3.4	0.1
60	Bhavnagar	Umrala	80,945	8,050	7,909	156	91.0	9.0	8.9	0.2
61	Bhavnagar	Vallabhipur	74,868	-	4,587	39	100 0	-	6.1	0 1
62	Dohad	Devgadbaria	188,996	19,202	7,659	48,185	90 8	9.2	3.7	23 1
63	Dohad	Dhanpur	131,974	-	1,385	89,288	100.0	-	1.0	67.7
64	Dohad	Dohad	256,458	112,026	8,197	273,469	69.6	30.4	2.2	74.2
65	Dohad	Fatepura	185,419	-	3,037	170,982	100.0	-	1.6	92.2
66	Dohad	Garbada	142,448	-	2,639	134,378	100.0	-	1.9	94.3
67	Dohad	Jhalod	335,458	25,095	5,623	319,443	93.0	7.0	1.6	88.6
68	Dohad	Limkheda	239,357	-	4,344	146,764	100 0	-	1.8	61.3
69	Gandhinagar	Dehgam	212,171	38,082	12,519	2,130	84.8	15.2	5.0	0.9
70	Gandhinagar	Gandhinagar	284,444	286,863	57,862	13,105	49.8	50.2	10.1	2.3
71	Gandhinagar	Kalol	195,688	114,393	32,463	1,279	63.1	36.9	10.5	0.4
72	Gandhinagar	Mansa	174,892	27,922	13,111	1,167	86.2	13.8	6.5	0.6
73	Jamnagar	Bhanvad	89,827	19,718	7,752	2,750	82.0	18.0	7.1	2 5
74	Jamnagar	Dhrol	51,315	23,628	6,904	247	68.5	31.5	9.2	0.3
75	Jamnagar	Jamjodhpur	94,819	22,661	13,025	1,413	80.7	19.3	11.1	1.2
76	Jamnagar	Jamnagar	177,185	584,190	59,353	3,546	23.3	76.7	7.8	0.5
77	Jamnagar	Jodiya	89,578	-	7,117	151	100.0	-	7.9	0.2
78	Jamnagar	Kalavad	111,316	24,858	15,317	327	81.7	18.3	11.2	0.2
79	Jamnagar	Kalyanpur	150,538	-	8,087	343	100.0	-	5.0	0.2
80	Jamnagar	Khambhalia	145,385	63,354	10,395	346	69.6	30.4	5.0	0.2
81	Jamnagar	Lalpur	101,637	-	10,080	618	100.0	-	9.9	0 6
82	Jamnagar	Okhamandal	46,422	97,847	16,789	718	32.2	67.8	11.6	0.5
83	Junagadh	Bhesan	73,737	-	6,362	549	100.0	-	8.6	0.7
84	Junagadh	Junagadh	128,764	252,108	29,114	3,143	33.8	66.2	7.6	0.8
85	Junagadh	Keshod	112,842	63,257	19,685	1,171	64.1	35.9	11.2	0 7
86	Junagadh	Kodinar	165,571	32,610	32,632	793	83.5	16.5	16.5	0 4
87	Junagadh	Malia	123,735	21,240	11,904	842	85.3	14.7	8.2	0 6
88	Junagadh	Manavadar	84,735	42,781	16,336	475	66.5	33.5	12.8	0.4
89	Junagadh	Mangrol	132,733	56,320	19,740	835	70.2	29.8	10.4	0.4
90	Junagadh	Mendarda	66,068	-	6,995	424	100.0	-	10.6	0.6
91	Junagadh	Patan-Veraval	122,453	158,032	22,835	1,751	43.7	56.3	8.1	0 6
92	Junagadh	Sutrapada	122,406	-	13,673	118	100.0	-	11.2	0 1
93	Junagadh	Talala	127,794	-	10,132	6,715	100.0	-	7 9	5 3
94	Junagadh	Una	279,548	51,261	24,339	1,102	84.5	15.5	7.4	0.3
95	Junagadh	Vanthali	81,467	15,858	12,871	137	83.7	16.3	13.2	0.1
96	Junagadh	Visavadar	114,792	18,061	9,006	777	86.4	13 6	6.8	0.6
97	Kachchh	Abdasa	97,508	-	10,331	5,538	100.0	-	10 6	5 7
98	Kachchh	Anjar	91,949	68,343	14,101	10,023	57.4	42.6	8.8	6.3
99	Kachchh	Bhachau	122,502	25,389	14,993	27,535	82.8	17.2	10.1	18.6
100	Kachchh	Bhuj	208,584	136,429	32,159	14,933	60.5	39.5	9.3	4.3
101	Kachchh	Gandhidham	35,181	166,388	33,678	7,897	17.5	82.5	16 7	3.9
102	Kachchh	Lakhpat	50,120	-	5,273	2,162	100.0	-	10 5	4.3
103	Kachchh	Mandvi	128,218	42,355	21,145	8,970	75.2	24.8	12 4	5.3
104	Kachchh	Mundra	70,079	12,931	13,839	4,449	84.4	15.6	16 7	5.4
105	Kachchh	Nakhatrana	129,249	-	19,519	6,696	100.0	-	15 1	5.2
106	Kachchh	Rapar	174,943	23,057	20,894	41,935	88.4	11.6	10 6	21.2
107	Kheda	Balasinor	96,491	33,705	10,188	2,689	74.1	25 9	7 8	2 1
108	Kheda	Kapadvanj	185,731	43,950	14,290	3,824	80 9	19 1	6 2	1 7
109	Kheda	Kathlal	181,511	-	4,927	852	100 0	-	2 7	0 5
110	Kheda	Kheda	94,284	24,136	12,356	6,413	79.6	20 4	10.4	5 4
111	Kheda	Mahudha	98,924	15,792	3,686	892	86.2	13 8	3 2	0 8
112	Kheda	Matar	147,201	-	8,179	1,657	100 0	-	5 6	1 1
113	Kheda	Mehmedabad	189,114	30,768	8,576	1,885	86.0	14 0	3 9	0 9
114	Kheda	Nadiad	255,734	232,894	20,382	5,579	52 3	47 7	4 2	1 1

GUJARAT SOCIO ECONOMIC VULNERABILITY ZONATION: RURAL, URBAN, SC & ST POPULATION DISTRIBUTION
(2001) Table No. VSET - 01 of 01

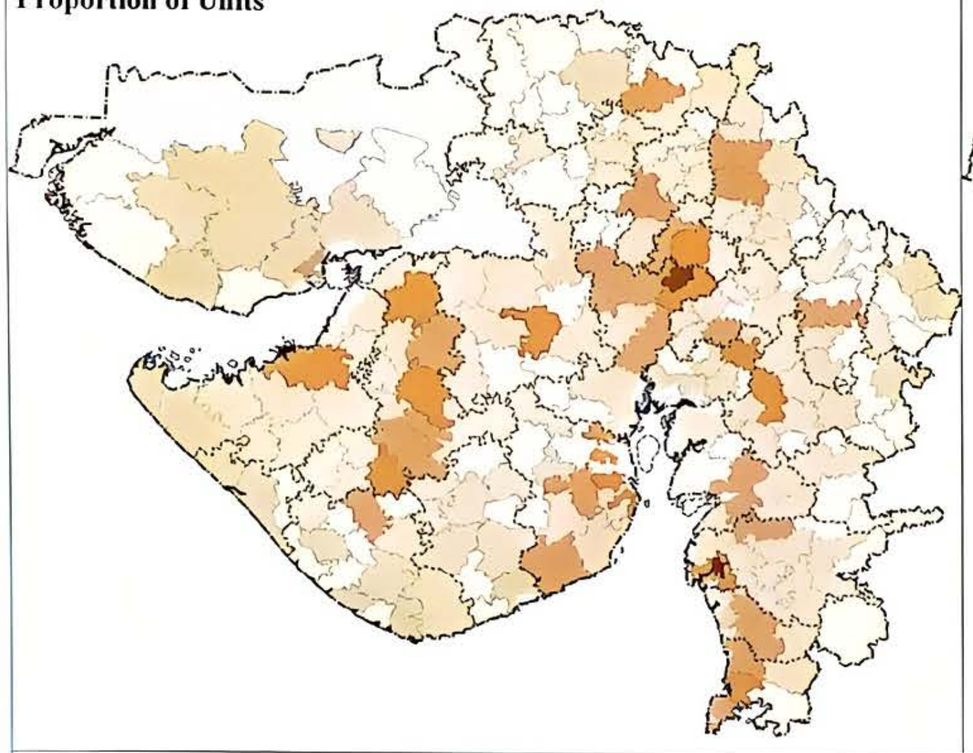
GSDMA

Sr. No	District	Taluka	Rural	Urban	S.C.	S.T.	Rural %	Urban %	S.C. %	S.T. %
115	Kheda	Thasra	281,685	25,205	18,019	7,998	91.8	8.2	5.9	2.6
116	Kheda	Virpur	87,091	-	5,508	605	100.0	-	6.3	0.7
117	Mahesana	Becharaji	92,096	-	8,154	79	100.0	-	8.9	0.1
118	Mahesana	Kadi	236,895	60,026	27,320	1,257	79.8	20.2	9.2	0.4
119	Mahesana	Kheralu	94,589	20,141	10,524	246	82.4	17.6	9.2	0.2
120	Mahesana	Mahesana	313,128	148,192	37,608	3,925	67.9	32.1	8.2	0.9
121	Mahesana	Satlasana	75,940	-	6,862	388	100.0	-	9.0	0.5
122	Mahesana	Unjha	120,427	53,876	13,300	420	69.1	30.9	7.6	0.2
123	Mahesana	Vadnagar	105,587	25,033	9,299	172	80.8	19.2	7.1	0.1
124	Mahesana	Vijapur	207,822	30,961	16,807	1,517	87.0	13.0	7.0	0.6
125	Mahesana	Visnagar	179,691	73,488	18,723	971	71.0	29.0	7.4	0.4
126	Narmada	Dediapada	143,574	-	556	137,553	100.0	-	0.4	95.8
127	Narmada	Nandod	179,032	52,106	6,713	159,443	77.5	22.5	2.9	69.0
128	Narmada	Sagbara	83,633	-	444	74,980	100.0	-	0.5	89.7
129	Narmada	Tilakwada	56,059	-	2,325	29,678	100.0	-	4.1	52.9
130	Navsari	Bansda	201,288	-	1,138	181,785	100.0	-	0.6	90.3
131	Navsari	Chikhli	286,065	6,949	6,298	205,275	97.6	2.4	2.1	70.1
132	Navsari	Gandevi	153,016	87,275	8,849	73,028	63.7	36.3	3.7	30.4
133	Navsari	Jalalpore	140,124	79,879	9,218	41,744	63.7	36.3	4.2	19.0
134	Navsari	Navsari	112,617	162,250	14,071	89,332	41.0	59.0	5.1	32.5
135	Panch Mahals	Ghoghamba	179,659	-	4,353	72,123	100.0	-	2.4	40.1
136	Panch Mahals	Godhra	262,491	131,172	22,991	47,760	66.7	33.3	5.8	12.1
137	Panch Mahals	Halol	150,827	44,473	5,404	54,680	77.2	22.8	2.8	28.0
138	Panch Mahals	Jambughoda	36,319	-	639	11,779	100.0	-	1.8	32.4
139	Panch Mahals	Kadana	110,389	-	4,432	80,810	100.0	-	4.0	73.2
140	Panch Mahals	Kalol	163,414	28,571	12,878	18,772	85.1	14.9	6.7	9.8
141	Panch Mahals	Khanpur	85,047	-	4,941	8,313	100.0	-	5.8	9.8
142	Panch Mahals	Lunawada	196,429	33,369	15,730	12,108	85.5	14.5	6.8	5.3
143	Panch Mahals	Morwa (Hadaf)	152,751	-	3,769	55,445	100.0	-	2.5	36.3
144	Panch Mahals	Santrampur	203,264	15,777	6,498	157,852	92.8	7.2	3.0	72.1
145	Panch Mahals	Shehera	231,325	-	10,857	36,358	100.0	-	4.7	15.7
146	Patan	Chanasma	112,807	15,822	12,362	543	87.7	12.3	9.6	0.4
147	Patan	Harij	66,341	18,472	8,036	974	78.2	21.8	9.5	1.1
148	Patan	Patan	181,872	113,749	32,606	4,037	61.5	38.5	11.0	1.4
149	Patan	Radhanpur	87,986	32,191	9,660	3,191	73.2	26.8	8.0	2.7
150	Patan	Sami	164,705	-	17,234	545	100.0	-	10.5	0.3
151	Patan	Santalpur	109,487	-	7,384	1,344	100.0	-	6.7	1.2
152	Patan	Sidhpur	132,743	58,194	22,363	1,639	69.5	30.5	11.7	0.9
153	Patan	Vagdod	88,340	-	7,234	364	100.0	-	8.2	0.4
154	Porbandar	Kutiyana	65,633	17,110	10,137	113	79.3	20.7	12.3	0.1
155	Porbandar	Porbandar	152,940	197,382	27,863	2,040	43.7	56.3	8.0	0.6
156	Porbandar	Ranavav	56,887	46,883	10,233	4,303	54.8	45.2	9.9	4.1
157	Rajkot	Dhoraji	68,195	80,811	14,110	199	45.8	54.2	9.5	0.1
158	Rajkot	Gondal	168,448	97,506	19,896	807	63.3	36.7	7.5	0.3
159	Rajkot	Jamkandorna	75,729	-	8,616	144	100.0	-	11.4	0.2
160	Rajkot	Jasdan	223,909	39,046	14,132	426	85.2	14.8	5.4	0.2
161	Rajkot	Jetpur	123,455	104,312	17,235	294	54.2	45.8	7.6	0.1
162	Rajkot	Kotda Sangani	79,847	-	9,895	351	100.0	-	12.4	0.4
163	Rajkot	Lodhika	46,276	-	5,829	168	100.0	-	12.6	0.4
164	Rajkot	Maliya	83,471	-	4,652	126	100.0	-	5.6	0.2
165	Rajkot	Morvi	148,940	178,055	27,487	690	45.5	54.5	8.4	0.2
166	Rajkot	Paddhari	63,858	9,234	6,673	473	87.4	12.6	9.1	0.6
167	Rajkot	Rajkot	134,969	1,003,015	78,722	8,136	11.9	88.1	6.9	0.7
168	Rajkot	Tankara	84,517	-	7,348	427	100.0	-	8.7	0.5
169	Rajkot	Upleta	96,583	73,692	19,294	277	56.7	43.3	11.3	0.2
170	Rajkot	Wankaner	145,822	40,191	10,475	645	78.4	21.6	5.6	0.3
171	Sabar Kantha	Bayad	186,328	-	13,508	2,343	100.0	-	7.2	1.3
172	Sabar Kantha	Bhiloda	206,168	-	11,538	114,007	100.0	-	5.6	55.3
173	Sabar Kantha	Dhansura	96,389	-	5,728	1,503	100.0	-	5.9	1.6
174	Sabar Kantha	Himatnagar	200,298	56,464	28,797	4,200	78.0	22.0	11.2	1.6
175	Sabar Kantha	Idar	203,188	32,805	38,321	11,341	86.1	13.9	16.2	4.8
176	Sabar Kantha	Khedbrahma	197,946	25,556	8,333	153,704	88.6	11.4	3.7	68.8
177	Sabar Kantha	Malpur	79,551	6,512	5,509	2,981	92.4	7.6	6.4	3.5
178	Sabar Kantha	Meghraj	131,951	9,902	5,381	51,612	93.0	7.0	3.8	36.4
179	Sabar Kantha	Modasa	137,861	54,135	17,489	5,990	71.8	28.2	9.1	3.1
180	Sabar Kantha	Prantij	124,168	22,282	12,447	852	84.8	15.2	8.5	0.6
181	Sabar Kantha	Talod	120,563	17,473	11,270	876	87.3	12.7	8.2	0.6
182	Sabar Kantha	Vadali	82,225	-	10,091	2,288	100.0	-	12.3	2.8
183	Sabar Kantha	Vijaynagar	90,766	-	4,913	68,545	100.0	-	5.4	75.5
184	Surat	Bardoli	158,843	51,946	11,196	99,213	75.4	24.6	5.3	47.1
185	Surat	Chorasi	199,195	386,538	18,111	54,881	34.0	66.0	3.1	9.4
186	Surat	Kamrej	172,295	-	13,092	64,563	100.0	-	7.6	37.5
187	Surat	Mahuva	142,434	-	2,788	112,655	100.0	-	2.0	79.1
188	Surat	Mandvi	185,911	-	4,888	140,800	100.0	-	2.6	75.7
189	Surat	Mangrol	157,981	13,543	8,901	90,370	92.1	7.9	5.2	52.7
190	Surat	Nizar	105,385	-	1,878	83,843	100.0	-	1.8	79.6
191	Surat	Olpad	172,997	12,847	8,961	47,276	93.1	6.9	4.8	25.4
192	Surat	Palsana	91,294	27,593	6,256	45,131	76.8	23.2	5.3	38.0
193	Surat	Songadh	170,981	33,289	2,732	170,464	83.7	16.3	1.3	83.5
194	Surat	Surat City	-	2,433,835	86,575	86,400	-	100.0	3.6	3.5
195	Surat	Uchchhal	73,042	-	193	71,084	100.0	-	0.3	97.3
196	Surat	Umarpada	68,288	-	171	65,867	100.0	-	0.3	96.5
197	Surat	Valod	87,127	-	953	64,112	100.0	-	1.1	73.6
198	Surat	Vyara	213,584	36,226	2,629	211,611	85.5	14.5	1.1	84.7
199	Surendranagar	Chotila	135,553	36,880	16,669	334	78.6	21.4	9.7	0.2
200	Surendranagar	Chuda	87,947	-	9,004	26	100.0	-	10.2	0.0
201	Surendranagar	Dasada	158,199	10,924	24,521	287	93.5	6.5	14.5	0.2
202	Surendranagar	Dhrangadhra	124,422	70,663	21,344	713	63.8	36.2	10.9	0.4
203	Surendranagar	Halvad	119,980	24,325	9,820	510	83.1	16.9	6.8	0.4
204	Surendranagar	Lakhtar	69,551	-	10,654	349	100.0	-	15.3	0.5
205	Surendranagar	Limbdi	117,908	40,071	23,432	11,018	74.6	25.4	14.8	7.0
206	Surendranagar	Muli	101,568	-	10,666	194	100.0	-	10.5	0.2
207	Surendranagar	Sayla	101,162	-	7,405	163	100.0	-	7.3	0.2
208	Surendranagar	Wadhwan	96,410	219,585	32,696	744	30.5	69.5	10.3	0.2
209	The Dangs	The Dangs	186,729	-	921	175,079	100.0	-	0.5	93.8
210	Vadodara	Chhota Udaipur	179,486	23,211	6,389	175,480	88.5	11.5	3.2	86.6
211	Vadodara	Dabhoi	128,077	54,952	11,755	58,213	70.0	30.0	6.4	31.8
212	Vadodara	Jetpur Pavi	225,894	-	5,463	175,183	100.0	-	2.4	77.6
213	Vadodara	Karjan	136,128	26,358	12,011	41,215	83.8	16.2	7.4	25.4
214	Vadodara	Kavant	170,524	-	4,195	157,738	100.0	-	2.5	92.5
215	Vadodara	Nasvadi	124,828	-	1,672	107,547	100.0	-	1.3	86.2
216	Vadodara	Padra	201,031	39,205	15,651	7,922	83.7	16.3	6.5	3.3
217	Vadodara	Sankheda	175,366	10,490	5,966	83,276	94.4	5.6	3.2	44.8
218	Vadodara	Savli	237,929	-	12,407	17,065	100.0	-	5.2	7.2
219	Vadodara	Sinor	69,094	-	5,185	25,020	100.0	-	7.5	36.2
220	Vadodara	Vadodara	214,944	1,491,045	117,249	80,393	12.6	87.4	6.9	4.7
221	Vadodara	Vaghodia	132,279	961	6,342	38,341	99.3	0.7	4.8	28.8
222	Valsad	Dharampur	160,456	19,930	898	165,662	89.0	11.0	0.5	91.8
223	Valsad	Kaprada	202,862	-	933	189,939	100.0	-	0.5	93.6
224	Valsad	Pardi	232,644	173,258	11,065	158,786	57.3	42.7	2.7	39.1
225	Valsad	Umbergaon	210,822	25,425	11,310	115,392	89.2	10.8	4.8	48.8
226	Valsad	Valsad	222,608	162,548	13,098	142,626	57.8	42.2	3.4	37.0

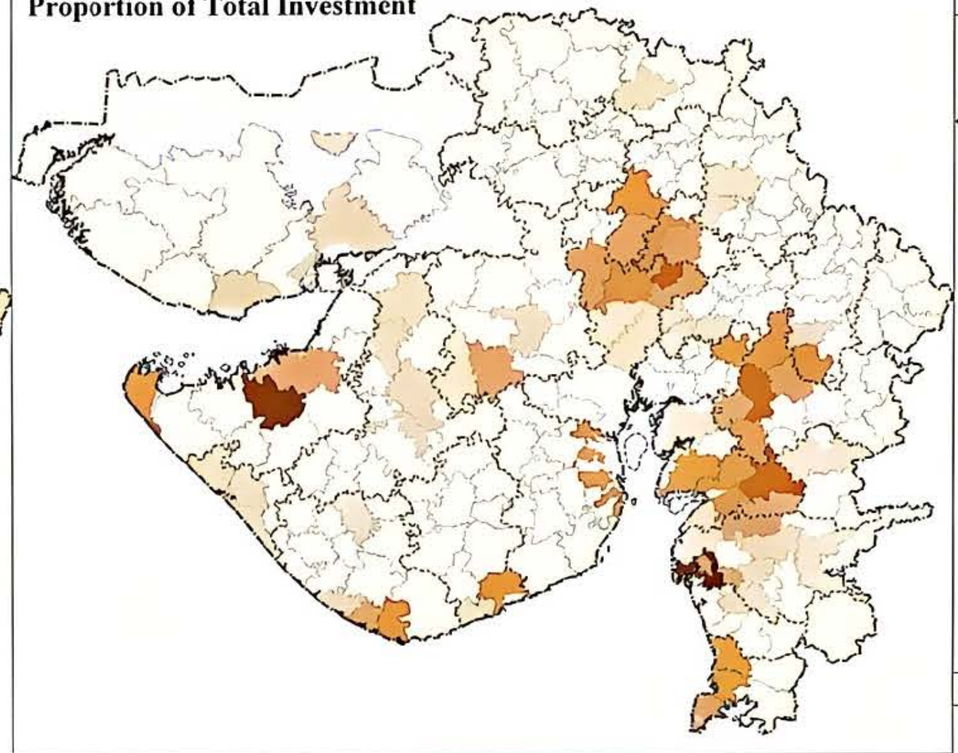
Gujarat Economic Vulnerability Zonation: Manufacturing Sector Profile (1999-2000)

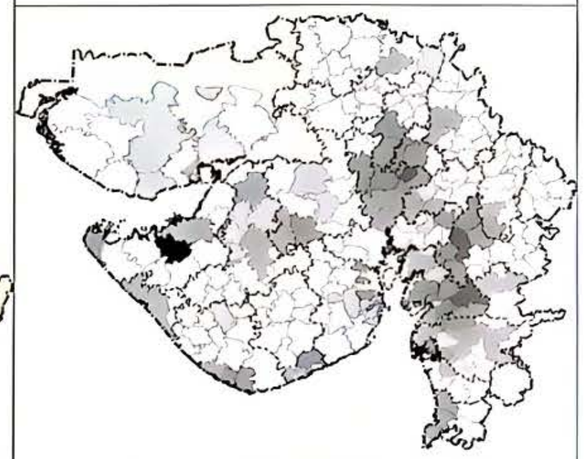
GSDMA

Proportion of Units



Proportion of Total Investment





Total Fixed Capital Investment in Manufacturing Sector (Rs. Million)

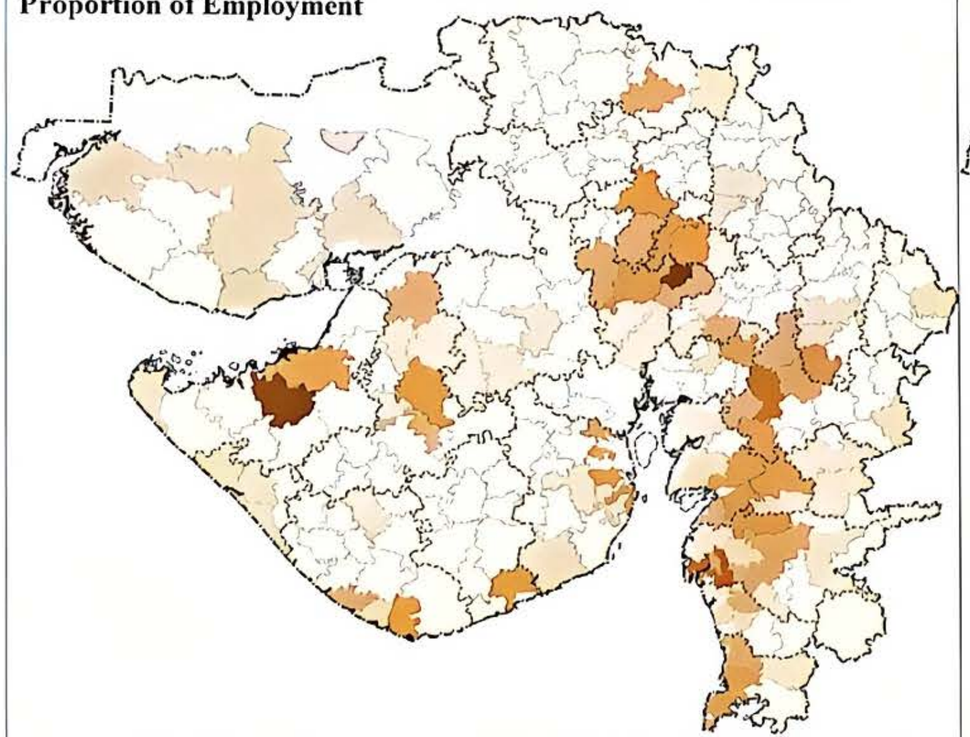
- < 100
- > 100 to 500
- > 500 to 1000
- > 1000 to 5000
- > 5000 to 10000
- > 10000 to 50000
- > 50000 to 100000
- > 100000

LEGEND

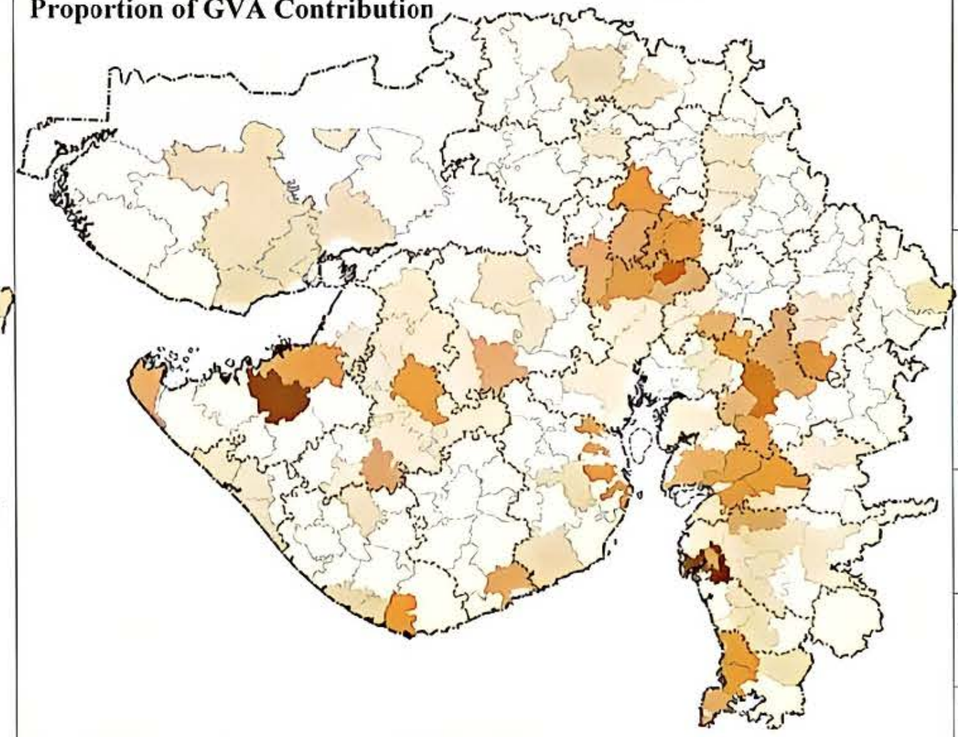
% Proportion to Total

- > 0 to 0.1
- > 0.1 to 0.5
- > 0.5 to 1
- > 1 to 5
- > 5 to 10
- > 10

Proportion of Employment



Proportion of GVA Contribution



Source: TARU Analysis, 2004; Census of Industries, 1999-2000, Department of Industries, GoG;
Annual Survey of Industries, 2000-2001, Central Statistical Organisation, GoI, New Delhi;
NSS 56th Round, 2000-2001 and NSS 57th Round, 2001-2002, National Sample Survey Organisation, GoI; BISAG, GoG.

0 100 km

N

Projection : Lambert Azimuthal Equal Area
Datum : WGS 84

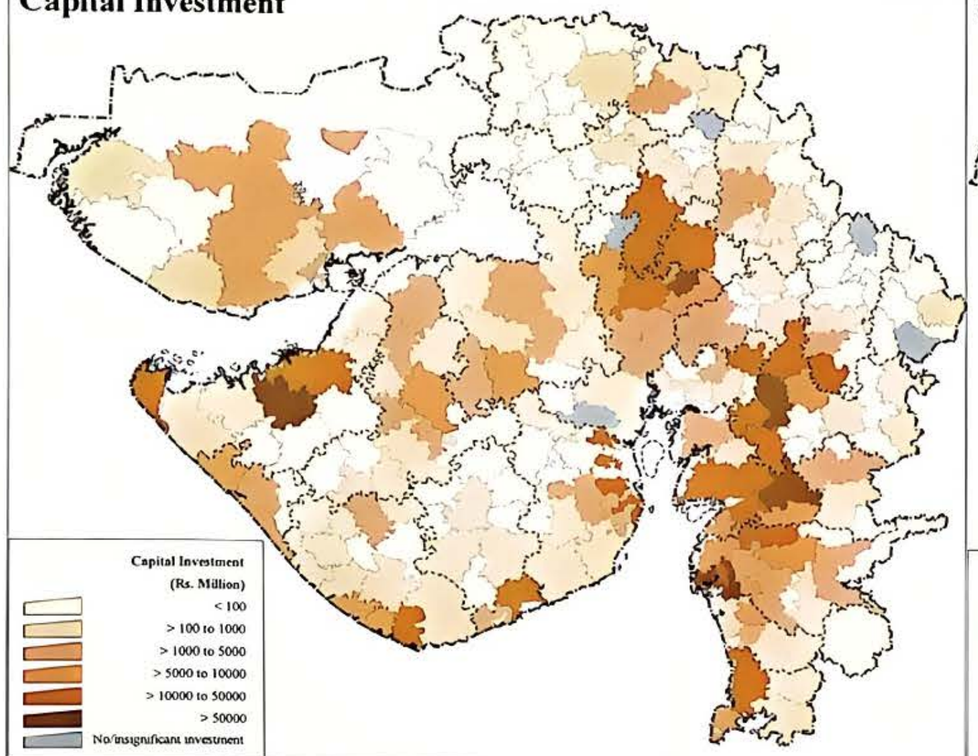
MAP No. : VECM - 01 OF 14

Date : 18/6/2005

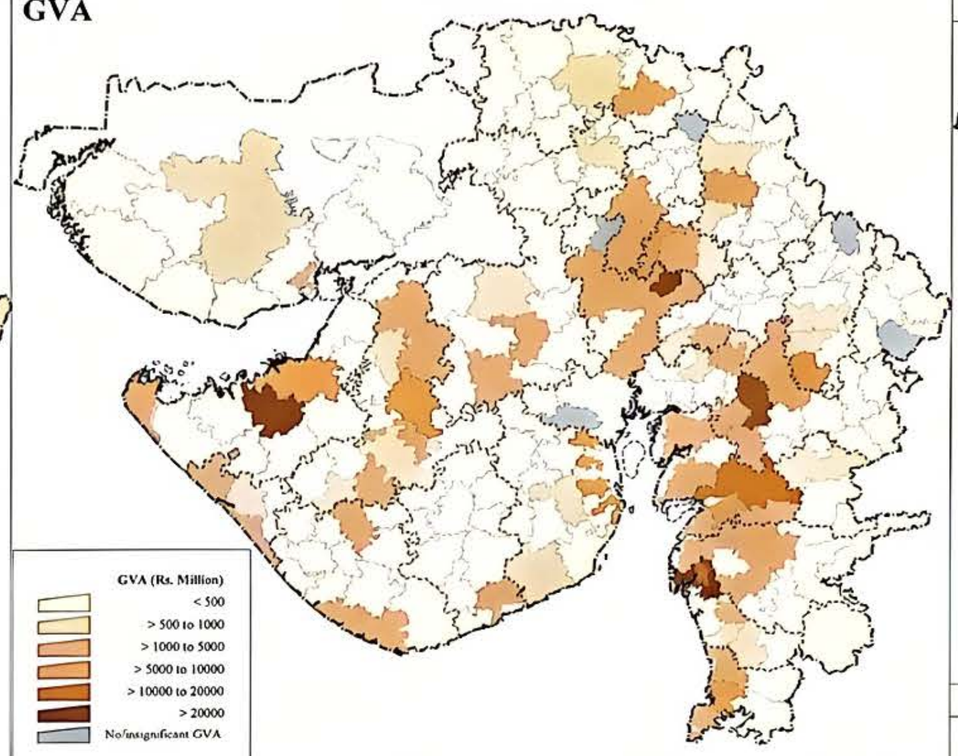
Gujarat Economic Vulnerability Zonation: Capital Investment, GVA & Employment in Manufacturing Sector (1999-2000)

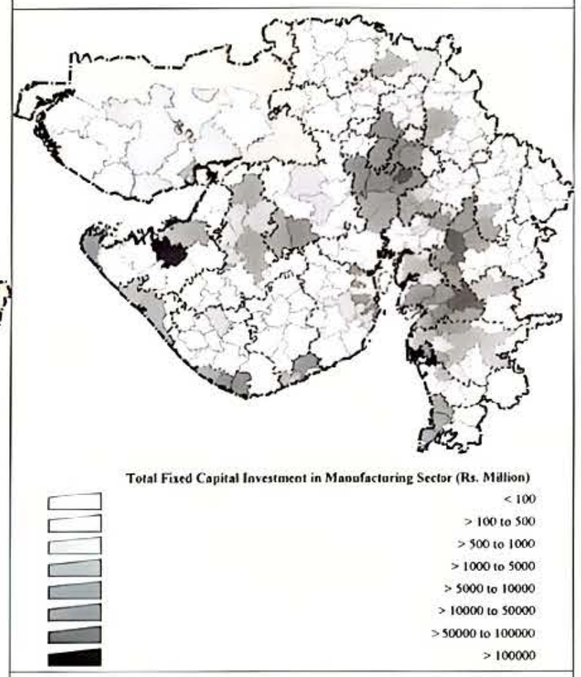
GSDMA

Capital Investment

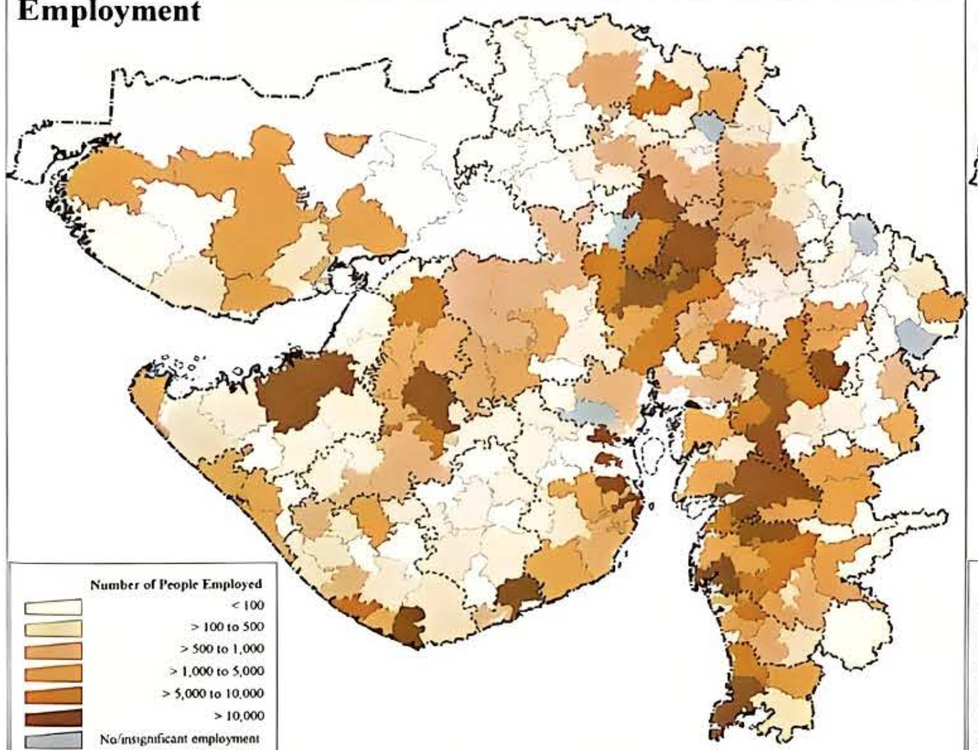


GVA

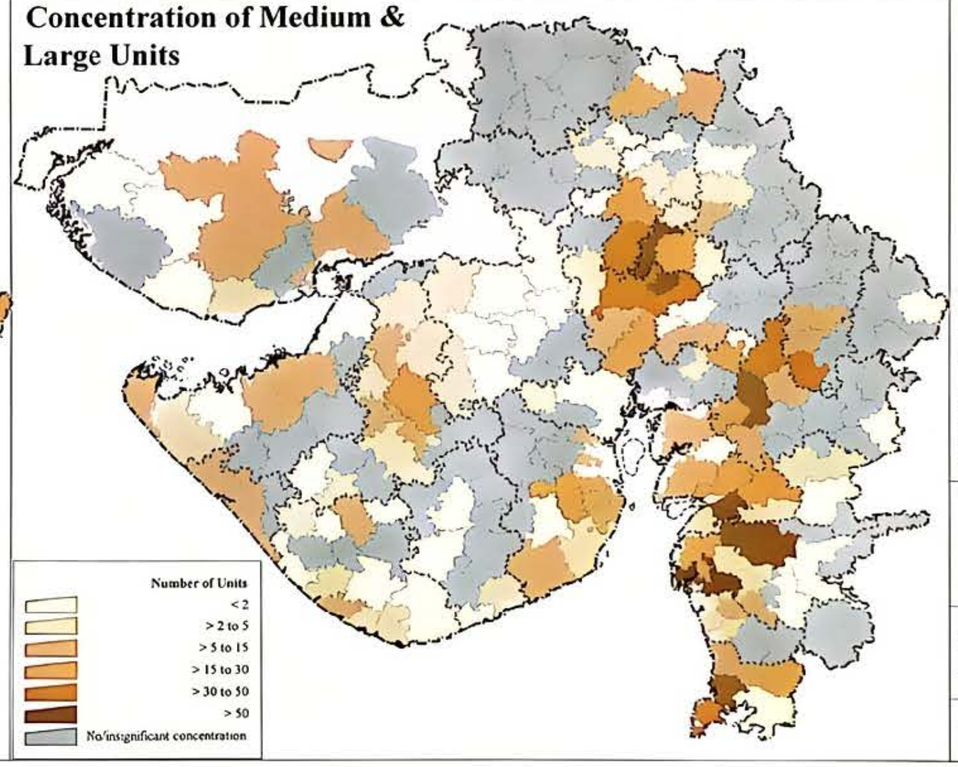




Employment



Concentration of Medium & Large Units



Medium and large industrial units account for 91% of capital investment, 60% of GVA and 74% of employment in manufacturing sector in Gujarat.

Source: TARU Analysis, 2004; Census of Industries, 1999-2000, Department of Industries, GoG; Annual Survey of Industries, 2000-2001, Central Statistical Organisation, GoI, New Delhi; NSS 56th Round, 2000-2001 and NSS 57th Round, 2001-2002, National Sample Survey Organisation, GoI; BISAG, GoG

0 100 km

N

Projection : Lambert Azimuthal Equal Area
Datum : WGS 84

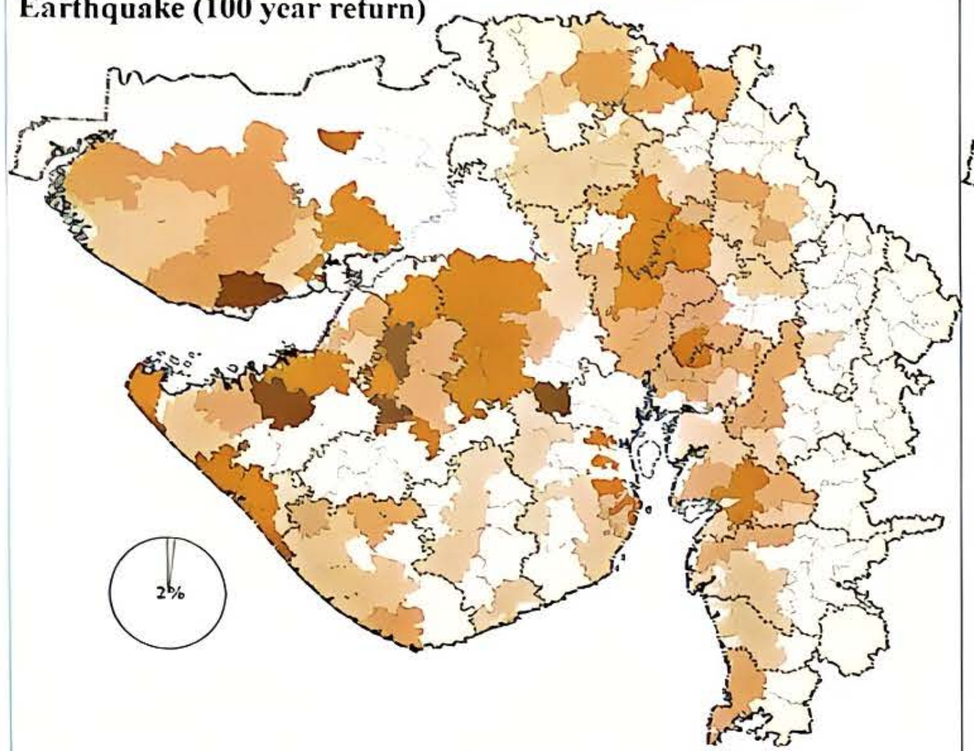
MAP No. : VECM - 02 OF 14

Date : 18/6/2005

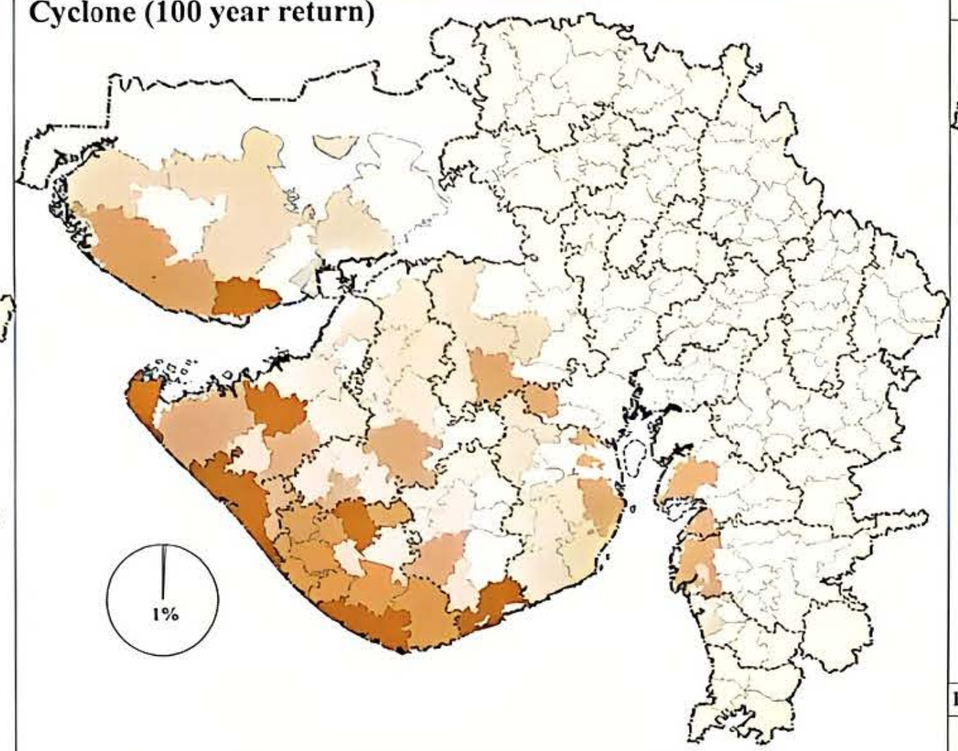
Gujarat Economic Vulnerability Zonation: Manufacturing Sector GVA Vulnerability
(Worst Case Scenario, 1999-2000)

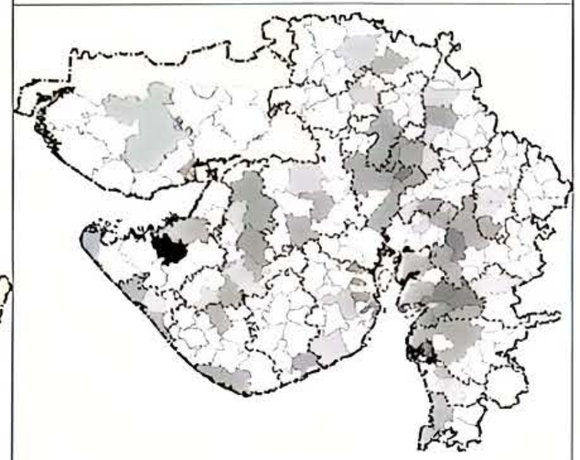
GSDMA

Earthquake (100 year return)



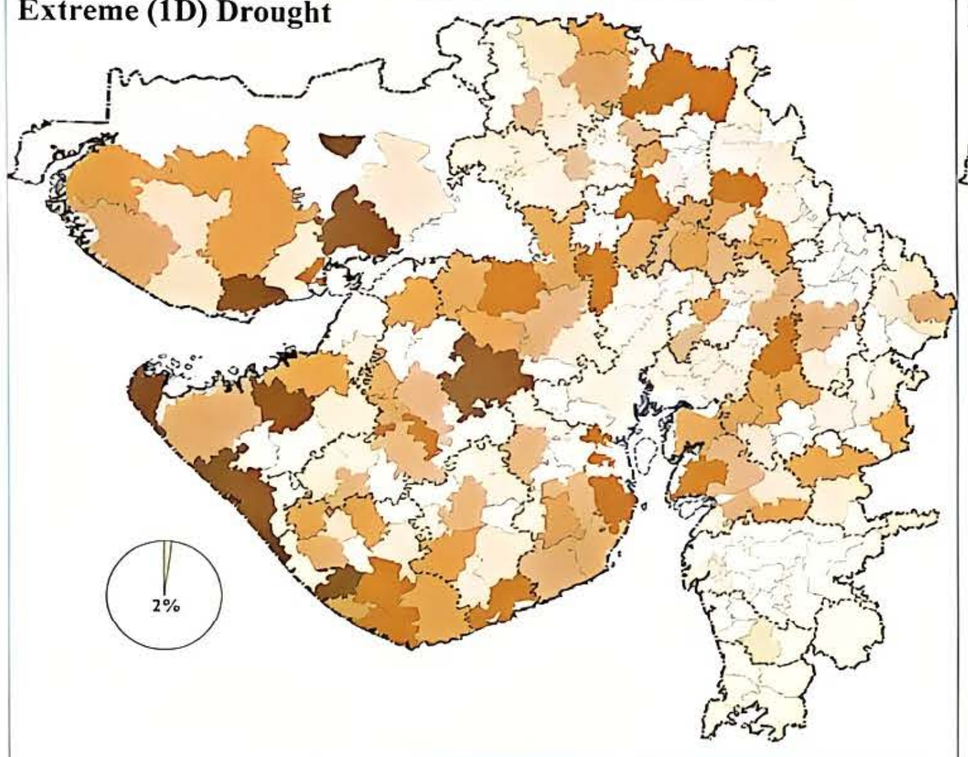
Cyclone (100 year return)



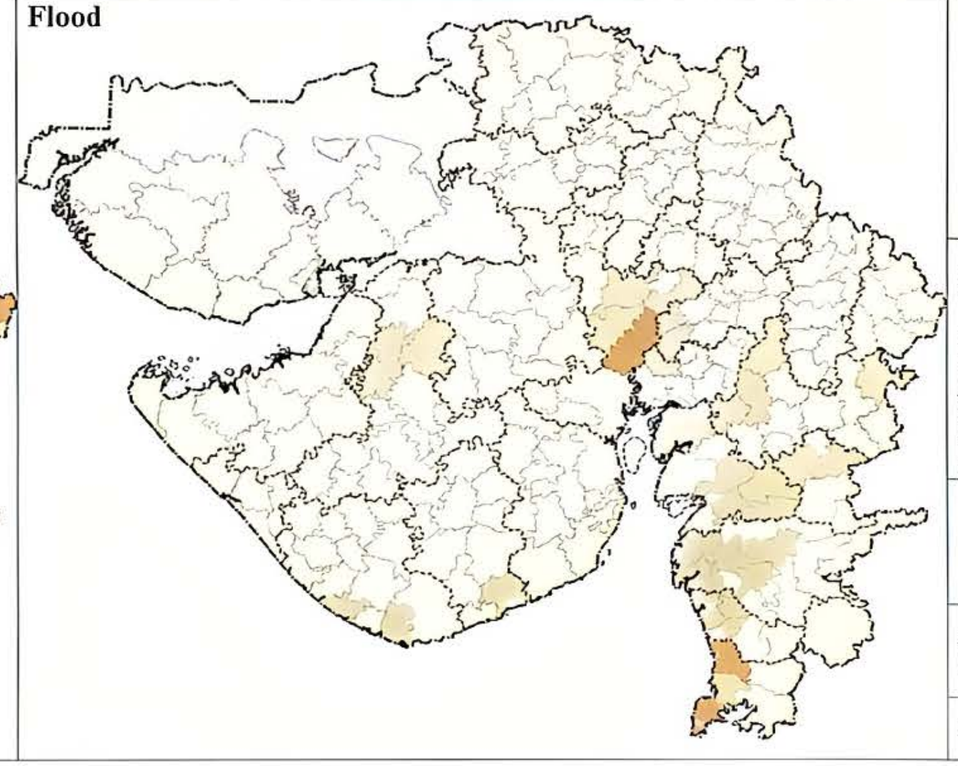


Manufacturing Sector GVA (Rs. Million)
- < 100
- > 100 to 500
- > 500 to 1000
- > 1000 to 5000
- > 5000 to 10000
- > 10000 to 50000
- > 50000

Extreme (1D) Drought



Flood



LEGEND

% GVA Loss
- > 0 to 0.1
- > 0.1 to 0.5
- > 0.5 to 1
- > 1 to 2
- > 2 to 5
- > 5

Main map pie charts show the proportion of GVA vulnerability due to respective event to total GVA in manufacturing sector.

Source: TARU Analysis, 2004; Census of Industries, 1999-2000, Department of Industries, GoG;
Annual Survey of Industries, 2000-2001,
Central Statistical Organisation, GoI, New Delhi;
NSS 56th Round, 2000-2001and NSS 57th Round, 2001-2002,
National Sample Survey Organisation, GoI; BISAG, GoG.

0 100 km

N

Projection : Lambert Azimuthal Equal Area
Datum : WGS 84

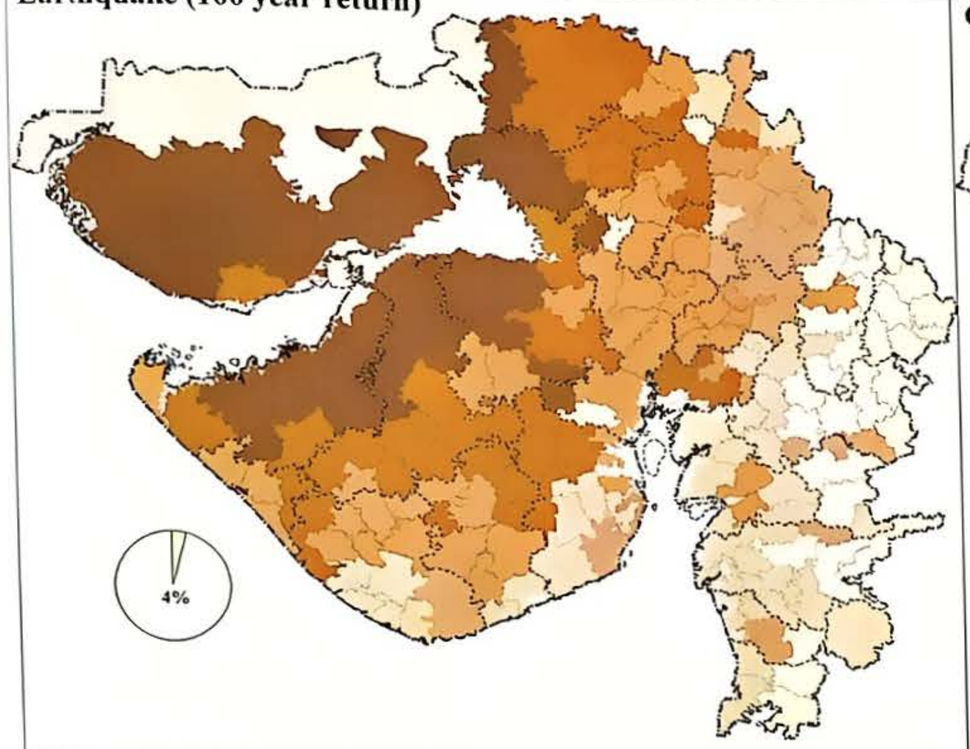
MAP No. : VECM - 03 OF 14

Date : 18/6/2005

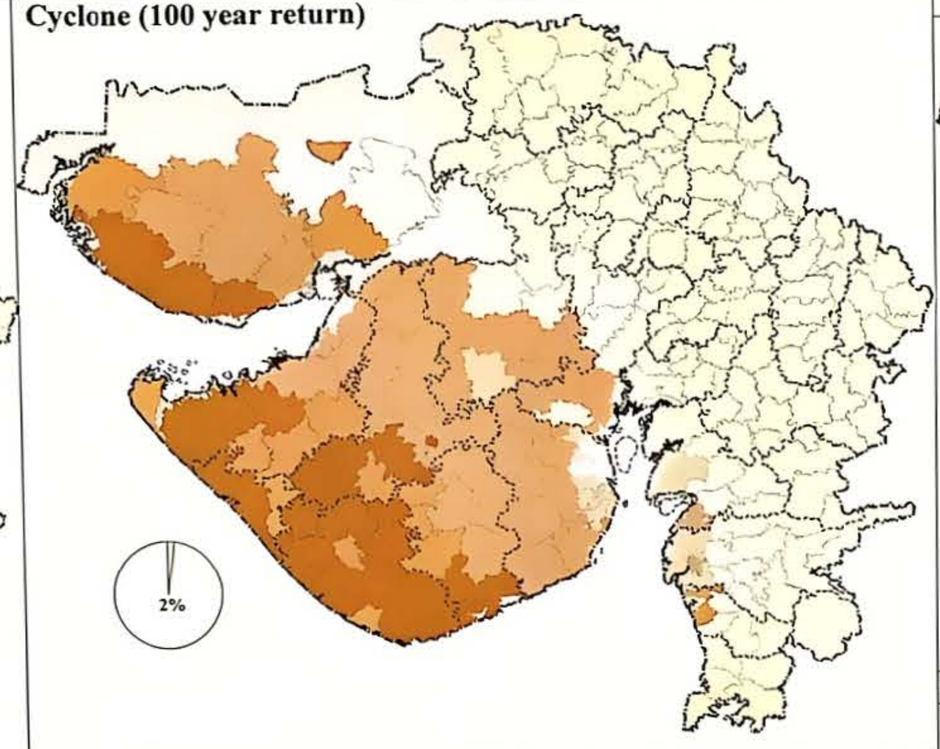
Gujarat Economic Vulnerability Zonation: Manufacturing Sector Capital Stock Vulnerability
(Worst Case Scenario, 1999-2000)

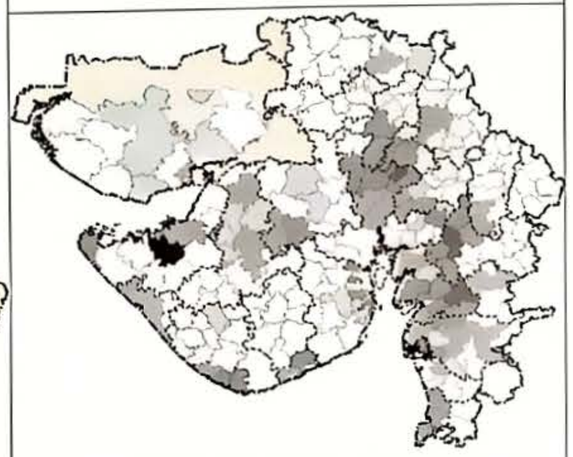
GSDMA

Earthquake (100 year return)



Cyclone (100 year return)





Total Fixed Capital Investment in Manufacturing Sector (Rs. Million)

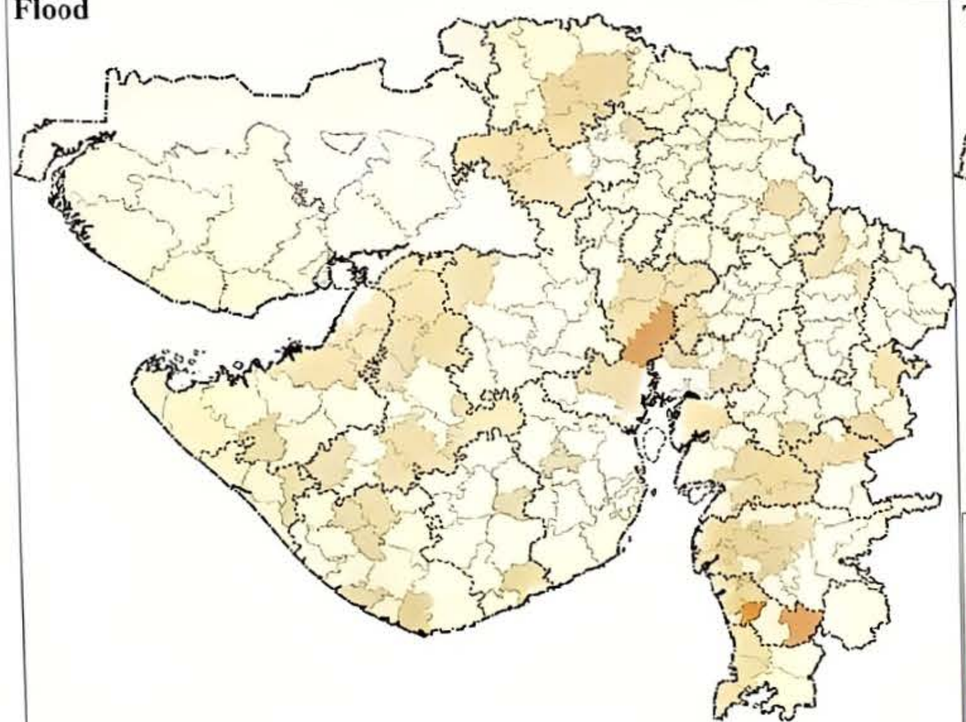
- < 100
- > 100 to 500
- > 500 to 1000
- > 1000 to 5000
- > 5000 to 10000
- > 10000 to 50000
- > 50000 to 100000
- > 100000

LEGEND

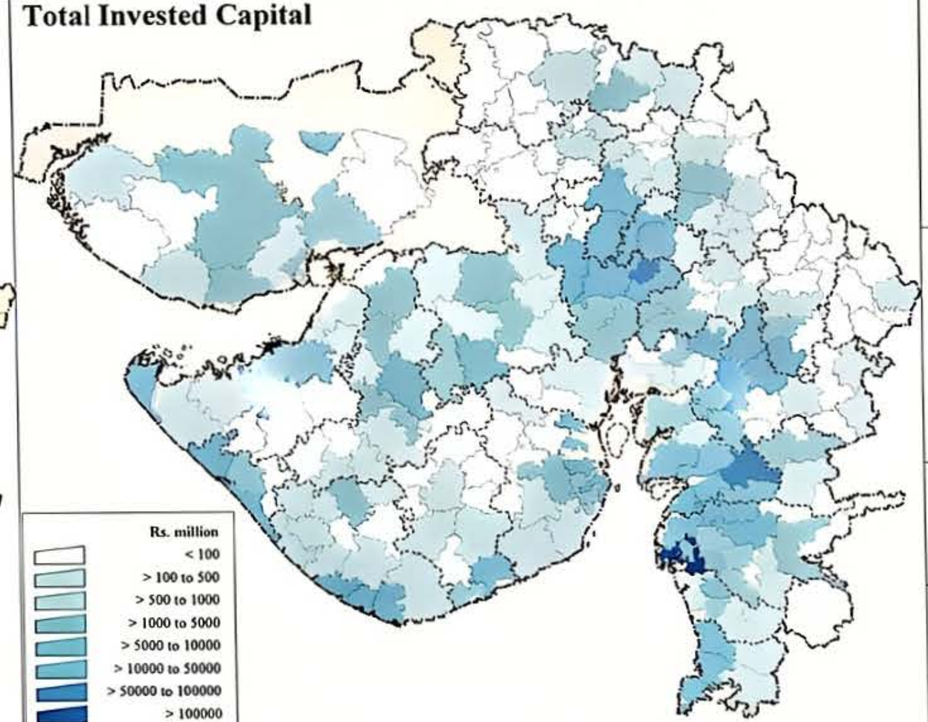
% Capital Stock Loss

- > 0 to 0.1
- > 0.1 to 0.5
- > 0.5 to 1
- > 1 to 5
- > 5 to 10
- > 10

Flood



Total Invested Capital



Rs. million

- < 100
- > 100 to 500
- > 500 to 1000
- > 1000 to 5000
- > 5000 to 10000
- > 10000 to 50000
- > 50000 to 100000
- > 100000

Main map pie charts show the proportion of capital stock vulnerability due to respective event to total capital stock in manufacturing sector.

Source: TARU Analysis, 2004; Census of Industries, 1999-2000, Department of Industries, GoG;
Annual Survey of Industries, 2000-2001, Central Statistical Organisation, GoI, New Delhi;
NSS 56th Round, 2000-2001 and NSS 57th Round, 2001-2002, National Sample Survey Organisation, GoI; BISAG, GoG.

0 100 km

N

Projection : Lambert Azimuthal Equal Area
Datum : WGS 84

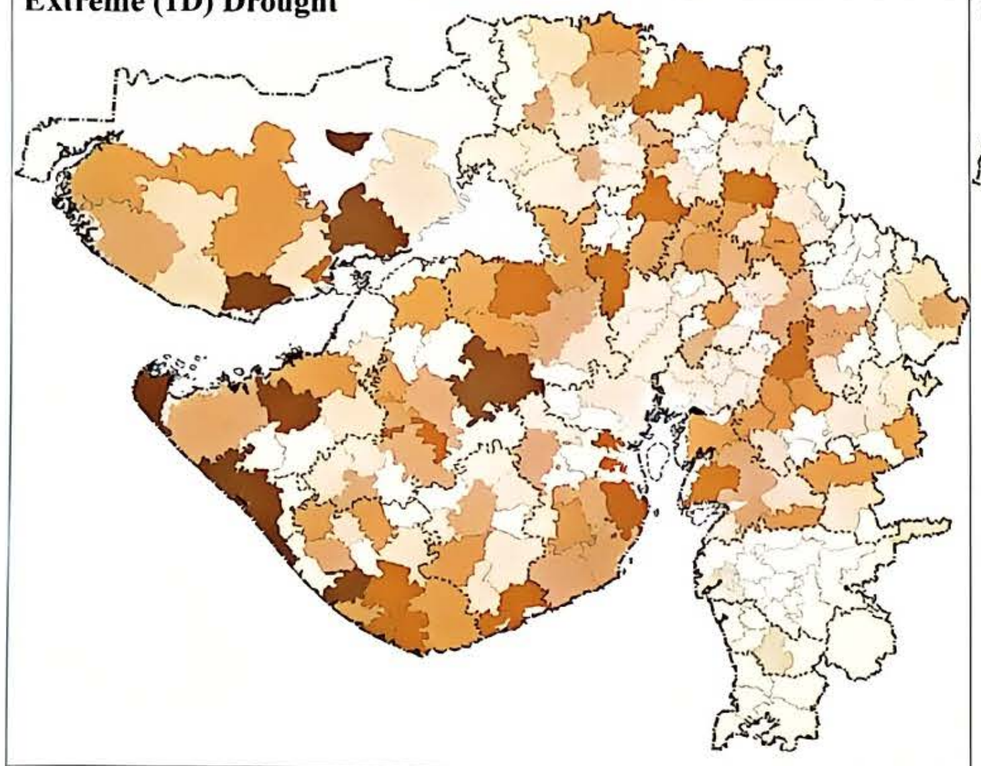
MAP No. : VECM - 04 OF 14

Date : 6/8/2005

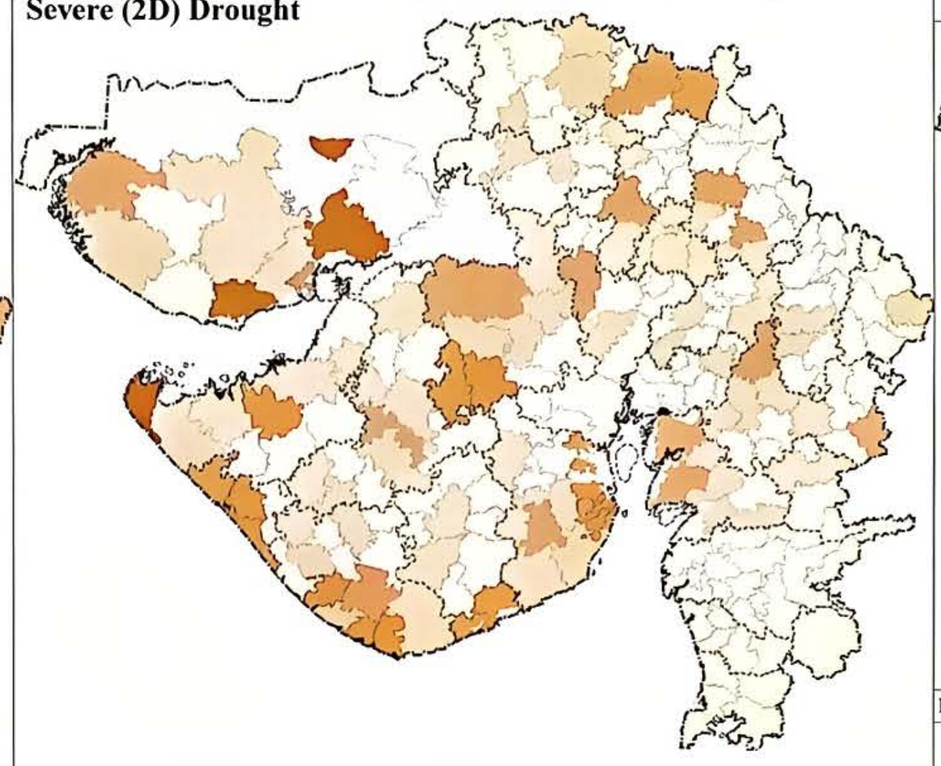
Gujarat Economic Vulnerability Zonation: Manufacturing Sector GVA Vulnerability due to Drought (1999-2000)

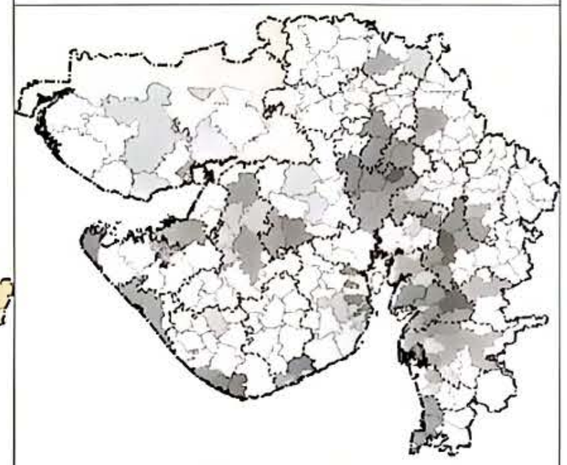
GSDMA

Extreme (1D) Drought



Severe (2D) Drought



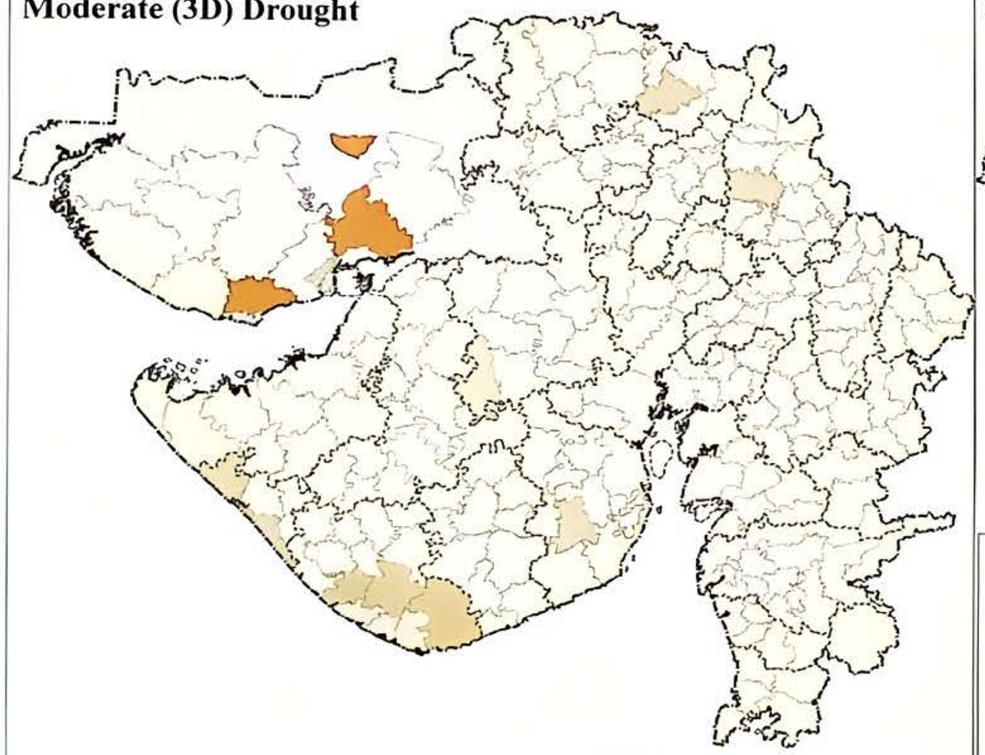


Total Fixed Capital Investment in Manufacturing Sector (Rs. Million)

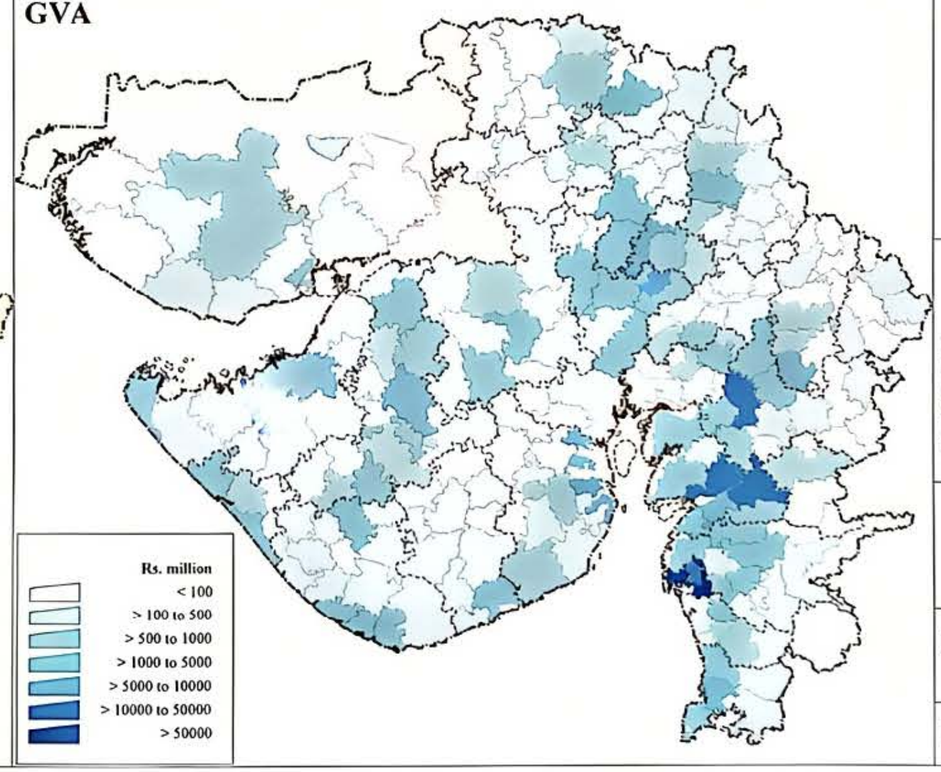
- < 100
- > 100 to 500
- > 500 to 1000
- > 1000 to 5000
- > 5000 to 10000
- > 10000 to 50000
- > 50000 to 100000
- > 100000

LEGEND

Moderate (3D) Drought



GVA



Rs. million

- < 100
- > 100 to 500
- > 500 to 1000
- > 1000 to 5000
- > 5000 to 10000
- > 10000 to 50000
- > 50000

% GVA Loss

- > 0 to 0.1
- > 0.1 to 0.5
- 0.5 to 1
- > 1 to 2
- > 2 to 5
- > 5

Source: TARU Analysis, 2004; Census of Industries. 1999-2000, Department of Industries, GoG;
Annual Survey of Industries, 2000-2001,
Central Statistical Organisation, GoI, New Delhi;
NSS 56th Round, 2000-2001 and NSS 57th Round, 2001-2002,
National Sample Survey Organisation, GoI; BISAG, GoG.

0 100 km

N

Projection : Lambert Azimuthal Equal Area
Datum : WGS 84

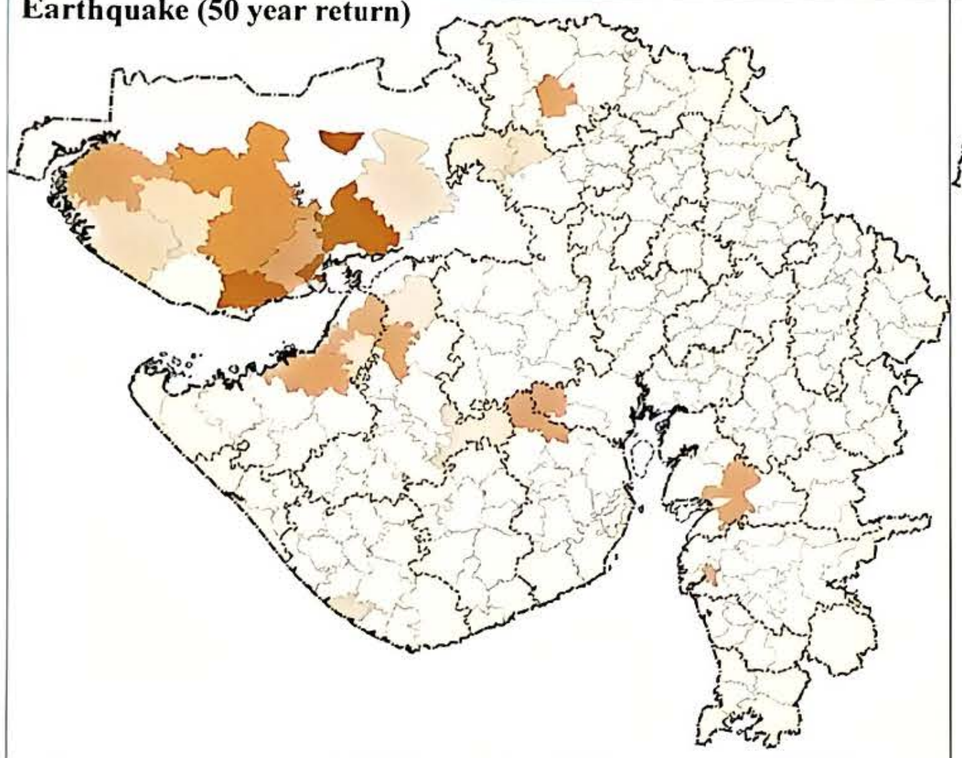
MAP No. : VECM - 05 OF 14

Date : 18/6/2005

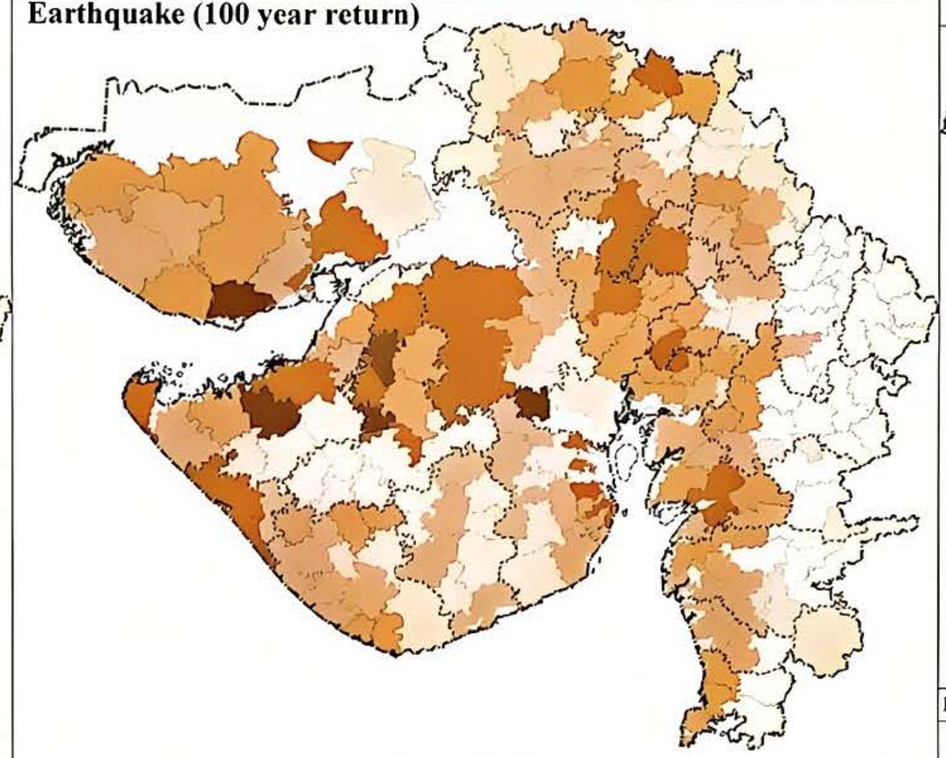
Gujarat Economic Vulnerability Zonation: Manufacturing Sector GVA Vulnerability due to Earthquake & Cyclone (1999-2000)

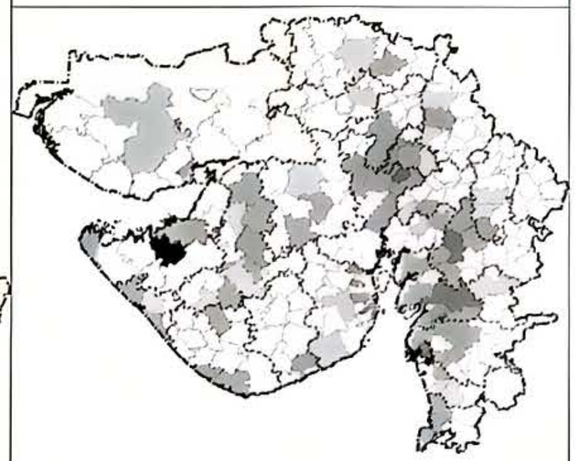
GSDMA

Earthquake (50 year return)



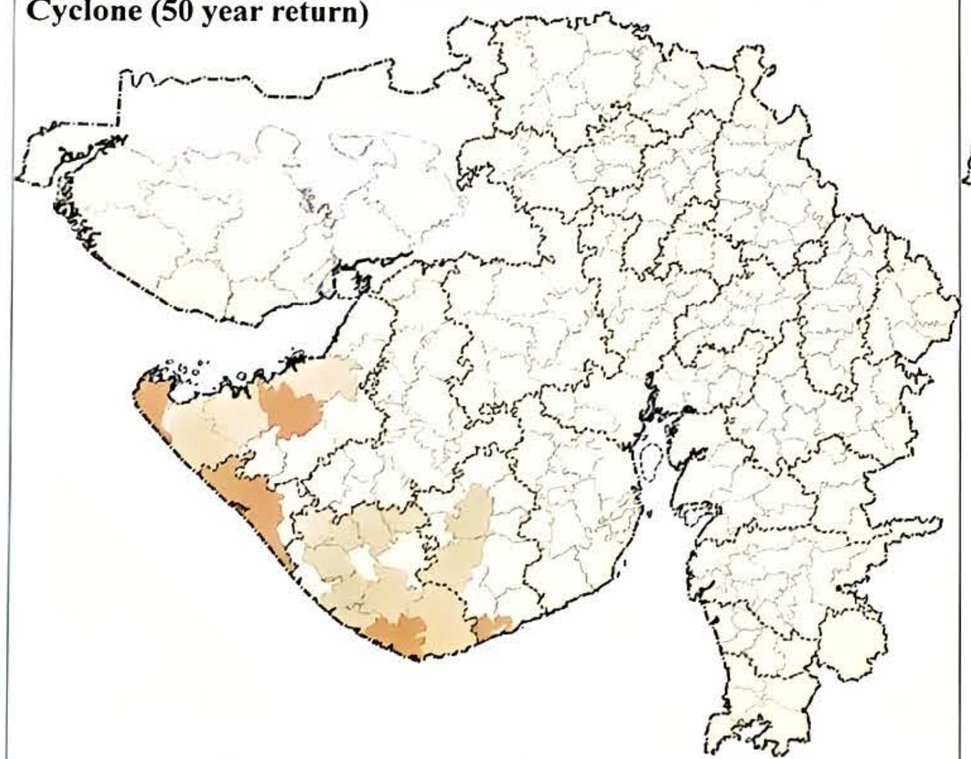
Earthquake (100 year return)



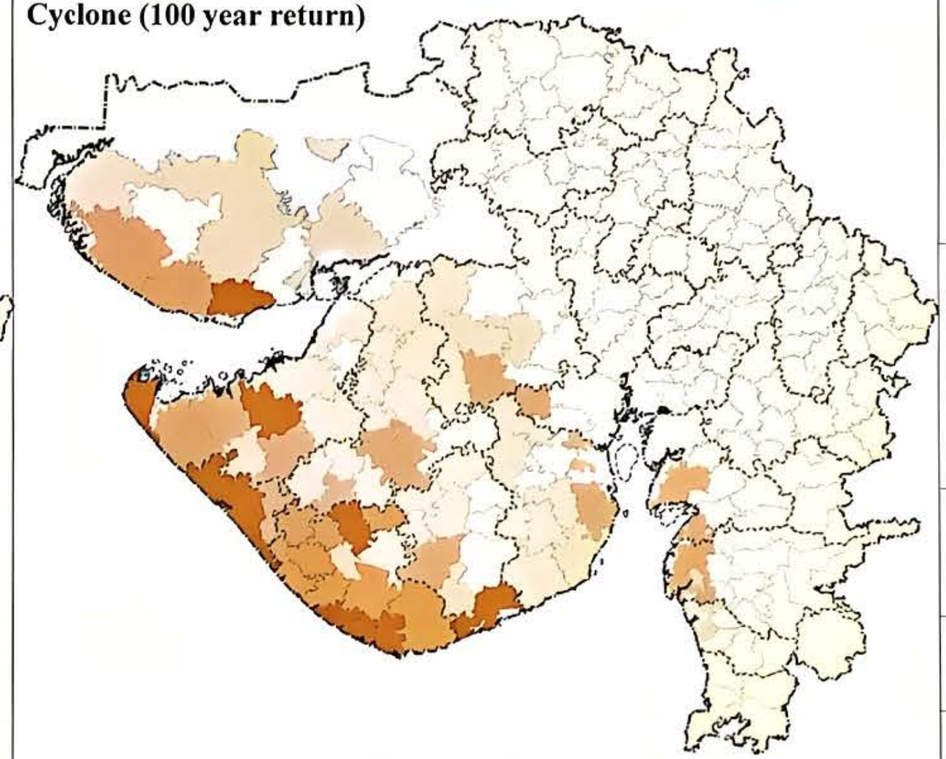


Manufacturing Sector GVA (Rs. Million)
- < 100
- > 100 to 500
- > 500 to 1000
- > 1000 to 5000
- > 5000 to 10000
- > 10000 to 50000
- > 50000

Cyclone (50 year return)



Cyclone (100 year return)



LEGEND

% GVA Loss
- > 0 to 0.1
- > 0.1 to 0.5
- > 0.5 to 1
- > 1 to 2
- > 2 to 5
- > 5

Source: TARU Analysis, 2004; Census of Industries, 1999-2000, Department of Industries, GoG;
Annual Survey of Industries, 2000-2001, Central Statistical Organisation, GoI, New Delhi;
NSS 56th Round, 2000-2001 and NSS 57th Round, 2001-2002, National Sample Survey Organisation, GoI; BISAG, GoG.

0 100 km

N

Projection : Lambert Azimuthal Equal Area
Datum : WGS 84

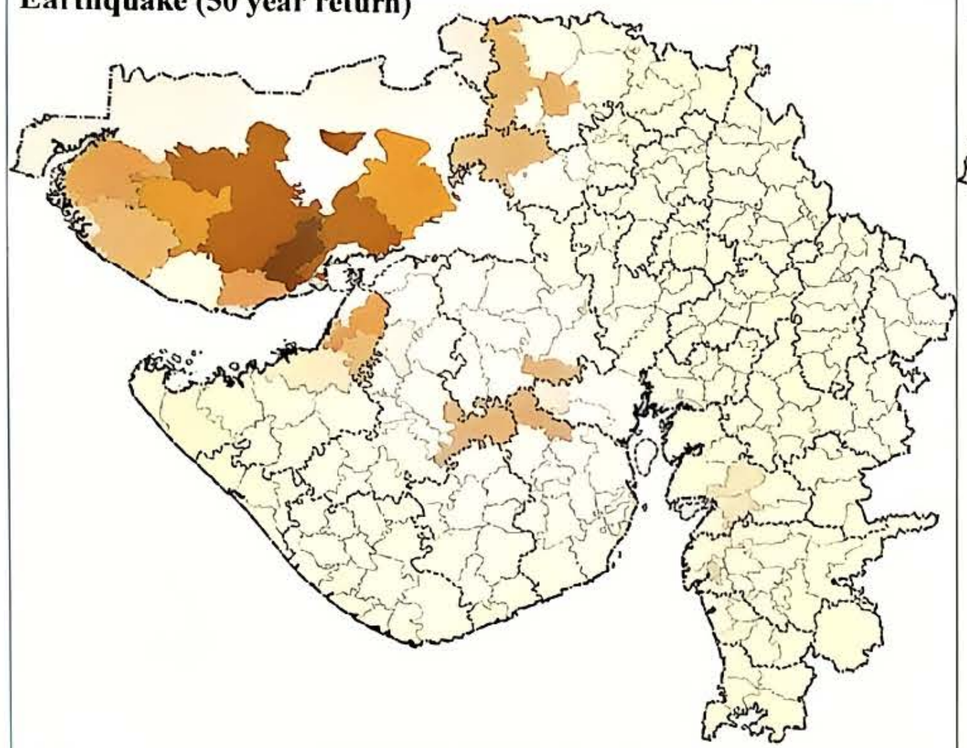
MAP No. : VECM - 06 OF 14

Date : 17/8/2005

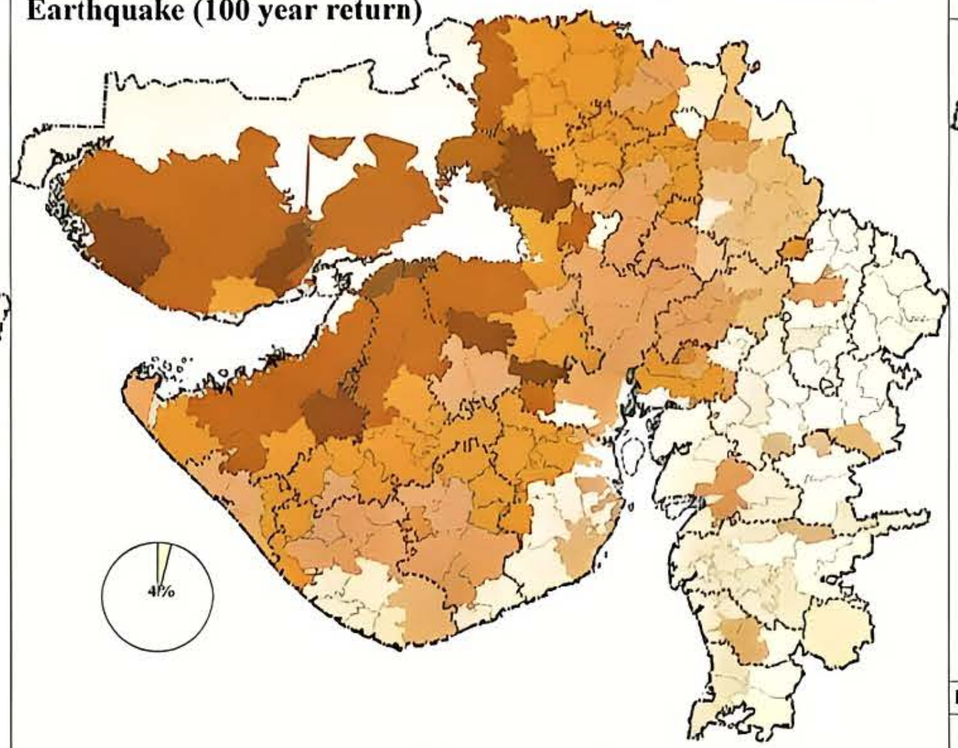
Gujarat Economic Vulnerability Zonation: Manufacturing Sector Capital Stock Vulnerability due to Earthquake & Cyclone (1999-2000)

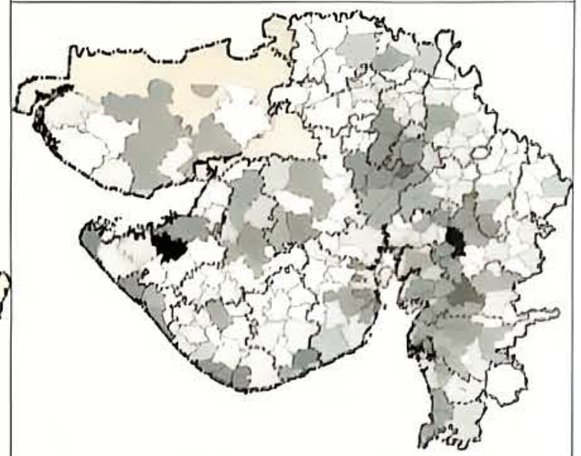
GSDMA

Earthquake (50 year return)



Earthquake (100 year return)

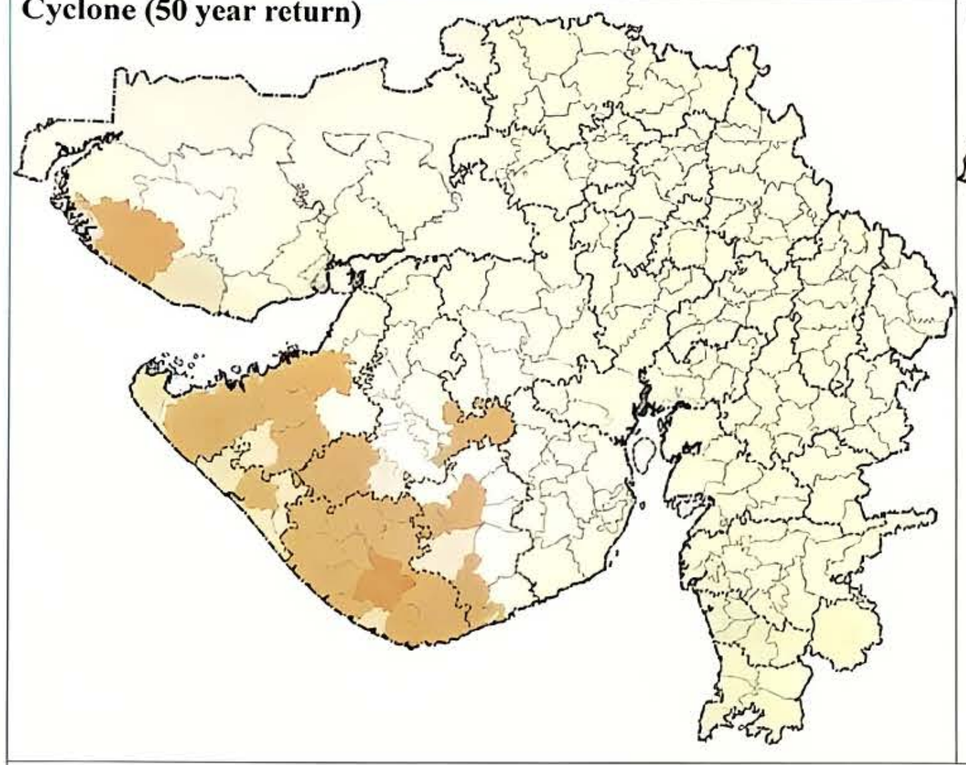




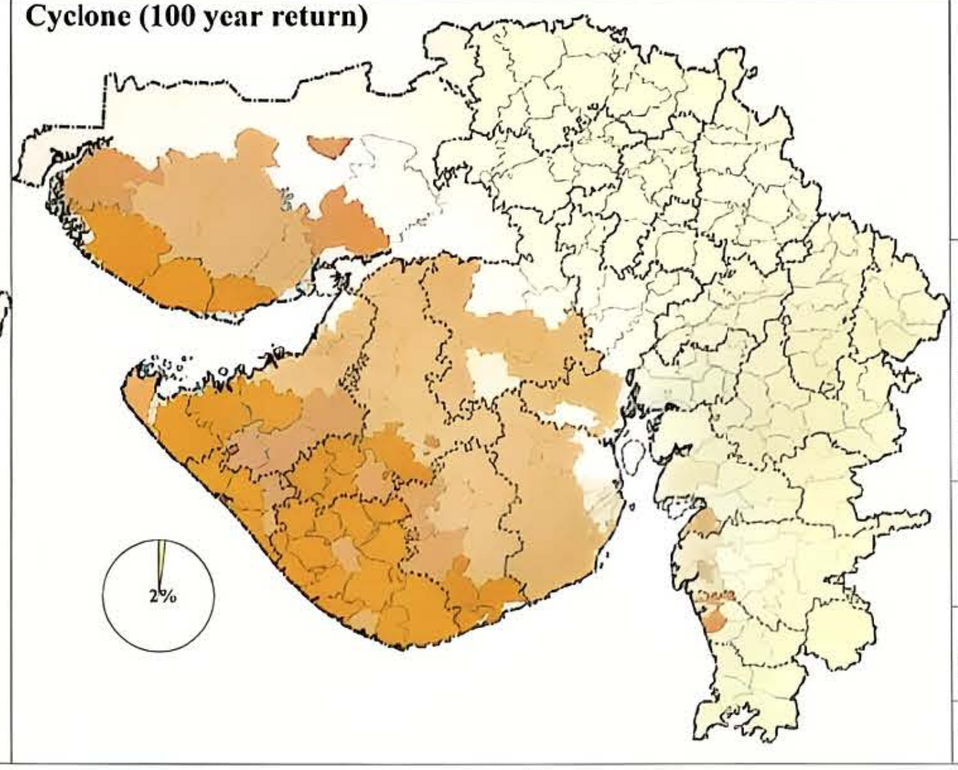
Manufacturing Sector Capital Investment (Rs. Million)
- < 100
- > 100 to 500
- > 500 to 1000
- > 1000 to 5000
- > 5000 to 10000
- > 10000 to 50000
- > 50000 to 100000
- > 100000

LEGEND

Cyclone (50 year return)



Cyclone (100 year return)



% Capital Stock Loss
- > 0 to 0.1
- > 0.1 to 0.5
- > 0.5 to 1
- > 1 to 5
- > 5 to 10
- > 10 to 20
- > 20

Main map pie charts show the proportion of capital stock vulnerability due to respective event to total capital stock in manufacturing sector.

Source: TARU Analysis, 2004, Census of Industries, 1999-2000, Department of Industries, GoG, Annual Survey of Industries, 2000-2001, Central Statistical Organisation, GoI, New Delhi;
NSS 56th Round, 2000-2001 and NSS 57th Round, 2001-2002, National Sample Survey Organisation, GoI, BISAG, GoG.

0 100 km

N

Projection : Lambert Azimuthal Equal Area
Datum : WGS 84

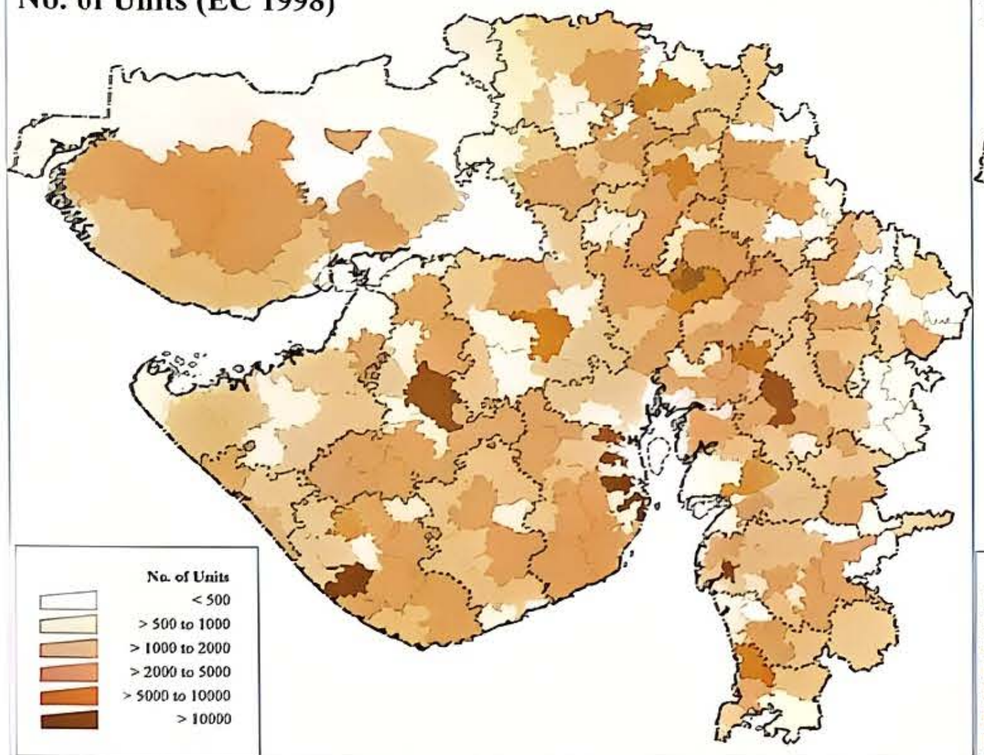
MAP No. : VECM - 07 OF 14

Date : 17/8/2005

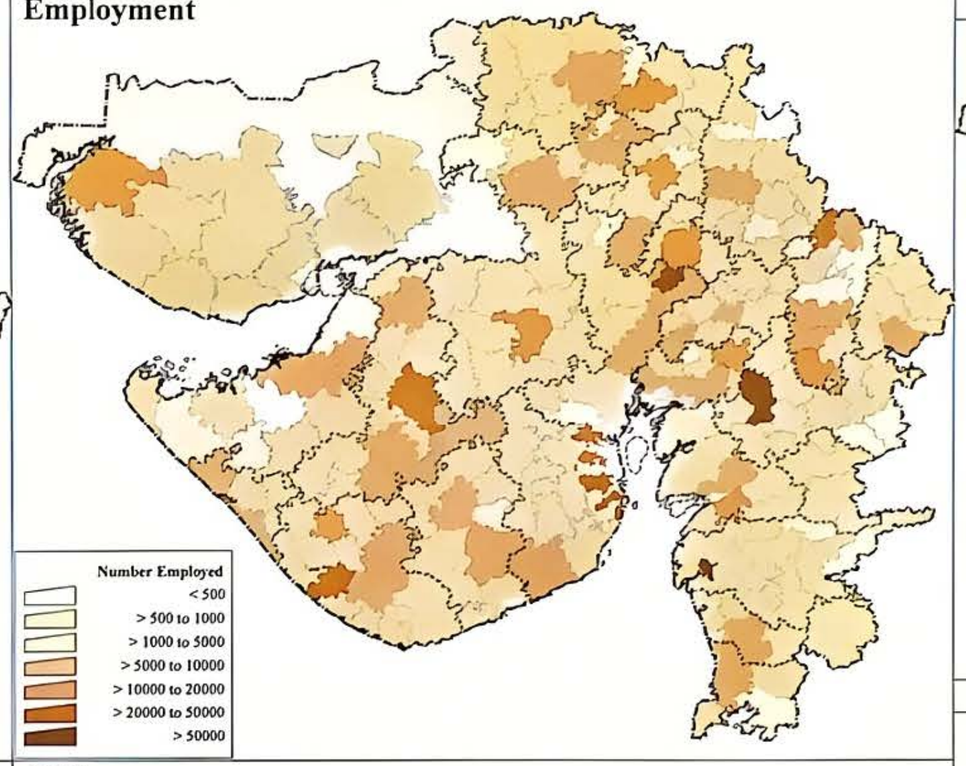
Gujarat Economic Vulnerability Zonation: Concentration of Trade & Hospitality Enterprises (1998)

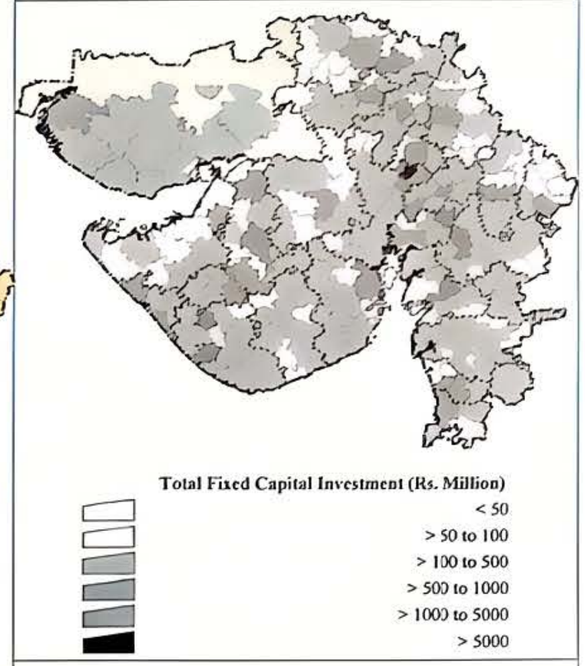
GSDMA

No. of Units (EC 1998)

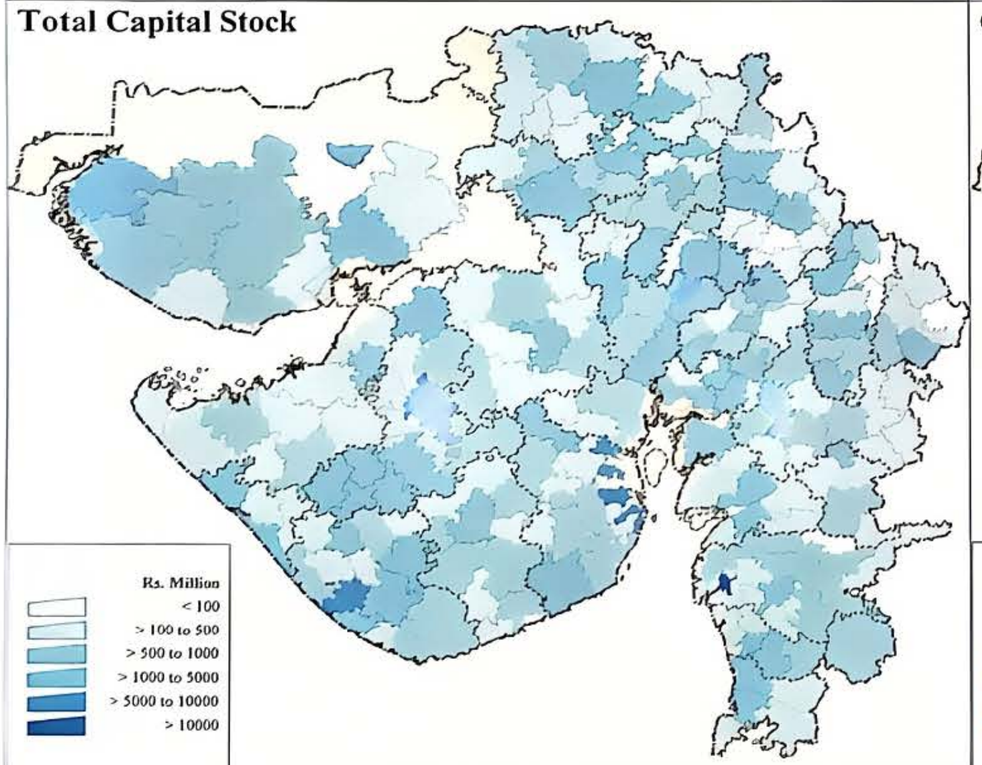


Employment

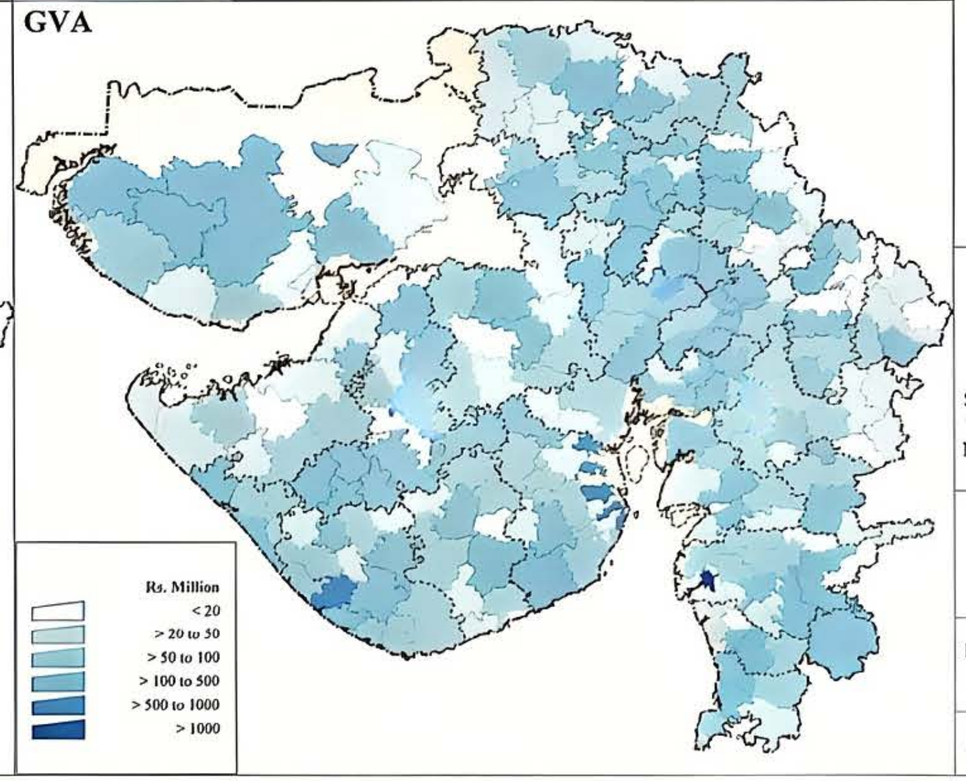




Total Capital Stock



GVA



Source: TARU Analysis, 2004;
Report on Fourth Economic Census, 1998, GoG;
NSS 53rd Round, 1997-1998,
National Sample Survey Organisation, GoI; BISAG, GoG.

0 100 km

N

Projection : Lambert Azimuthal Equal Area
Datum : WGS 84

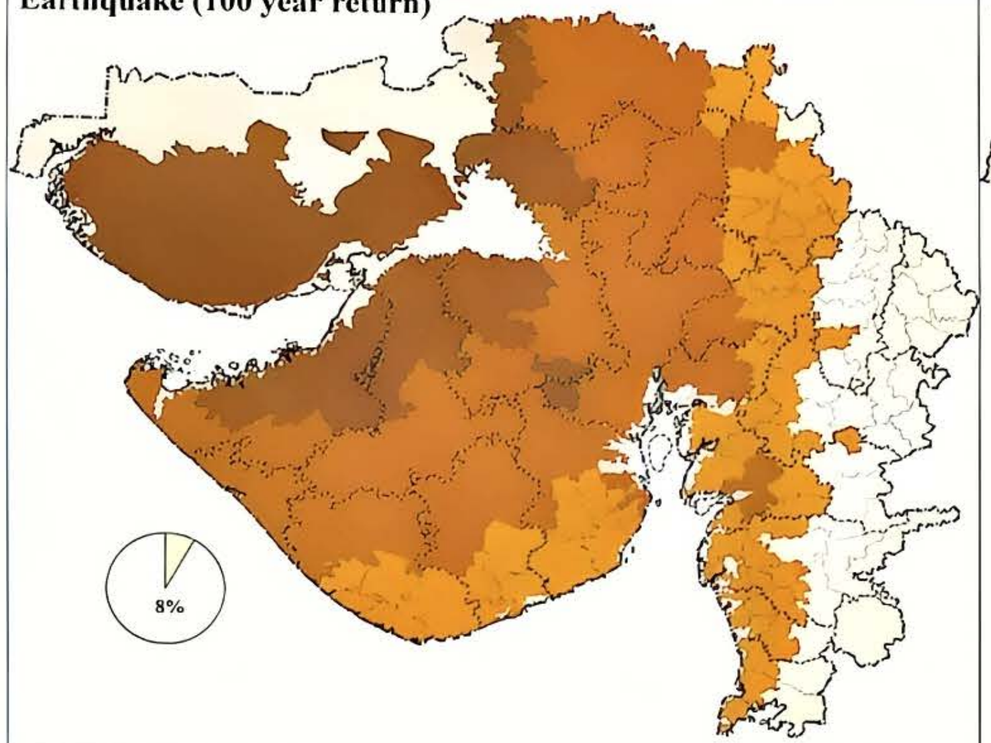
MAP No. : VECM - 08 OF 14

Date : 18/6/2005

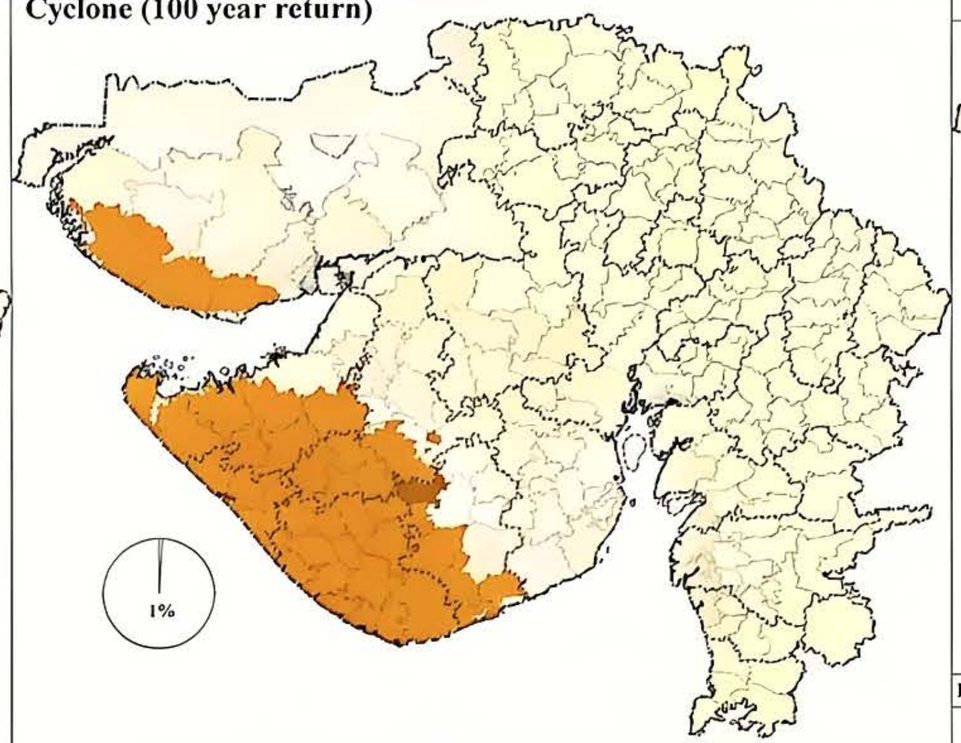
Gujarat Economic Vulnerability Zonation: Trade & Hospitality Enterprises GVA Vulnerability
(Worst Case Scenario, 1998)

GSDMA

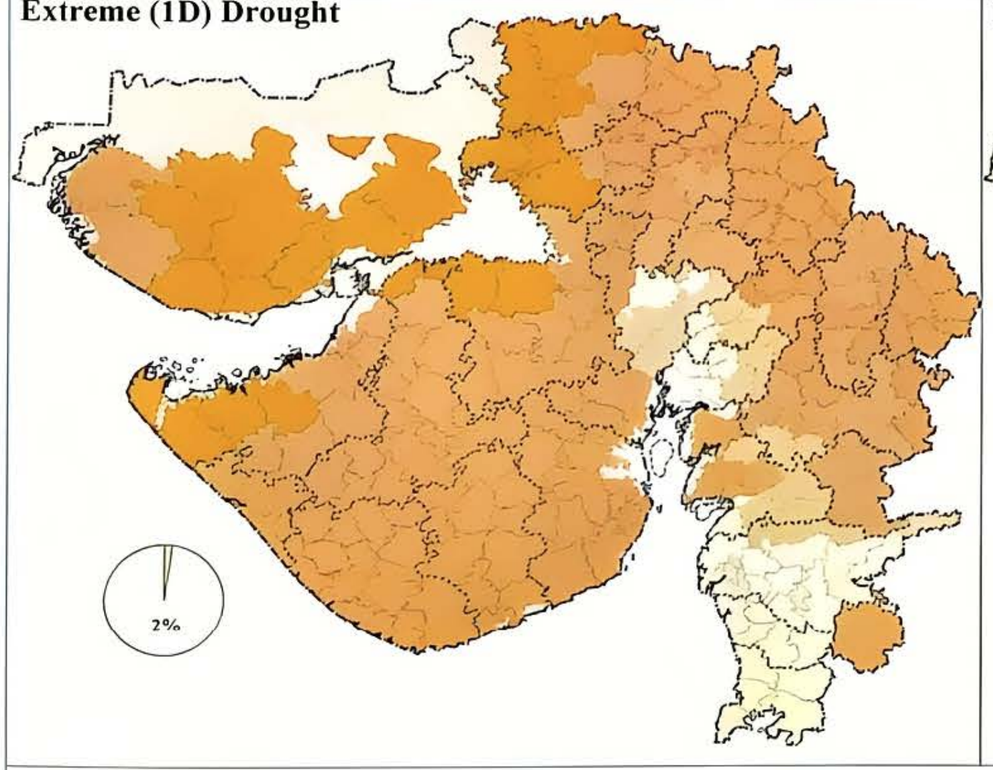
Earthquake (100 year return)



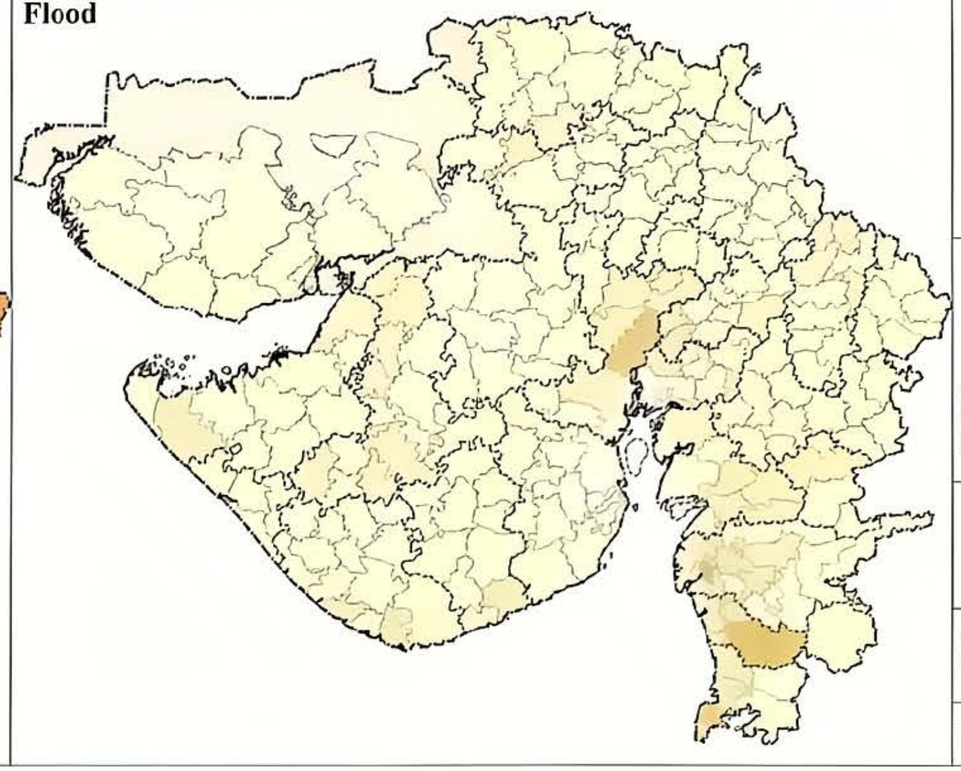
Cyclone (100 year return)

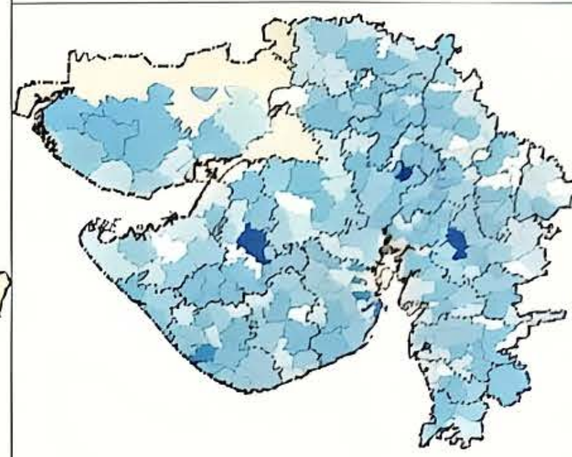


Extreme (1D) Drought

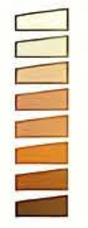


Flood





LEGEND



Main map pie charts show the proportion of GVA vulnerability in respective event to total GVA in trade & hospitality enterprises.

Source: TARU Analysis, 2004;
Report on Fourth Economic Census,1998, GoG;
NSS 53rd Round, 1997-1998,
National Sample Survey Organisation, GoI; BISAG, GoG.





Projection : Lambert Azimuthal Equal Area
Datum : WGS 84

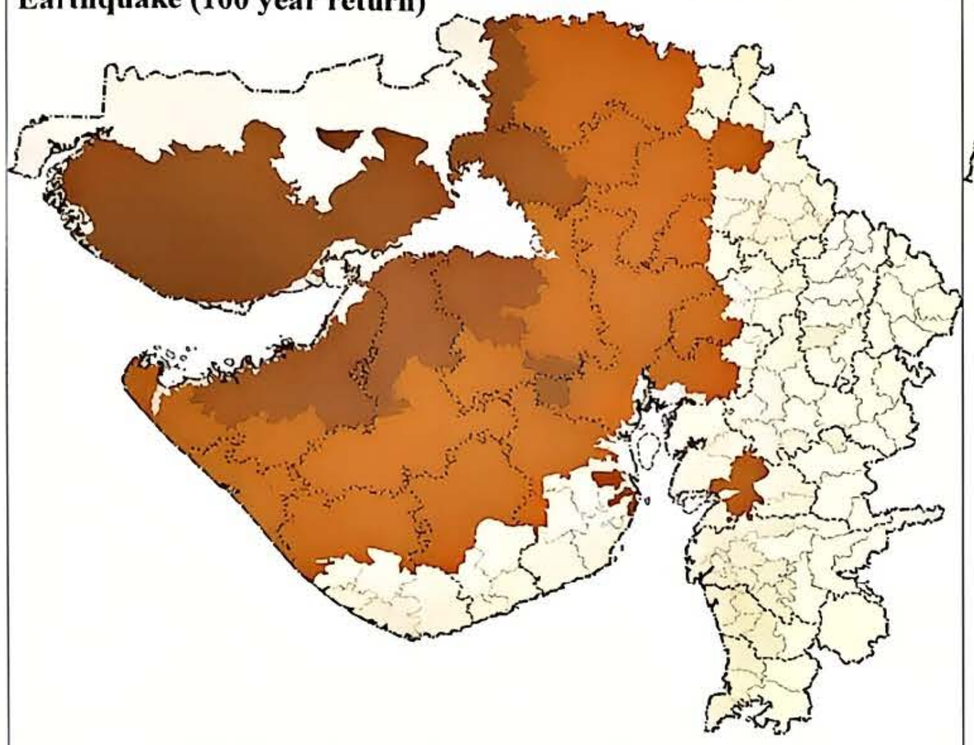
MAP No. : VECM - 09 OF 14

Date : 18/6/2005

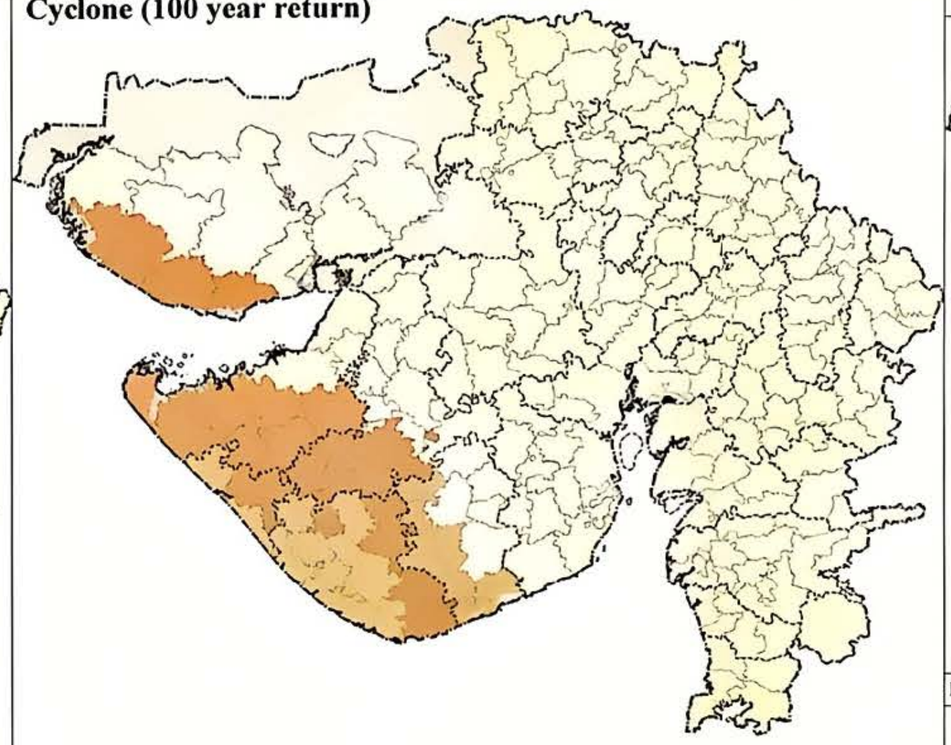
Gujarat Economic Vulnerability Zonation: Trade & Hospitality Enterprises Capital Stock Vulnerability (Worst Case Scenario,1998)

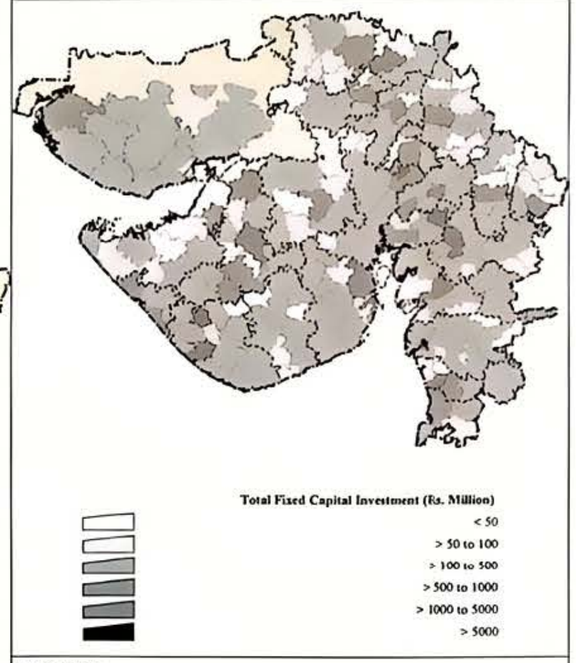
GSDMA

Earthquake (100 year return)

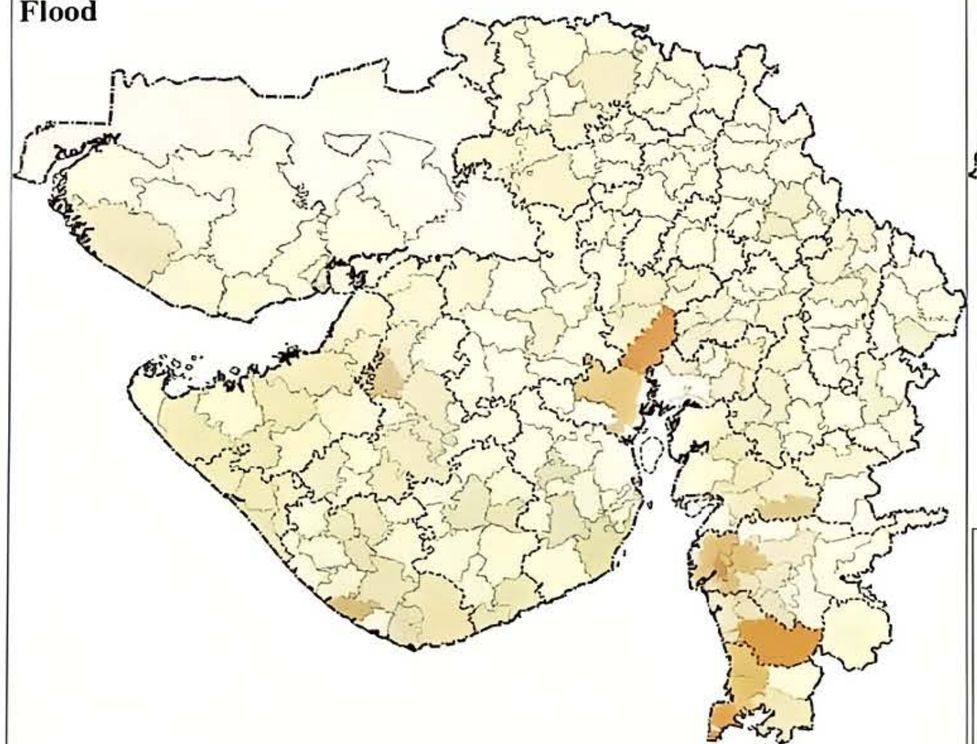


Cyclone (100 year return)

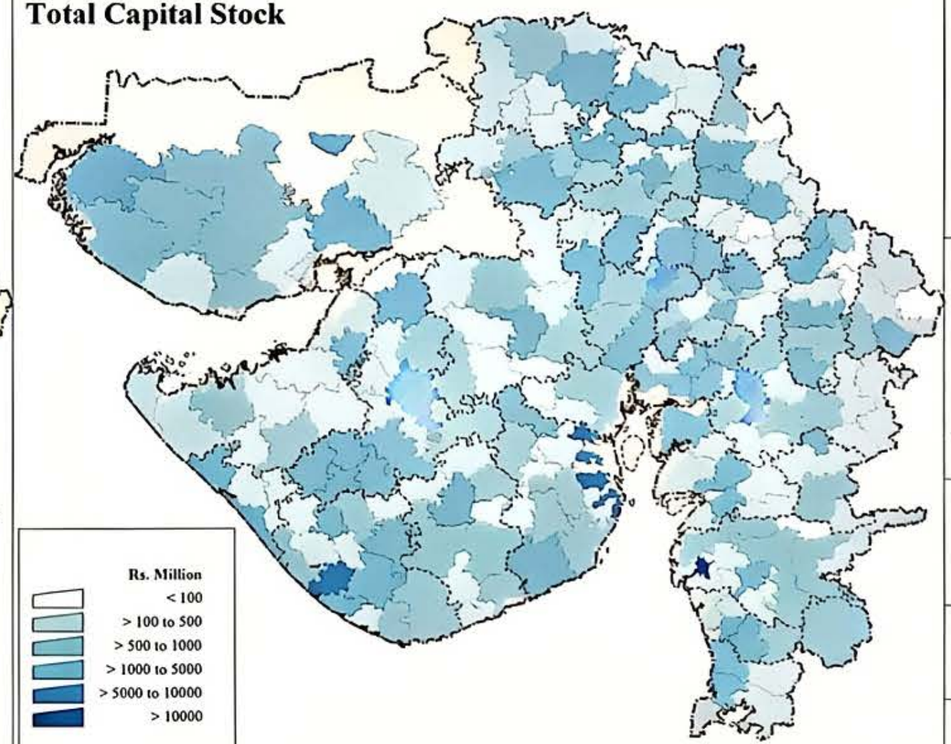




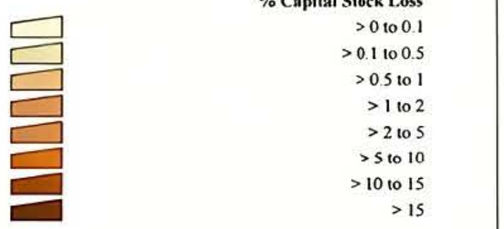
Flood



Total Capital Stock



LEGEND



Source: TARU Analysis, 2004;
Report on Fourth Economic Census, 1998, GoG;
NSS 53rd Round, 1997-1998,
National Sample Survey Organisation, GoI; BISAG, GoG.

0 100 km

N

Projection : Lambert Azimuthal Equal Area
Datum : WGS 84

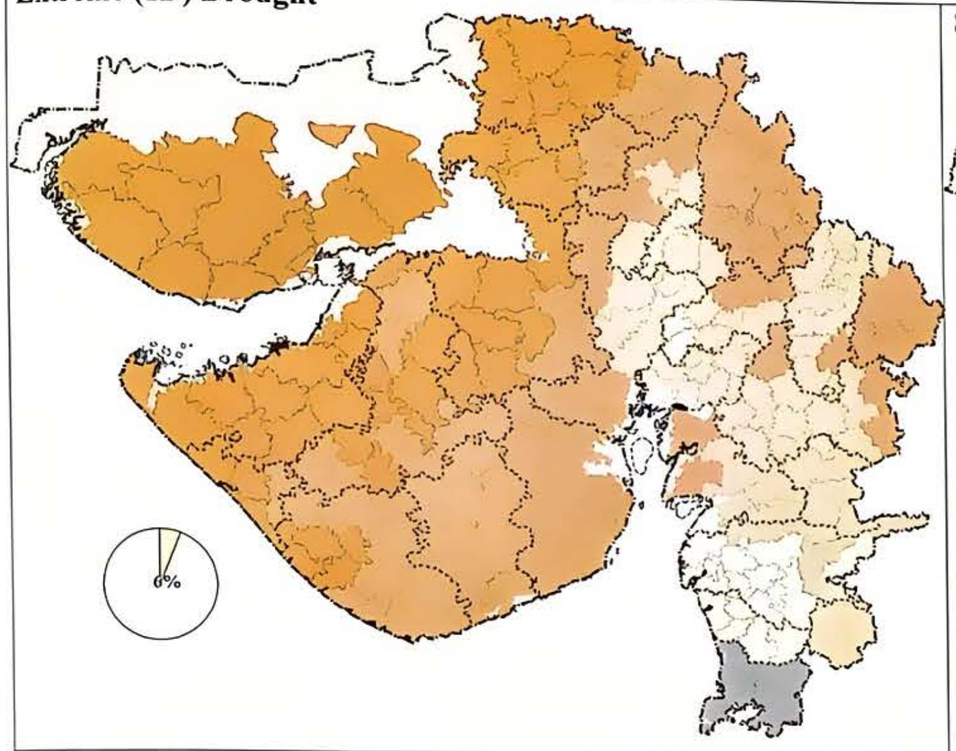
MAP No. : VECM - 10 OF 14

Date : 18/6/2005

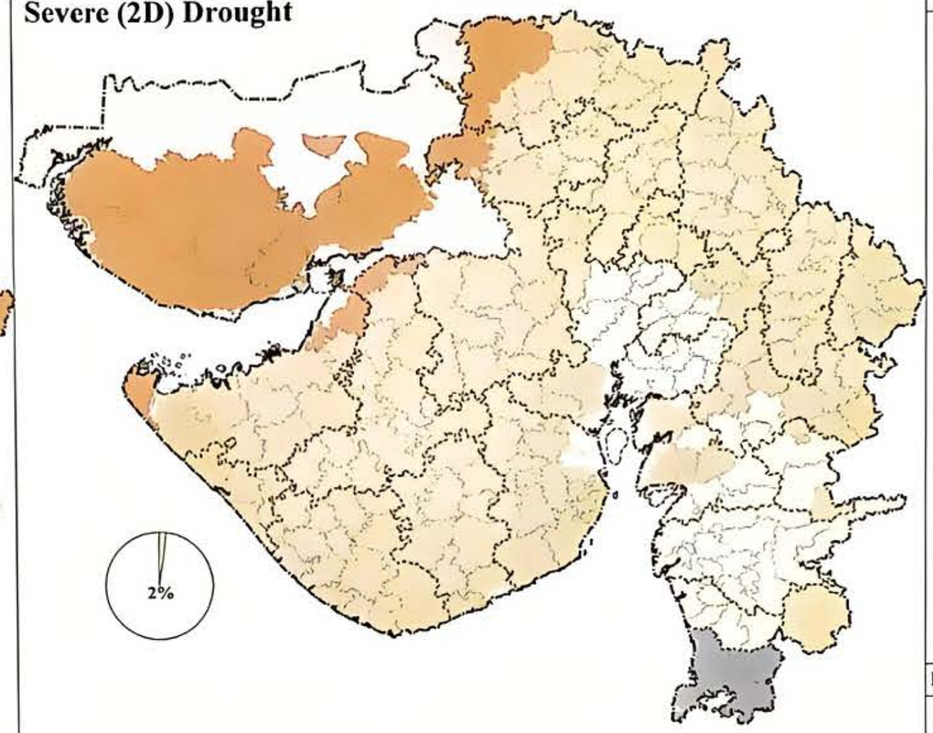
Gujarat Economic Vulnerability Zonation: Animal Husbandry Sector Capital Stock Vulnerability due to Drought and Flood

GSDMA

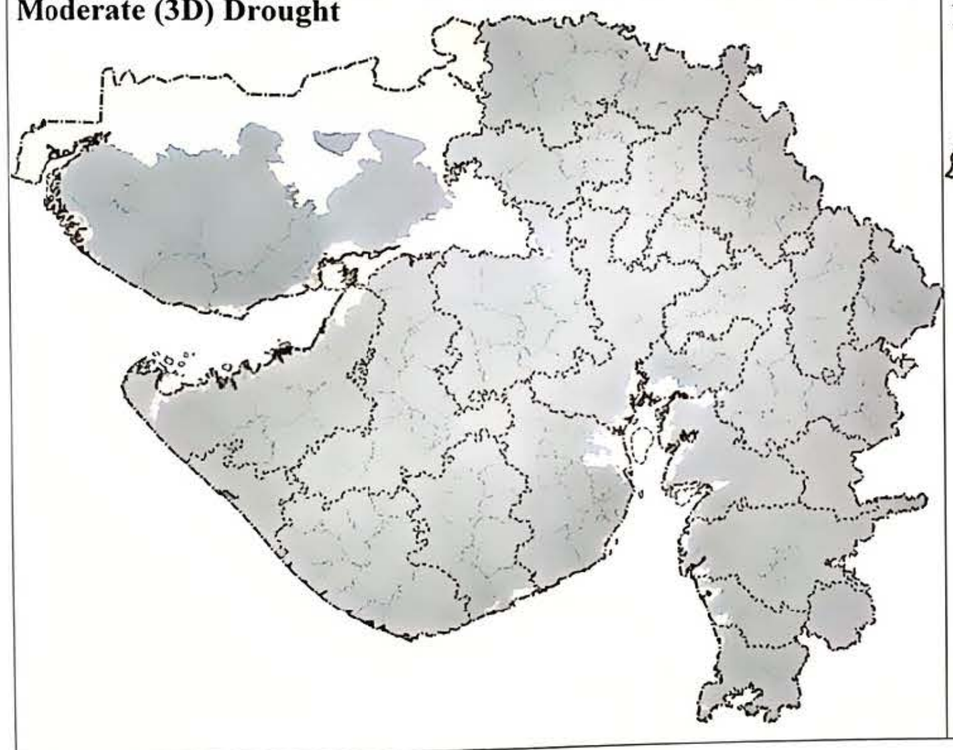
Extreme (1D) Drought



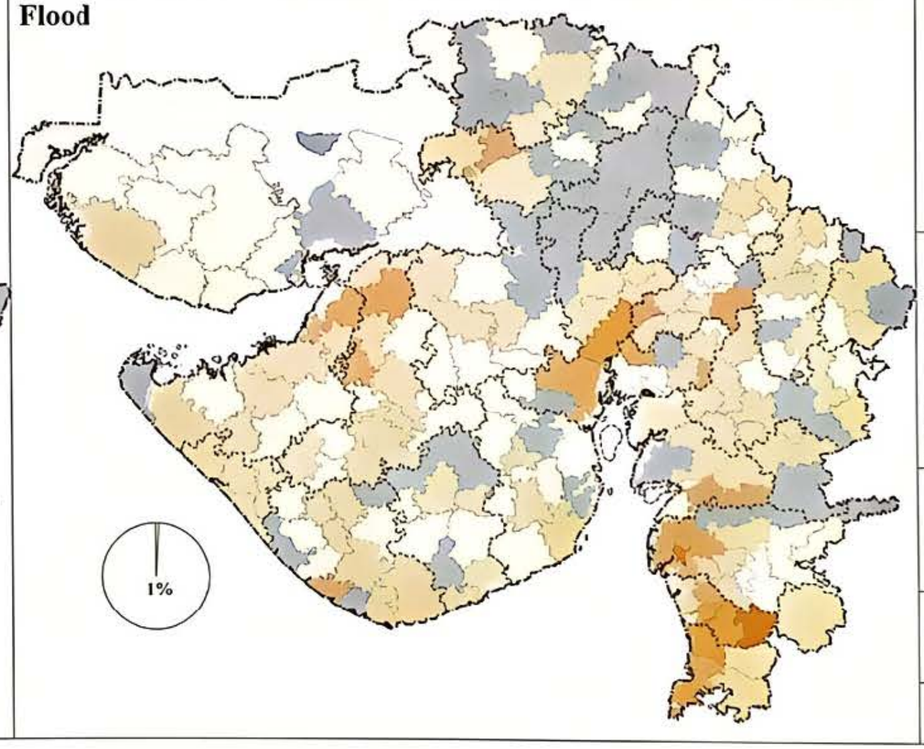
Severe (2D) Drought

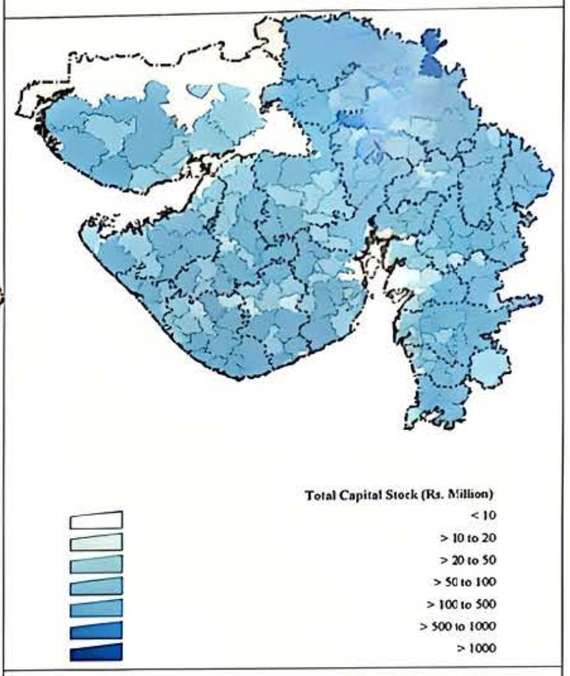


Moderate (3D) Drought



Flood





LEGEND



Main map pie charts show the proportion of capital stock vulnerability in respective event to total capital stock in animal husbandry sector.

Source: TARU Analysis, 2004; Livestock Census, 1997; 20th Survey Report on Estimates of Major Livestock Products, 2002-2003, DoAH, GoG; BISAG, GoG.

0 100 km

N

Projection : Lambert Azimuthal Equal Area
Datum : WGS 84

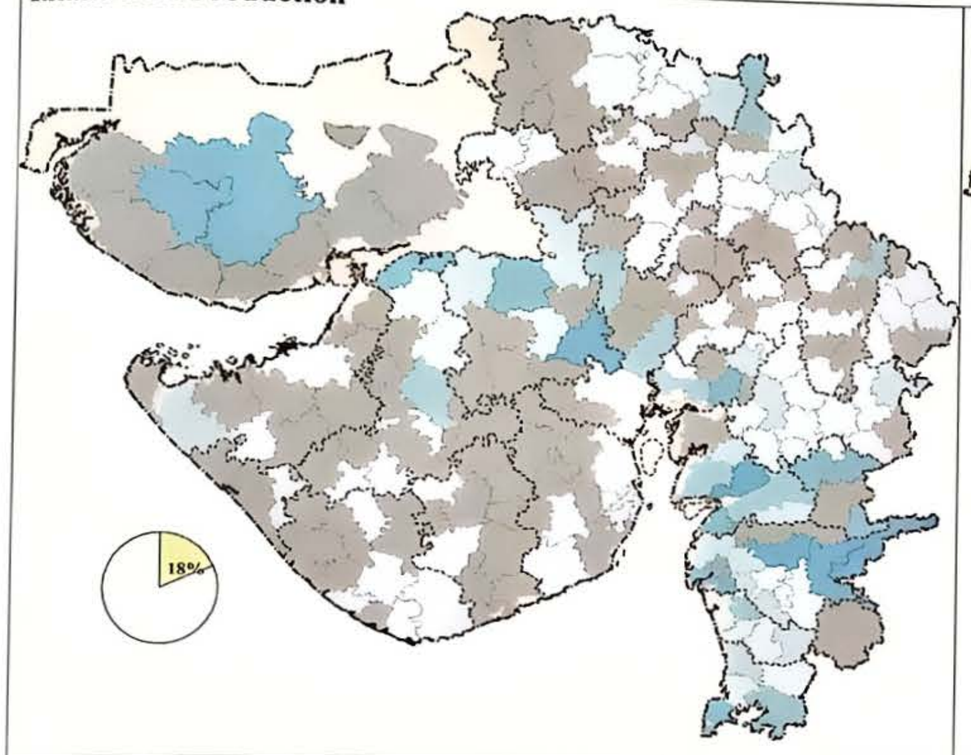
MAP No. : VECM - 11 OF 14

Date : 18/6/2005

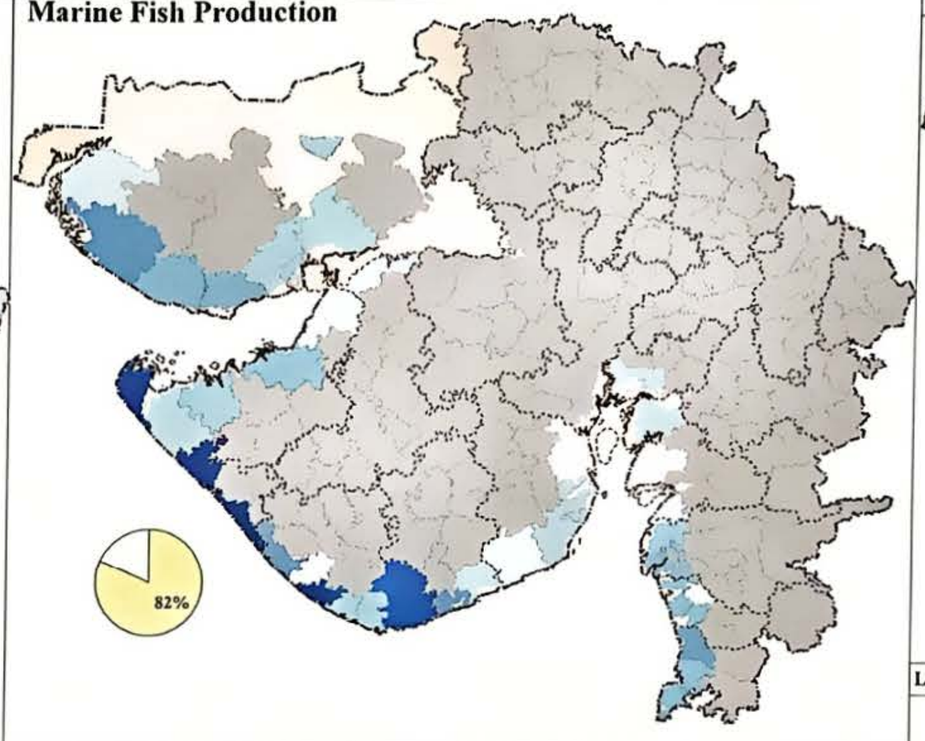
Gujarat Economic Vulnerability Zonation: Profile of Fishing Sector
(Rs. Million 2002-2003 prices)

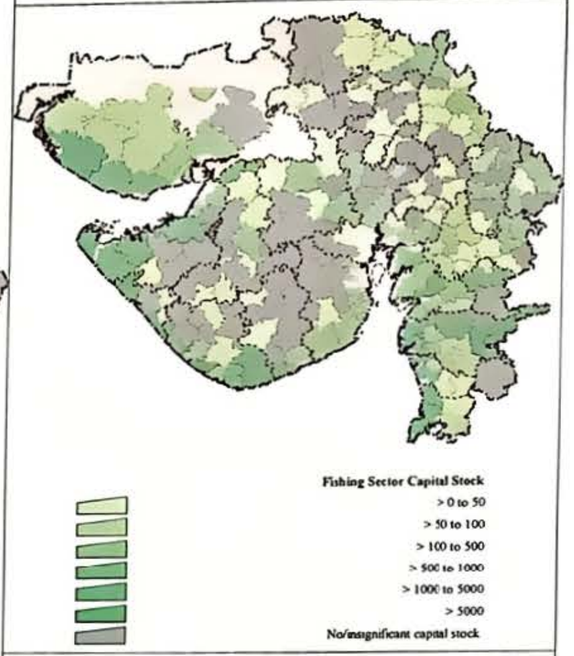
GSDMA

Inland Fish Production

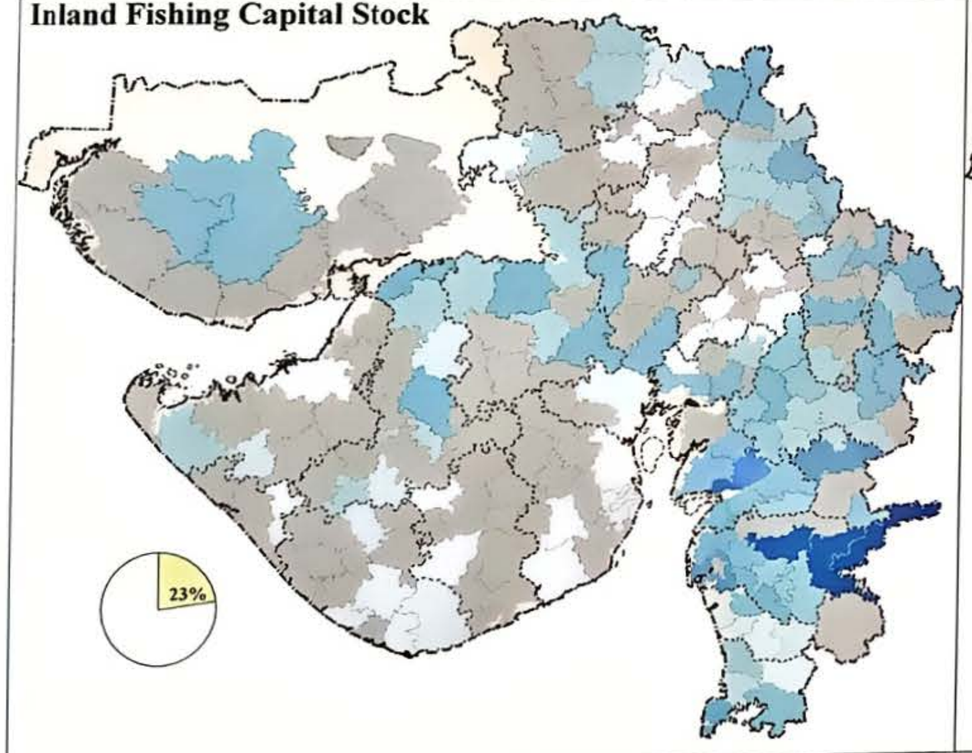


Marine Fish Production

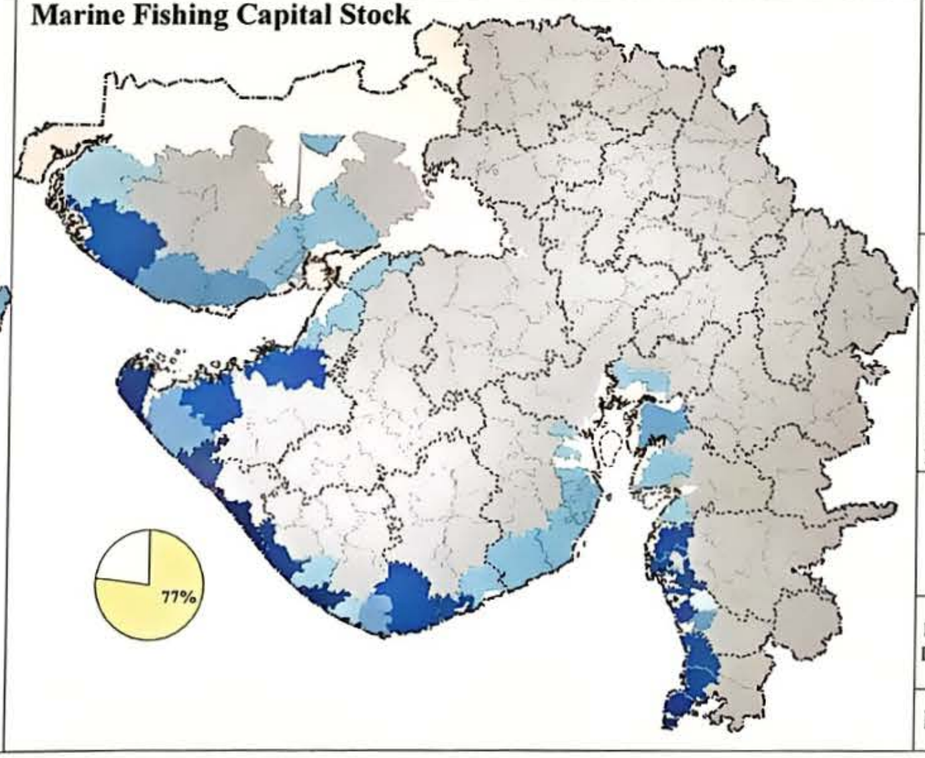




Inland Fishing Capital Stock



Marine Fishing Capital Stock



LEGEND



Main map pie charts show the proportion of the respective parameter to the total value of respective sector.

Source: TARU Analysis, 2004;
Gujarat Fishery Statistics, 1999-2000 and 2001-2002;
BISAG, GoG.

0 100 km

N

Projection : Lambert Azimuthal Equal Area
Datum : WGS 84

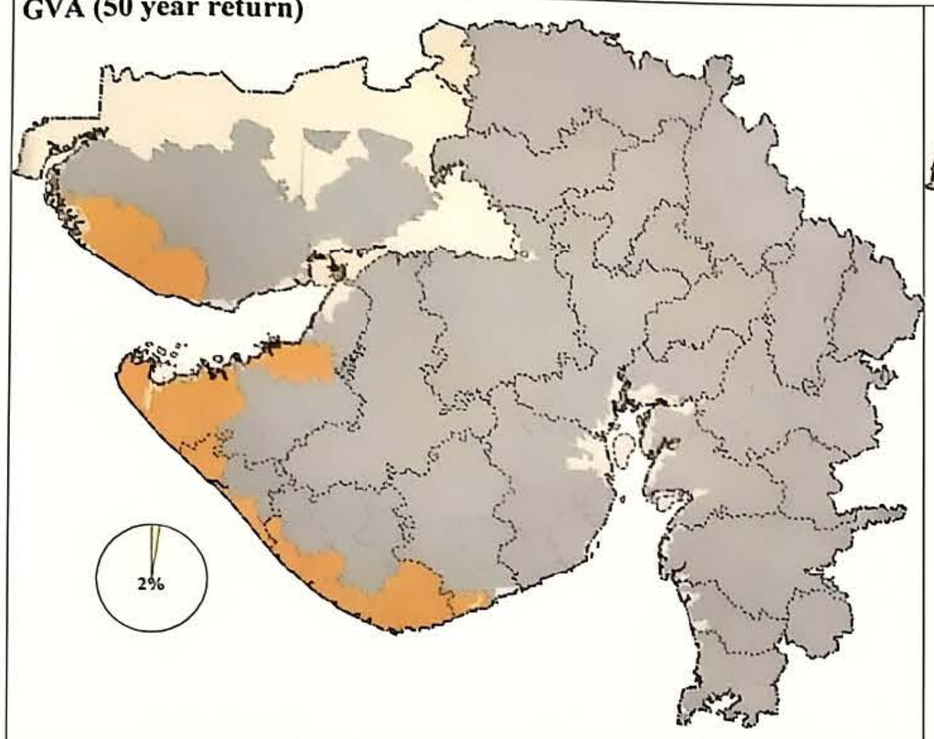
MAP No. : VECM - 12 OF 14

Date : 17/8/2005

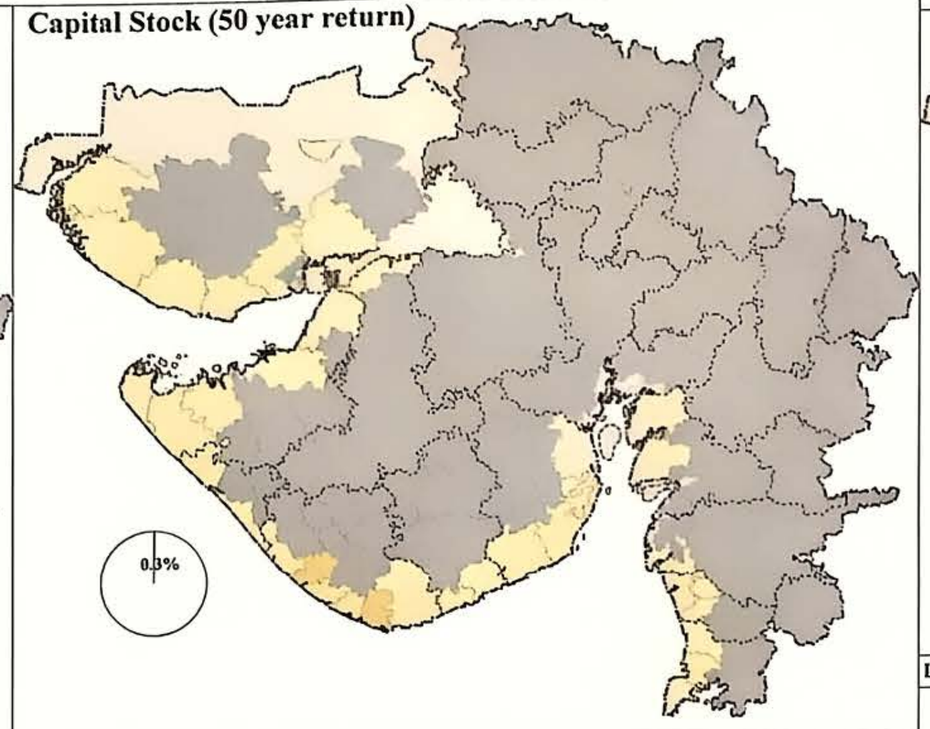
Gujarat Economic Vulnerability Zonation: Marine Fishing Sector Vulnerability due to Cyclone

GSDMA

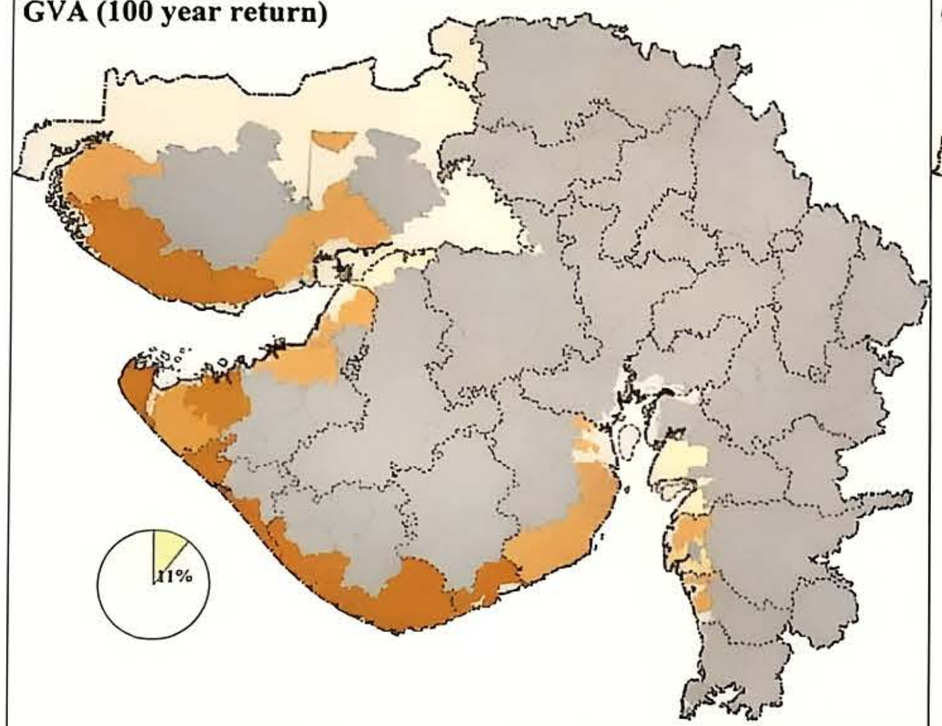
GVA (50 year return)



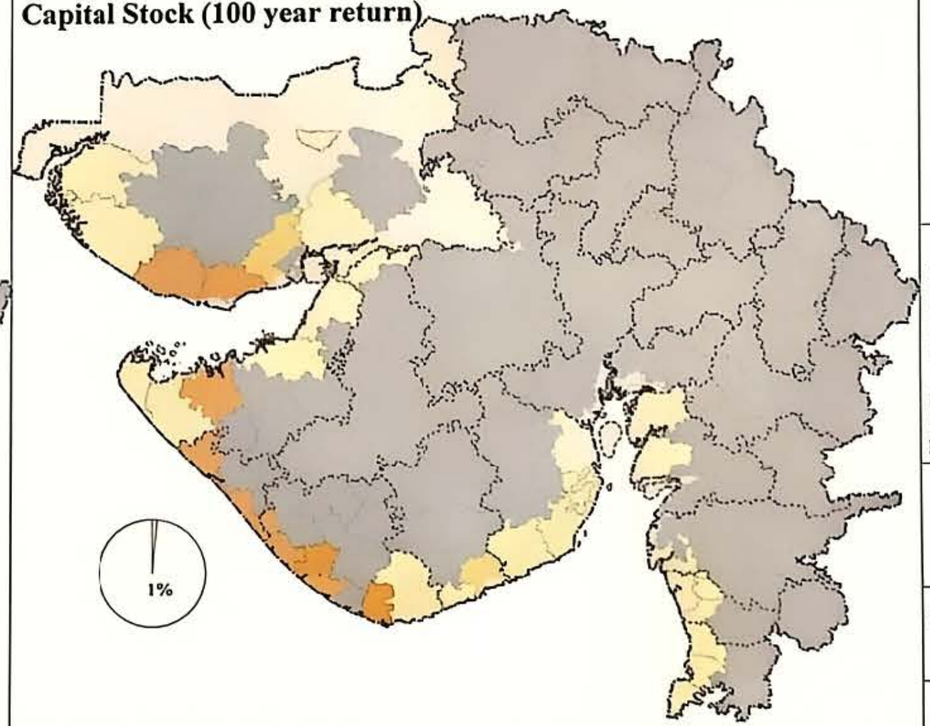
Capital Stock (50 year return)

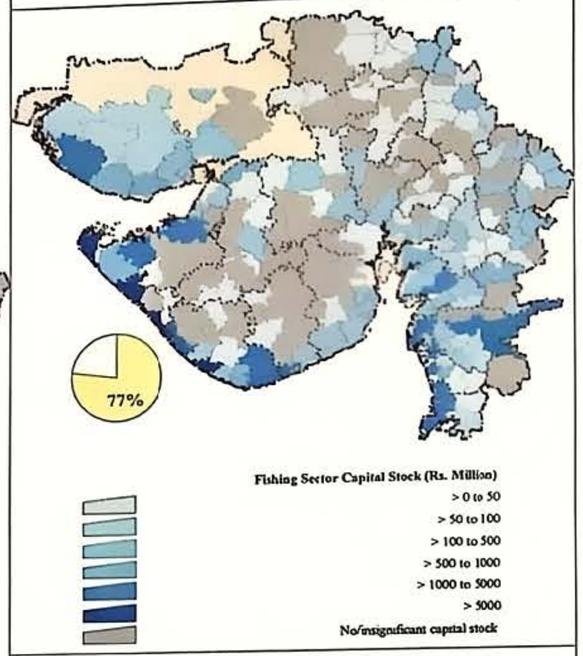


GVA (100 year return)

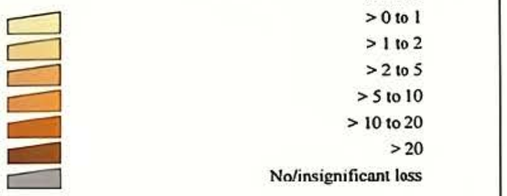


Capital Stock (100 year return)





LEGEND



Inset map pie chart shows the proportion of marine fishing sector capital stock to total fishing sector capital stock.
Main map pie charts show the proportion of marine fishing sector respective loss to total fishing sector respective loss.

Source: TARU Analysis, 2004;
Gujarat Fishery Statistics, 1999-2000 and 2001-2002;
BISAG, GoG.

0 100 km

N

Projection : Lambert Azimuthal Equal Area
Datum : WGS 84

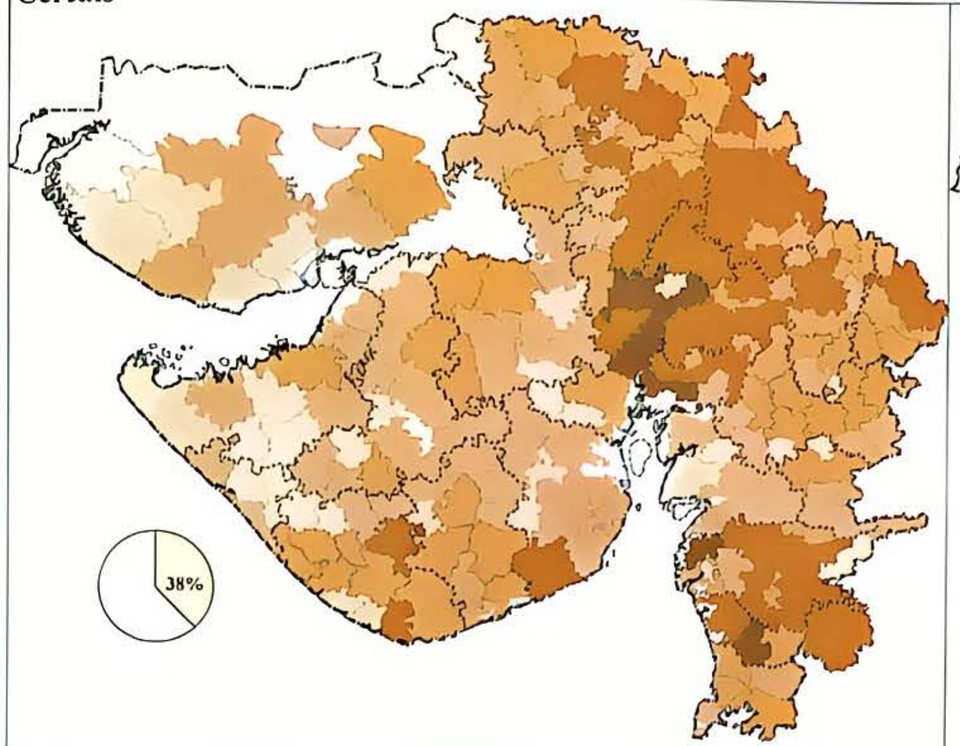
MAP No. : VECM - 13 OF 14

Date : 17/8/2005

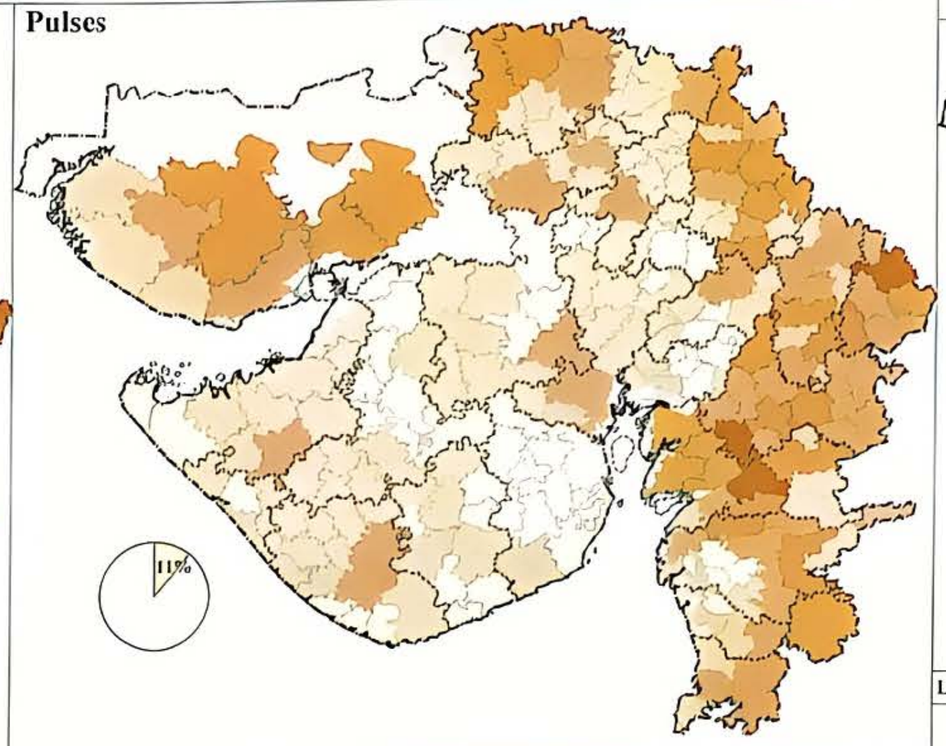
Gujarat Economic Vulnerability Zonation: GVA of Major Crops
(Rs. Million 2002-2003 prices)

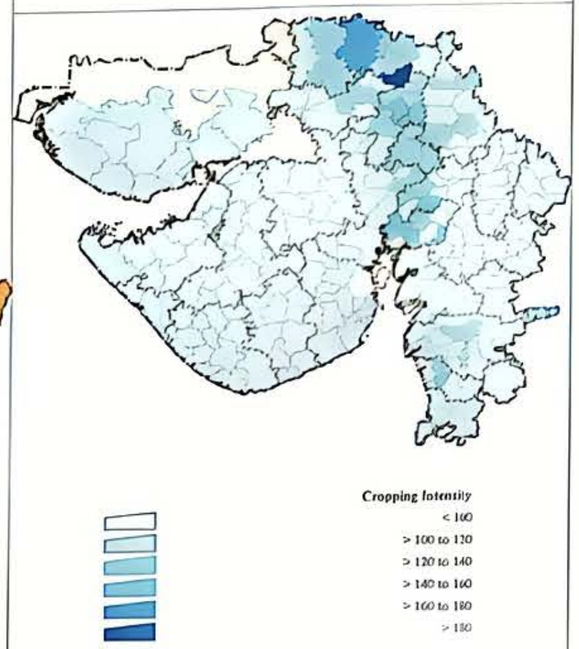
GSDMA

Cereals

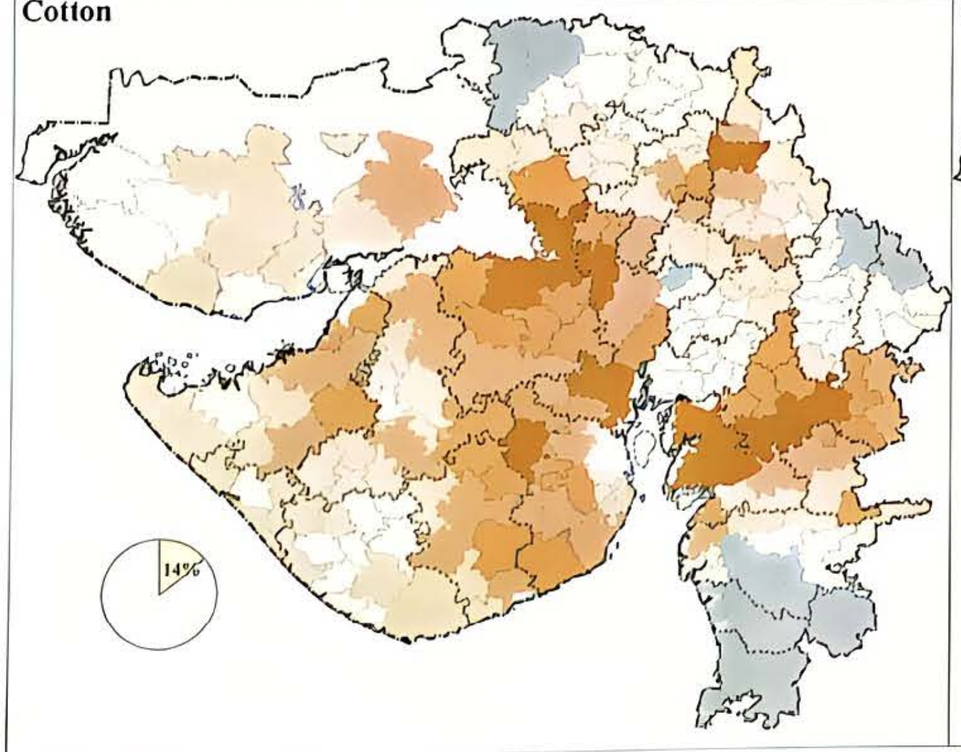


Pulses

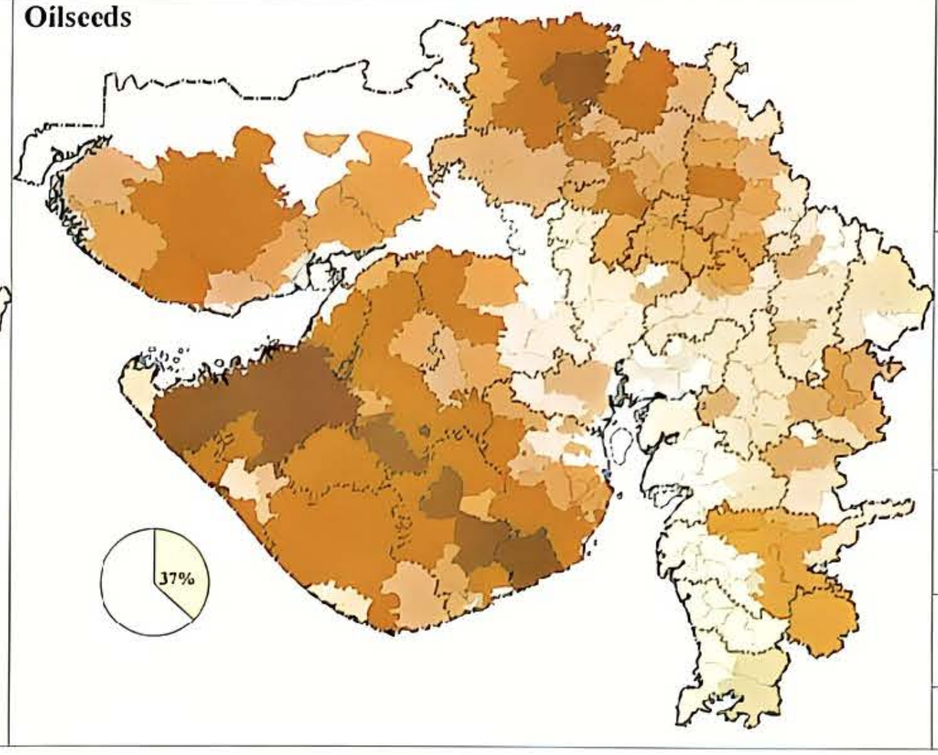




Cotton



Oilseeds



LEGEND

Crop Production (Rs. Million)
- > 0 to 10
- > 10 to 50
- > 50 to 100
- > 100 to 200
- > 200 to 500
- > 500
- No/insignificant production

Main map pie charts show the proportion of production value of the crop to total production value of all crops.

Source: TARU Analysis, 2004;
Department of Economics & Statistics, GoG;
Department of Agriculture, GoG; FAO/ICRISAT;
GAU, Anand; BISAG, GoG.

0 100 km

N

Projection : Lambert Azimuthal Equal Area
Datum : WGS 84

MAP No. : VECM - 14 OF 14

Date : 6/8/2005

GUJARAT ECONOMIC VULNERABILITY ZONATION : MANUFACTURING SECTOR GVA VULNERABILITY
(WORST CASE SCENARIO, 1999-2000) (in PERCENT) Table No. VECT - 01 of 01

GSDMA

Sr. No	District	Taluka	Earthquake (100 year return)	Cyclone (100 year return)	Extreme Drought	Flood	Mfg. Sector GVA Rs Millions
1	Ahmadabad	Ahmadabad City	1.7	-	0.1	0.1	32,694
2	Ahmadabad	Barwala	-	-	-	-	-
3	Ahmadabad	Bavla	1.8	-	0.4	0.2	406
4	Ahmadabad	Daskroi	1.5	-	0.3	0.1	3,453
5	Ahmadabad	Detroj-Rampura	-	-	-	-	-
6	Ahmadabad	Dhandhuka	0.5	0 1	0.1	-	449
7	Ahmadabad	Dholka	1.3	-	0.2	0.5	1,901
8	Ahmadabad	Mandal	0.2	-	-	-	24
9	Ahmadabad	Ranpur	6.2	0.6	-	-	16
10	Ahmadabad	Sanand	2.3	-	0 1	0.2	4,517
11	Ahmadabad	Viramgam	1.9	-	2.8	-	2,214
12	Amreli	Amreli	0.6	0.1	0.8	-	303
13	Amreli	Babra	1.0	0.2	0.2	-	60
14	Amreli	Bagasara	0.3	0.4	0.1	-	172
15	Amreli	Dhari	0.6	0.7	1.1	-	256
16	Amreli	Jafrabad	0.9	2.2	4.1	0.1	327
17	Amreli	Khambha	0.2	0.5	0.2	-	102
18	Amreli	Kunkavav Vadia	0.1	0.2	-	-	212
19	Amreli	Lathi	0.3	0.1	0.2	-	216
20	Amreli	Lilia	0.2	-	0 1	-	58
21	Amreli	Rajula	1.0	2.5	4.8	0.2	3,390
22	Amreli	Savar Kundla	0.3	0.1	0.1	-	390
23	Anand	Anand	1.2	-	0.5	0.1	4,549
24	Anand	Anklav	0.3	-	0.1	-	90
25	Anand	Borsad	0.6	-	0.1	-	424
26	Anand	Khambhat	1.1	-	0.2	-	316
27	Anand	Petlad	1.2	-	0.1	-	510
28	Anand	Sojitra	2.2	-	0.1	-	69
29	Anand	Tarapur	1.1	-	0.2	0.1	36
30	Anand	Umreth	0.8	-	-	-	509
31	Banas Kantha	Amirgadh	2 0	-	2.9	-	46
32	Banas Kantha	Bhabhar	0.5	-	0.7	-	31
33	Banas Kantha	Danta	1.4	-	3.5	-	266
34	Banas Kantha	Dantiwada	0.1	-	-	-	18
35	Banas Kantha	Deesa	1.4	-	0.7	-	544
36	Banas Kantha	Deodar	0.9	-	0.2	-	58
37	Banas Kantha	Dhanera	0.6	-	1.0	-	115
38	Banas Kantha	Kankrej	0.4	-	0.3	-	87
39	Banas Kantha	Palanpur	1.9	-	3.8	-	1,283
40	Banas Kantha	Tharad	0.4	-	0.2	-	79
41	Banas Kantha	Vadgam	0.3	-	0.1	-	295
42	Banas Kantha	Vav	0.2	-	0.1	-	42
43	Bharuch	Amod	0.7	-	0.7	0.1	194
44	Bharuch	Anklesvar	2.6	-	0.7	0.3	8,884
45	Bharuch	Bharuch	2 4	-	1.0	0.1	11,132
46	Bharuch	Hansot	0.9	0.5	0.4	-	1,186
47	Bharuch	Jambusar	0.8	-	1.8	0.1	1,200
48	Bharuch	Jhagadia	1.0	-	0.3	0.2	15,555
49	Bharuch	Vagra	1.0	0.6	2.6	-	2,954
50	Bharuch	Valia	0.9	-	1.1	0.5	1,887
51	Bhavnagar	Bhavnagar	2.3	0.5	3 7	-	5,190
52	Bhavnagar	Botad	0.7	0.1	0.2	-	241
53	Bhavnagar	Gadhada	0.7	0.1	0.5	-	97
54	Bhavnagar	Gariadhar	0 7	0.1	0.5	-	78
55	Bhavnagar	Ghogha	1.5	0.6	4.5	-	375
56	Bhavnagar	Mahuva	0.4	0.1	0.6	-	806
57	Bhavnagar	Palitana	0 5	0 2	1.9	-	225
58	Bhavnagar	Sihor	0.7	0.2	0.9	-	707
59	Bhavnagar	Talaja	0.8	0.2	1.0	-	198
60	Bhavnagar	Umrala	0.2	-	0.1	-	122
61	Bhavnagar	Vallabhipur	0.3	0.1	0.1	-	53
62	Dohad	Devgadbaria	-	-	0.1	-	129
63	Dohad	Dhanpur	-	-	-	-	-
64	Dohad	Dohad	-	-	0.7	-	485
65	Dohad	Fatepura	-		0.1	-	16
66	Dohad	Garbada	-		0.1	-	41
67	Dohad	Jhalod	-	-	0.1	-	128
68	Dohad	Limkheda	-	-	0.2	-	37
69	Gandhinagar	Dehgam	0.6	-	0 7	-	562
70	Gandhinagar	Gandhinagar	2.3	-	1.1	-	4,993
71	Gandhinagar	Kalol	2.7	-	0.9	-	6,526
72	Gandhinagar	Mansa	1.8	-	1.2	-	258
73	Jamnagar	Bhanvad	0.2	0.2	-	-	150
74	Jamnagar	Dhrol	0.5	0.1	0.4	-	412
75	Jamnagar	Jamjodhpur	0.4	0.7	0.1	-	234
76	Jamnagar	Jamnagar	3.0	0.3	1.5	0.1	5,765
77	Jamnagar	Jodiya	1.2	0.1	-	0.1	323
78	Jamnagar	Kalavad	0.4	0.4	0.1	-	257
79	Jamnagar	Kalyanpur	0.6	0.7	0.6	-	184
80	Jamnagar	Khambhalia	1.2	1.0	0.6	-	223
81	Jamnagar	Lalpur	6.5	2.5	6.5	0.1	51,595
82	Jamnagar	Okhamandal	2.5	2.5	7.0	-	3,588
83	Junagadh	Bhesan	1.9	1.9	0.1	-	153
84	Junagadh	Junagadh	1.6	2.3	1.8	0 1	1,160
85	Junagadh	Keshod	0.8	1.3	0.6	-	207
86	Junagadh	Kodinar	1.0	2.5	4.9	0.2	4,142
87	Junagadh	Malia	0.8	2.0	5.8	-	198
88	Junagadh	Manavadar	1.2	1.7	1.6		277
89	Junagadh	Mangrol	0.9	1.3	-	-	110
90	Junagadh	Mendarda	0.2	0.4	0.1	-	56
91	Junagadh	Patan-Veraval	1.0	2.4	1.6	0 3	1,274
92	Junagadh	Sutrapada	1.0	2.5	4.5	-	1,591
93	Junagadh	Talala	0.6	1.4	3.0	-	205
94	Junagadh	Una	0.5	1.1	1.6	-	140
95	Junagadh	Vanthali	0.9	1.0	0.3		114
96	Junagadh	Visavadar	0.2	0.4	0.1	-	138
97	Kachchh	Abdasa	0.6	0.6	0.6		30
98	Kachchh	Anjar	0.9	0 1	0.4	-	402
99	Kachchh	Bhachau	4.8	0 4	9.1		483
100	Kachchh	Bhuj	1.9	0.2	1.4		602
101	Kachchh	Gandhidham	4.3	0.4	4.8	-	1,468
102	Kachchh	Lakhpat	1.8	0.2	1.8	-	19
103	Kachchh	Mandvi	1.0	0.8	0 1	-	192
104	Kachchh	Mundra	5.7	2.3	11.5	-	434
105	Kachchh	Nakhatrana	0.5	0.1	0.3	-	165
106	Kachchh	Rapar	0.2	-	0.1	-	40
107	Kheda	Balasinor	0.6	-	0 7	-	94
108	Kheda	Kapadvanj	0.7	-	0 4	-	264
109	Kheda	Kathlal	0.2		0.2	-	143
110	Kheda	Kheda	1.7		-	0.2	397
111	Kheda	Mahudha	0 1	-	-	-	72
112	Kheda	Matar	2.3	-	0.6	0.2	946
113	Kheda	Mehmedabad	1.7	-	1 0	-	443
114	Kheda	Nadiad	1.6	-	0 1	0 1	2,120

GUJARAT ECONOMIC VULNERABILITY ZONATION : MANUFACTURING SECTOR GVA VULNERABILITY
(WORST CASE SCENARIO, 1999-2000) (in PERCENT) Table No. VECT - 01 of 01

GSDMA

Sr. No	District	Taluka	Earthquake (100 year return)	Cyclone (100 year return)	Extreme Drought	Flood	Mfg. Sector GVA Rs Millions
115	Kheda	Thasra	0.5	-	0.7	-	331
116	Kheda	Vaipur	0.1	-	-	-	36
117	Mahesana	Becharaji	1.6	-	-	-	11
118	Mahesana	Kadi	2.5	-	1.3	-	2,625
119	Mahesana	Kheralu	0.3	-	0.1	-	212
120	Mahesana	Mahesana	2.3	-	3.0	-	4,592
121	Mahesana	Satlasana	-	-	-	-	-
122	Mahesana	Unjha	0.9	-	1.2	-	318
123	Mahesana	Vadnagar	0.2	-	0.1	-	149
124	Mahesana	Vijapur	0.9	-	0.3	-	359
125	Mahesana	Visnagar	0.8	-	0.3	-	253
126	Narmada	Dediapada	-	-	0.2	-	96
127	Narmada	Nandod	-	-	1.0	0.1	862
128	Narmada	Sagbara	0.1	-	-	-	55
129	Narmada	Tilakwada	0.1	-	-	-	71
130	Navsari	Bansda	-	-	-	0.1	304
131	Navsari	Chikhli	0.6	-	0.3	-	627
132	Navsari	Gandevi	1.0	-	-	0.5	838
133	Navsari	Jalalpore	0.7	0.3	-	0.1	328
134	Navsari	Navsari	0.9	-	-	0.2	1,723
135	Panch Mahals	Ghoghamba	-	-	-	-	42
136	Panch Mahals	Godhra	-	-	0.8	-	877
137	Panch Mahals	Halol	-	-	0.2	-	5,739
138	Panch Mahals	Jambughoda	-	-	0.1	-	70
139	Panch Mahals	Kadana	-	-	-	-	-
140	Panch Mahals	Kalol	1.0	-	0.6	-	723
141	Panch Mahals	Khanpur	-	-	-	-	32
142	Panch Mahals	Lunawada	-	-	-	-	339
143	Panch Mahals	Morwa (Hadaf)	-	-	-	-	38
144	Panch Mahals	Santrampur	-	-	0.1	-	59
145	Panch Mahals	Shehera	0.1	-	-	-	99
146	Patan	Chanasma	0.5	-	0.2	-	186
147	Patan	Harij	0.7	-	0.6	-	101
148	Patan	Patan	0.5	-	0.3	-	577
149	Patan	Radhanpur	0.8	-	0.3	-	147
150	Patan	Sami	0.7	-	0.2	-	94
151	Patan	Santalpur	0.3	-	0.2	-	47
152	Patan	Sidhpur	0.7	-	0.6	-	269
153	Patan	Vagdod	0.1	-	-	-	41
154	Porbandar	Kutiyana	0.5	0.9	-	-	20
155	Porbandar	Porbandar	2.3	2.4	5.7	0.1	1,499
156	Porbandar	Ranavav	2.4	2.6	5.5	0.1	880
157	Rajkot	Dhoraji	0.5	0.7	1.0	-	554
158	Rajkot	Gondal	0.5	0.7	0.6	-	821
159	Rajkot	Jamkandorna	0.3	0.4	0.3	-	198
160	Rajkot	Jasdan	0.2	-	0.1	-	470
161	Rajkot	Jetpur	0.3	0.4	0.1	-	2,055
162	Rajkot	Kotda Sangani	3.4	0.6	2.3	0.1	1,197
163	Rajkot	Lodhika	5.0	0.5	2.0	-	462
164	Rajkot	Maliya	0.3	-		-	329
165	Rajkot	Morvi	3.0	0.3	1.4	0 1	1,565
166	Rajkot	Paddhari	2.6	0.3	1.7	0.1	473
167	Rajkot	Rajkot	1.5	0.3	0.6	-	5,158
168	Rajkot	Tankara	5.2	0.5	-	0.2	639
169	Rajkot	Upleta	0.3	0.4	0.4	-	289
170	Rajkot	Wankaner	1 5	0.2	0 1	0.1	1,002
171	Sabar Kantha	Bayad	0.9	-	1.3	-	220
172	Sabar Kantha	Bhiloda	0.1	-	0.1	-	377
173	Sabar Kantha	Dhansura	1.0	-	1.6	-	247
174	Sabar Kantha	Himatnagar	1.0	-	2.2	-	1,070
175	Sabar Kantha	Idar	0.4	-	0.2	-	728
176	Sabar Kantha	Khedbrahma	0.3	-	0.2	-	265
177	Sabar Kantha	Malpur	0.2	-	0.1	-	72
178	Sabar Kantha	Meghraj	0.2	-	0.1	-	74
179	Sabar Kantha	Modasa	0.5	-	0.4	-	284
180	Sabar Kantha	Prantij	0.8	-	1.3	-	880
181	Sabar Kantha	Talod	0.7	-	0.4	-	132
182	Sabar Kantha	Vadali	0.3	-	0.2	-	161
183	Sabar Kantha	Vijaynagar	0.1	-	0.1	-	71
184	Surat	Bardoli	0.8	-	-	0.1	1,141
185	Surat	Chorasi	1.0	0.6	0.2	0.4	51,017
186	Surat	Kamrej	0.7	-	0.1	0.2	413
187	Surat	Mahuva	0.8	-	-	0.1	449
188	Surat	Mandvi	-	-	0.1	0.2	1,090
189	Surat	Mangrol	1.6	-	-	0.1	2,536
190	Surat	Nizar	-	-	0.2	-	22
191	Surat	Olpad	1.2	0.6	-	0.4	1,369
192	Surat	Palsana	1.0	-	-	0.1	1,520
193	Surat	Songadh	-	-	-	-	446
194	Surat	Surat City	-	0.2	0.1	0.1	12,113
195	Surat	Uchchhal	-	-	-	-	15
196	Surat	Umarpada	0.1	-	-	-	1
197	Surat	Valod	0.2	-			159
198	Surat	Vyara	0.1	-	0.1	-	362
199	Surendranagar	Chotila	2.7	0.5	6.9	-	498
200	Surendranagar	Chuda	0.2	-	-	-	33
201	Surendranagar	Dasada	0.7	-	1.4	-	311
202	Surendranagar	Dhrangadhra	3.5	-	3.4	-	556
203	Surendranagar	Halvad	2.8	0.3	2.0	0.1	223
204	Surendranagar	Lakhtar	1.0	-	0.9	-	112
205	Surendranagar	Limbdi	0.4	0.1	0.1	-	384
206	Surendranagar	Muli	2.8	0.3	1.2	-	229
207	Surendranagar	Sayla	2.5	0 6	6.0	0.1	2,478
208	Surendranagar	Wadhwan	1.6	0.3	0.6	-	1,459
209	The Dangs	The Dangs	0.2	-	-	-	54
210	Vadodara	Chhota Udaipur	-	-	0.1	0.2	271
211	Vadodara	Dabhoi	-	-	0.1	-	163
212	Vadodara	Jetpur Pavi	0.1	-	0.2	-	100
213	Vadodara	Karjan	1.0	-	0.1	0.1	4,285
214	Vadodara	Kavant	-		2.0	-	12
215	Vadodara	Nasvadi	-	-	-	-	59
216	Vadodara	Padra	1.0	-	1.7	0.1	2,990
217	Vadodara	Sankheda	0.1	-	0 4	-	188
218	Vadodara	Savli	1.1	-	2.6	0 1	3,594
219	Vadodara	Sinor	0.2	-	0.1	-	44
220	Vadodara	Vadodara	1.1	-	1.4	0.1	32,371
221	Vadodara	Vaghodia	-		1.0	0.1	2,205
222	Valsad	Dharampur	-	-	-	-	443
223	Valsad	Kaprada	-	-	-	0.1	121
224	Valsad	Pardi	1.2	-	-	0 4	7,267
225	Valsad	Umbergaon	1.5	-	-	0 6	2,795
226	Valsad	Valsad	1 0		-	0 5	4,263

ECONOMIC RISK

Gujarat accounts for nearly 6.5 percent of the India's GDP and more than 12 percent of the industrial output. The economy of Gujarat has achieved a moderately diversified economic structure in the last thirty years and has almost always grown faster than the national economy. A quick estimate of Gujarat's GSDP (at factor cost at constant 1993-94 prices) is Rs. 830 billion in 2001-02, a 67 percent growth over 1993-94. The share of primary, secondary and tertiary sectors is estimated at 19 percent, 39 percent and 42 percent respectively at constant (1993-94) prices.

TABLE (2.1): GUJARAT: SECTORAL GROWTH RATES AT CONSTANT (1980-81) PRICES (% Growth)

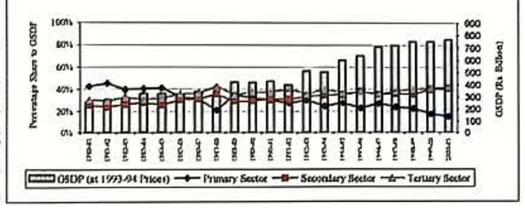
Sector	1960-61 to 1970-71	1970-71 to 1980-81	1980-81 to 1990-91	1990-91 to 1997-98
Primary Sector	3%	4%	-1%	3%
Secondary Sector	4%	6%	8%	13%
Tertiary Sector	4%	6%	7%	9%
Overall SDP of Gujarat	3%	5%	5%	9%
India GDP	3%	4%	5%	5%

Source Hirway, 2002 – based on EPW Research Foundation (1998) and DES (1999)

The secondary and tertiary economic sectors in the state have shown a consistently rising rate of growth since 1960, with growth rates between 19 percent and 13 percent in the 1990s (Hirway, 2002).

Gujarat has highly diversified economy with about 78 percent of the SDP coming from outside the primary sector, compared to 60 percent for the national economy. This is underpinned by the higher proportion of urban population in the state (38 percent compared to 28 percent for India in 2001), well-developed money and capital markets allowing relatively easy access of its enterprising population to finance.

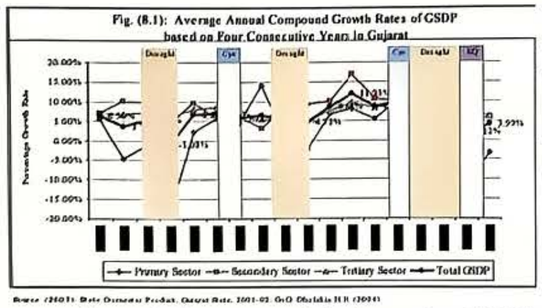
Fig. (2.1): Gujarat: GSDP Structure (1993-94 prices)



The share of the primary sector declined from 26 to 16 percent in the last two decades, while that of the secondary sector rose from 36 to 42 percent. The service sector saw a smaller rise in share from 39 to 43 percent. The per capita income in Gujarat (at constant prices) rose from Rs. 11,323 in 1993-94 to Rs. 15,748 in 2000-01 providing an indication of the real growth of the economy.

The Impact of Natural Hazards on the Economy

Fig. (8.1): Average Annual Compound Growth Rates of GSDP based on Four Consecutive Years in Gujarat



The impact of hazards on the economic performance of the state is relatively clear from the adjoining figure, which presents the average annual compound growth rates of the primary, secondary and tertiary sectors. Also presented are three episodes of drought, two major cyclonic storms and the devastating 2001 Kachchh earthquake. Drought especially in multiple years typically causes a significant decline in primary sector growth. Even for other major events like cyclones and earthquakes, there is an impact on both the secondary and service sectors.

DESIGN OF A VULNERABILITY ASSESSMENT SYSTEM FOR GUJARAT

Over the past decades, economic vulnerability assessment methods have developed steadily with an emphasis slowly shifting from qualitative (ADB, 1998; UNDRO, 1991; Winchester, 1992; UNDP, 1993) to increasingly quantitative and macro-economic analysis (World Bank, 2001; UNECLAC, 2002). The primary emphasis, however, is on definition of vulnerability and losses that hazards produce on:

1. Capital assets in the short or medium term **(direct loss potential)**
2. Potential flows of the production of goods and services **(indirect loss potential)**
3. Performance of macroeconomic parameters **(macroeconomic loss potential)**

This assignment primarily focuses on the direct loss potential and partially on indirect losses potential in Gujarat. Direct loss potential is easier to define compared to indirect loss potential, which is complex partially because of second order impact (which may actually lead to differential net gains to some economic activities due to increased rehabilitation investments) and their changing magnitude and dynamics over time. The current assignment attempts to deal with indirect losses by capturing potential losses based on past experiences such as interruption in productive business activities, functioning at reduced capacity over a period of time after an interruption apart from overall drop in business turnover.

DIRECT LOSS POTENTIAL ESTIMATION

The primary (non-population) direct losses that were estimated across the following elements at risk (with a focus on immovable assets and infrastructure):

- Immovable assets: (e.g. housing, critical buildings)
- Plants and machinery and installations
- Stock: (e.g. raw materials, goods in process and final stock)
- Infrastructure and utilities
- Irrigation works and reservoirs
- Farm land
- Cattle and other animal assets

Loss valuation was undertaken based on the estimated current market value based on the replacement cost (including depreciation) in the manufacturing and trade sector and without depreciation in primary sectors such as agriculture, animal husbandry and fisheries.

INDIRECT LOSS POTENTIAL ESTIMATION

The indirect loss potential estimation was undertaken based on current value of the sum of the flows of goods and services that was not produced or delivered due to the impact of a hazard. This also focused on loss of productive capacity and economic infrastructure of farmland, seed stocks, implements and livestock in the primary sector and plants and machinery and other economic assets in the industrial and trade sector.

GSDP AND CAPITAL STOCK VULNERABILITY AND RISK

The overall vulnerability assessment of the Gujarat's economy suggests that drought is the most important factor in GSDP compression followed by 100-year return period earthquake and cyclones, 50-year return period flood, earthquake and cyclone. Based on the sectors assessed in the current study which account for 59 percent of GSDP, a compression of 4.7 percent of GSDP in case of extreme drought, 2.6 percent where severe drought is concerned, 1.4 percent for moderate drought, 0.95 percent for 100-year return period earthquake, 0.3 percent for 100-year cyclone, 0.12 percent for flood and 0.06 percent for 50-year return period earthquake and cyclones.

TABLE (8.9): GUJARAT: ESTIMATED HAZARD RISK

Rank Order	Hazard Events	GVA Vulnerability*	GSDP Compression**	Capital Stock Compression
1	Extreme Drought	9.6%	4.7%	0.1%
2	Severe Drought	5.4%	2.6%	0.1%
3	Moderate Drought	2.9%	1.4%	Negligible
4	Earthquake - 100 year return period	2.0%	1.0%	3.9%
5	Cyclone - 100 year return period	0.7%	0.3%	0.2%
6	Floods	0.2%	0.1%	0.2%
7	Earthquake – 50 year return period	0.1%	0.1%	0.1%
8	Cyclone - 50 year return period	0.1%	0.1%	0.1%

Source: TARU Primary Analysis, 2004
Note:
* Vulnerability of GAV based on the sectors assessed
** Vulnerability imposed by assessed sectors to GSDP

TABLE (8.10): ESTIMATED RISK OF VARIOUS HAZARD TO GUJARAT'S ECONOMY *(Rs. million at current prices)*

Rank Order	Hazard Event	GSDP Loss	Capital Stock Loss
1	Extreme Drought	52,415	3,196
2	Severe Drought	29,365	1,211
3	Moderate Drought	15,811	Negligible
4	Earthquake (100-year return period)	10,642	59,512
5	Cyclone (100-year return period)	3,703	18,130
6	Floods	1,308	3,359
7	Earthquake (50-year return period)	646	1,923
8	Cyclone (50-year return period)	638	1,664

Source: TARU Primary Analysis, 2004
Note: *Reflects only the sectors assessed i.e. Agriculture and Animal Husbandry, Fishery, Manufacturing, Trade and hotels, which account for 59 percent of the GSDP only

The potential GSDP risk caused by drought based on the current assessed sectors (59 percent of GSDP), is estimated at Rs. 52,415 million for extreme drought, Rs. 29,365 million for severe drought, Rs. 15,811 million for moderate drought, Rs.10, 642 million for 100-year return period earthquake, Rs. 3,703 million for a 100-year return period of cyclone and Rs. 1,308 million for floods. The capital stock loss is highest at Rs. 59,512 for 100-year return period earthquake, followed by a 100-year return period cyclone at Rs.18,130 million. These losses pose a strong threat to the state economy's growth and have been one of the factors resenting in potential economic slow-down.

ANNUALISED GSDP AND CAPITAL STOCK RISKS

Based on the sectors assessed combined with the effect of natural hazards on Gujarat's economy of natural hazards, the estimated annualised risk to GSDP is substantive and accounts for Rs. 9,866 million which is roughly 1.8 percent of Gujarat's current GSDP. Of this, drought has the highest impact with an effective annualised risk of Rs. 9,561 million. The annualised loss to capital stock was estimated at Rs. 1,620 million every year. The adjoining table presents the annualised loss to GSDP and capital stock for drought, flood, earthquake and cyclone. An across the economy estimate of GSDP compression may touch 2 percent of the GSDP. This provides a strong economic rationale for mitigation in investment.

TABLE (8.11): GUJARAT: ESTIMATED (100-YEAR) ANNUALISED HAZARD RISK

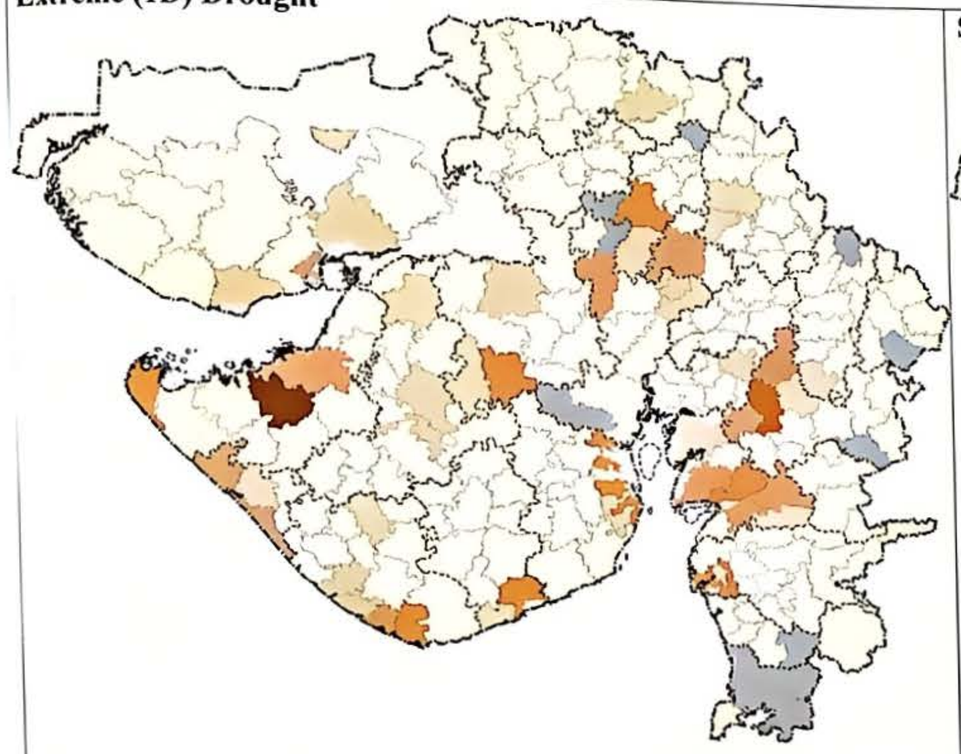
Rank Order	Hazard Events	Amount (Rs. Million at Current prices)	Percentage to Total
	A. GSDP Losses		
1	Drought	9,561	1.76%
2	Flood	136	0.02%
3	Earthquake	120	0.02%
4	Cyclone	50	0.01%
	All Event – GSDP Loss	**9,866**	**1.81%**
	B. Capital Stock Losses		
1	Earthquake	634	0.04%
2	Drought	441	0.03%
3	Flood	331	0.02%
4	Cyclone	215	0.01%
	All Event - Capital Stock	**1,620**	**0.11%**

Source TARU Primary Analysis, 2004

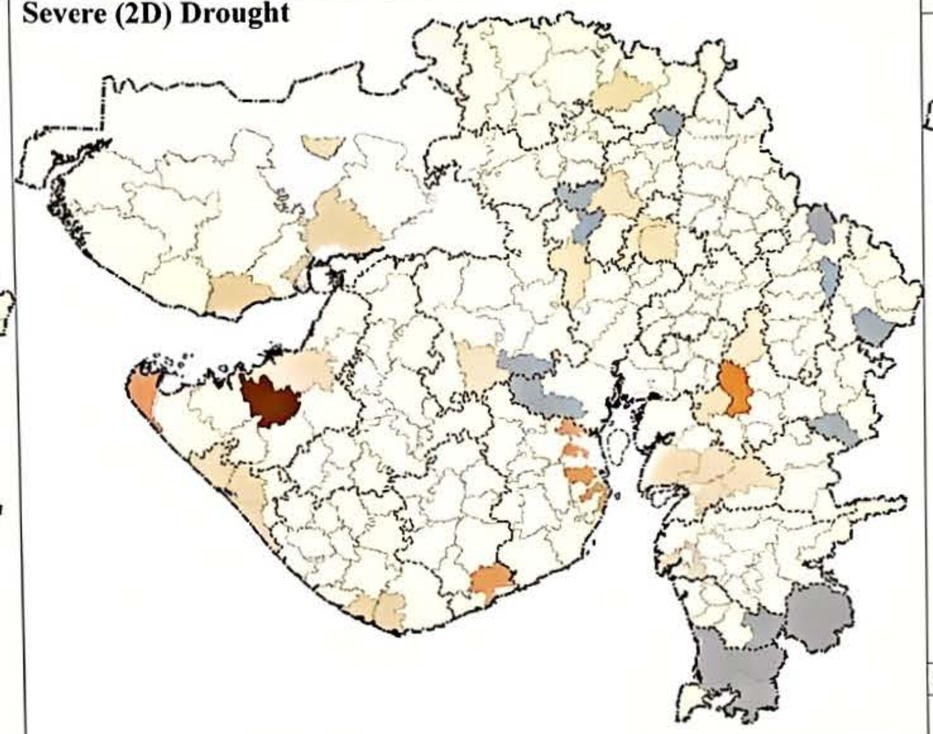
Gujarat Economic Risk Zonation: Manufacturing Sector GVA Loss due to Drought & Flood
(Rs. Million 1999-2000 Prices)

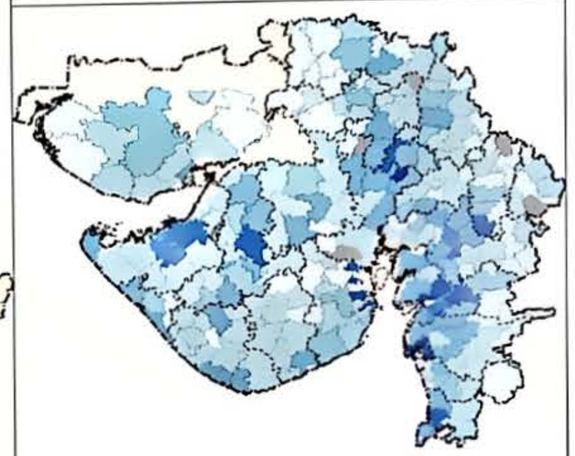
GSDMA

Extreme (1D) Drought



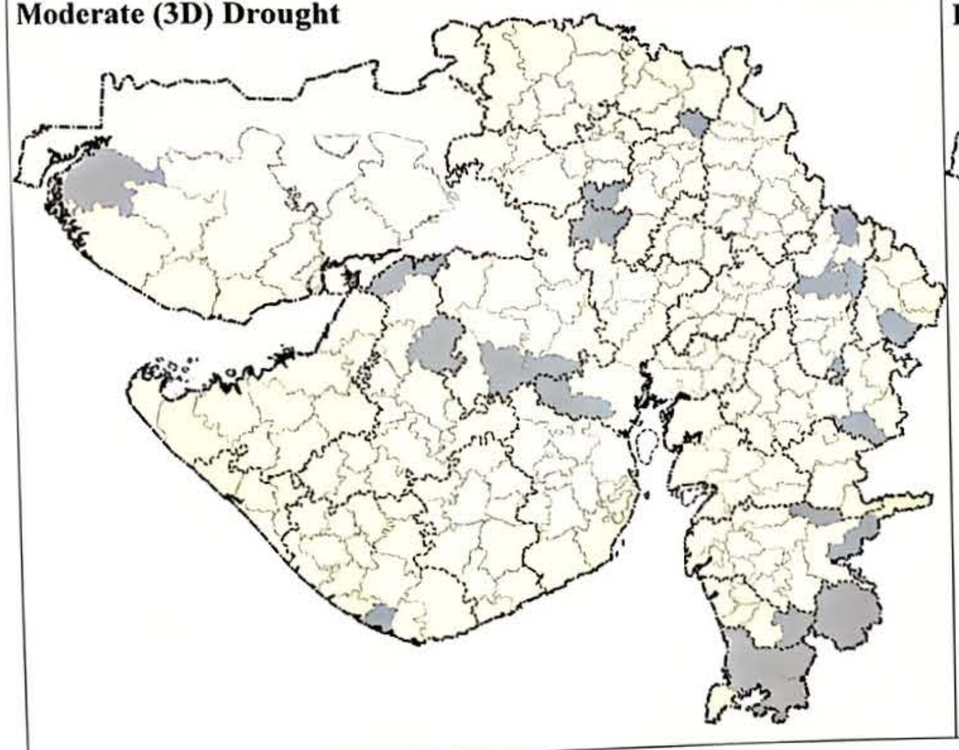
Severe (2D) Drought



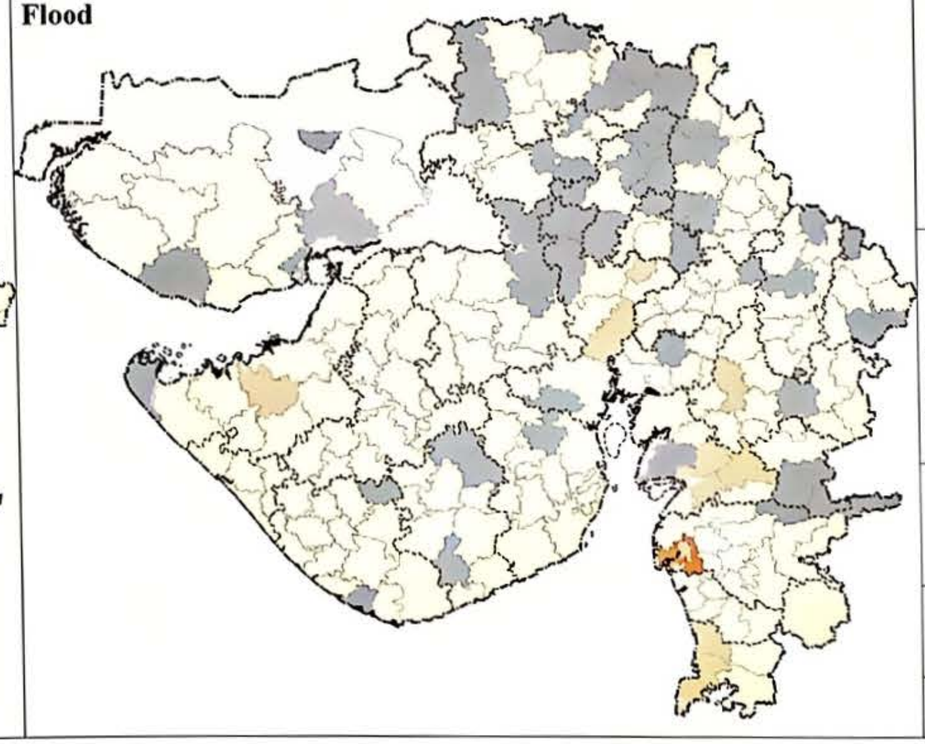


Total Manufacturing Sector GVA (Rs. Million)
- > 0 to 100
- > 100 to 500
- > 500 to 1000
- > 1000 to 5000
- > 5000 to 10000
- > 10000
- No/insignificant GVA

Moderate (3D) Drought



Flood



LEGEND

GVA Loss (Rs. Million)
- > 0 to 10
- > 10 to 50
- > 50 to 100
- > 100 to 300
- > 300 to 500
- > 500
- No/insignificant loss

Source: TARU Analysis, 2004; Census of Industries, 1999-2000, Department of Industries, GoG;
Annual Survey of Industries, 2000-2001, Central Statistical Organisation, GoI, New Delhi;
NSS 56th Round, 2000-2001 and NSS 57th Round, 2001-2002, National Sample Survey Organisation, GoI; BISAG, GoG.

0 100 km

N

Projection : Lambert Azimuthal Equal Area
Datum : WGS 84

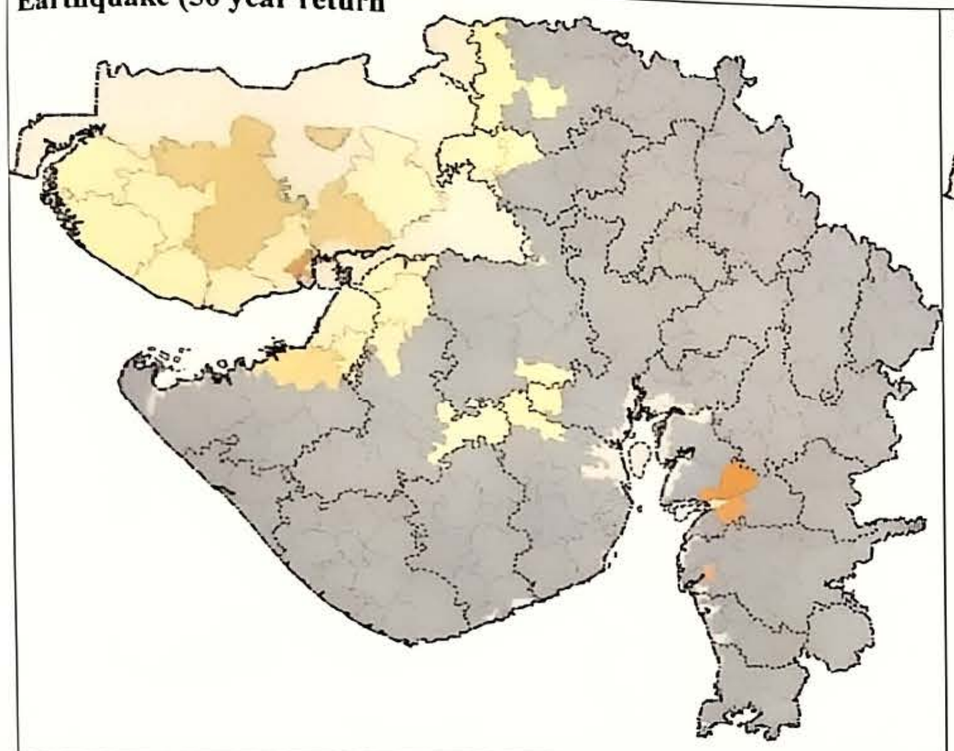
MAP No. : RECM - 01 OF 09

Date : 18/6/2005

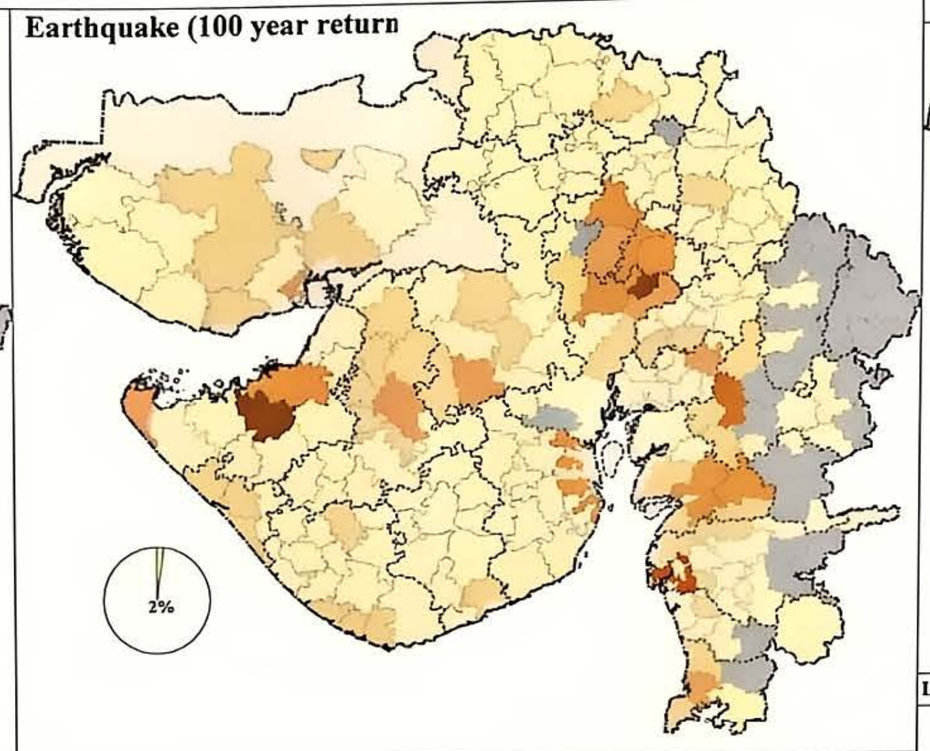
Gujarat Economic Risk Zonation: Manufacturing Sector GVA Loss due to Cyclone & Earthquake
(Rs. Million 1999-2000 Prices)

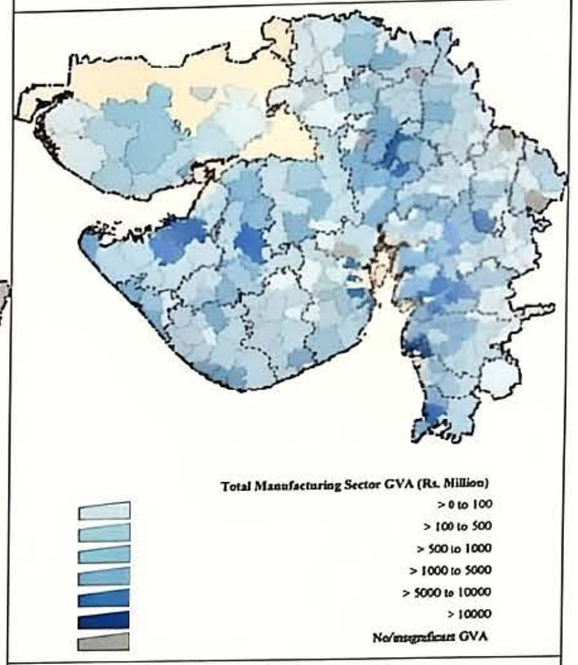
GSDMA

Earthquake (50 year return



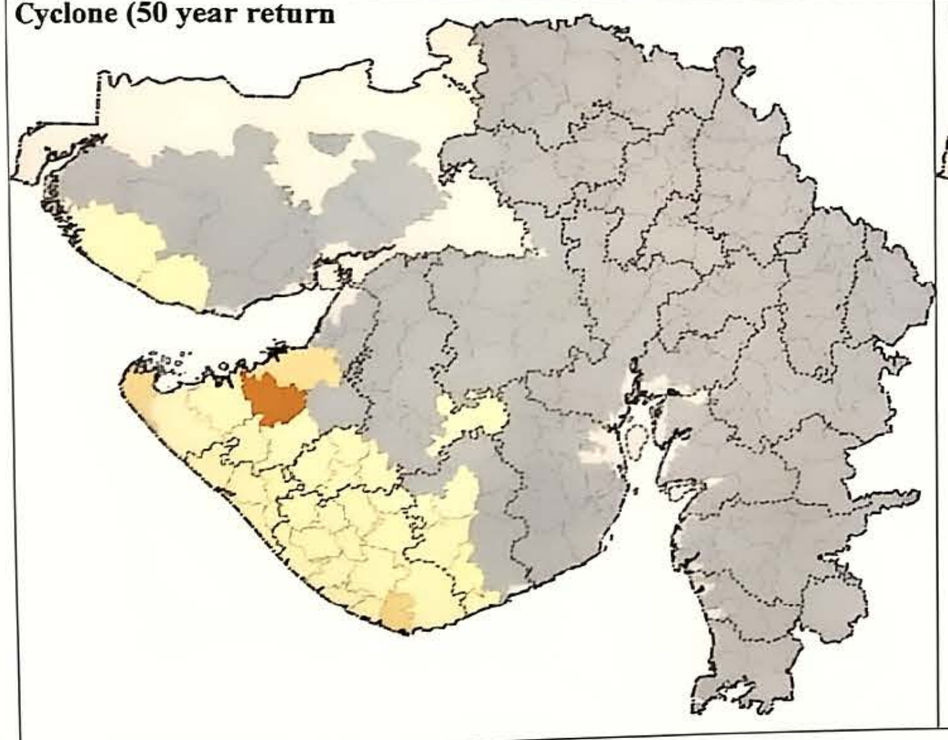
Earthquake (100 year return



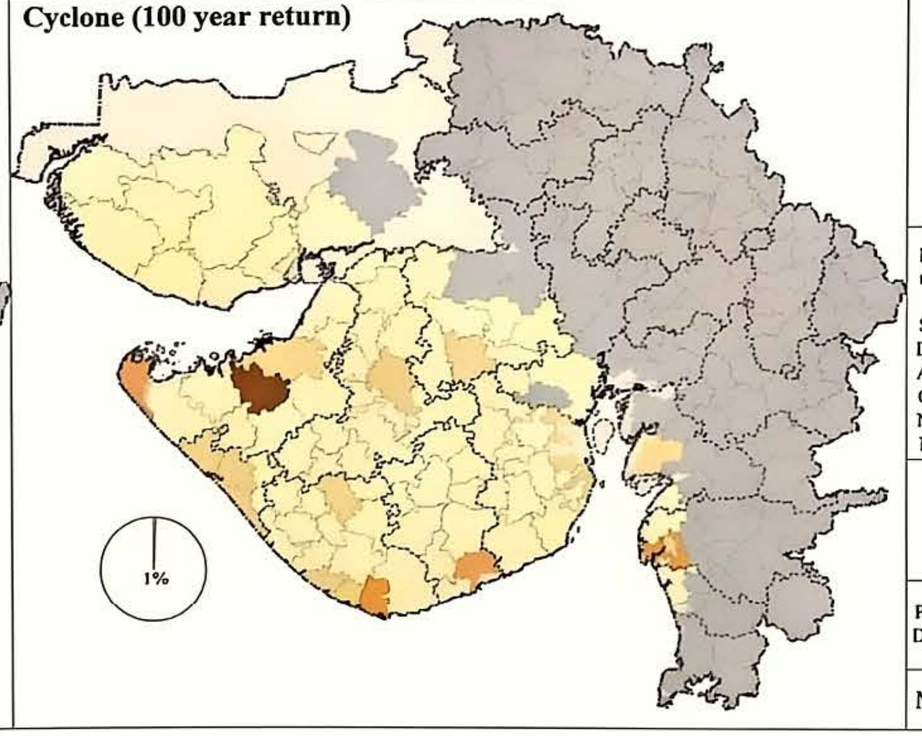


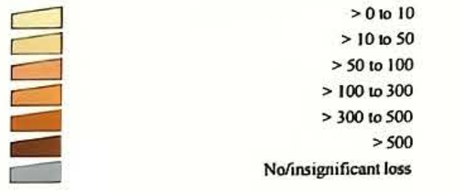
LEGEND

Cyclone (50 year return



Cyclone (100 year return)





Main map pie charts show the proportion of GVA loss due to respective event to total GVA in manufacturing sector.

Source: TARU Analysis, 2004; Census of Industries, 1999-2000, Department of Industries, GoG;
Annual Survey of Industries, 2000-2001,
Central Statistical Organisation, GoI, New Delhi;
NSS 56th Round, 2000-2001 and NSS 57th Round, 2001-2002,
National Sample Survey Organisation, GoI; BISAG, GoG.





Projection : Lambert Azimuthal Equal Area
Datum : WGS 84

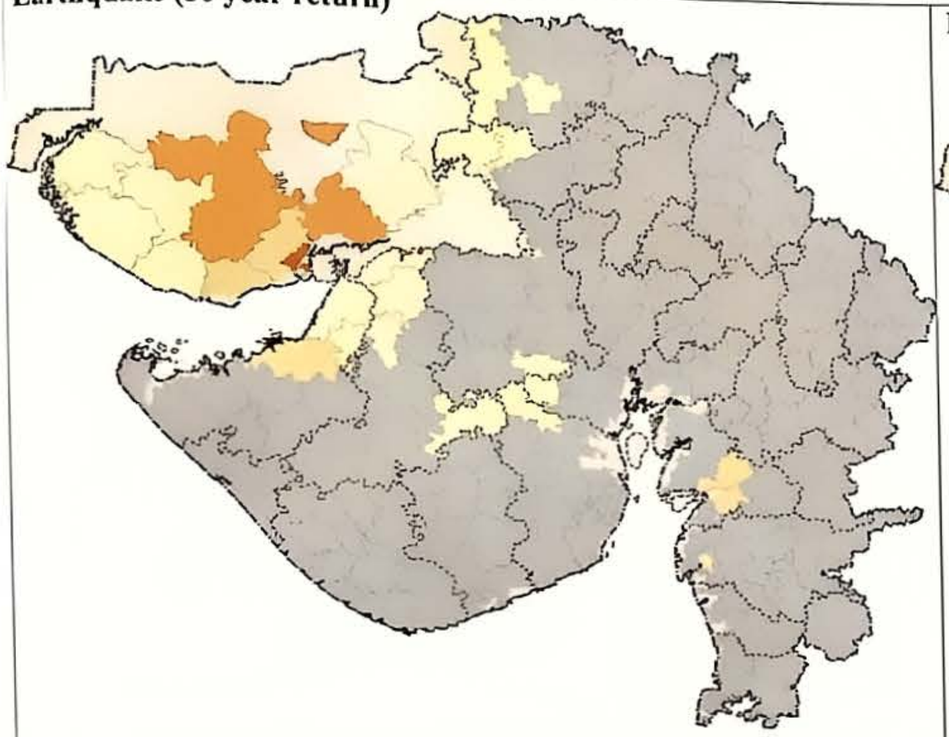
MAP No. : RECM - 02 OF 09

Date : 18/6/2005

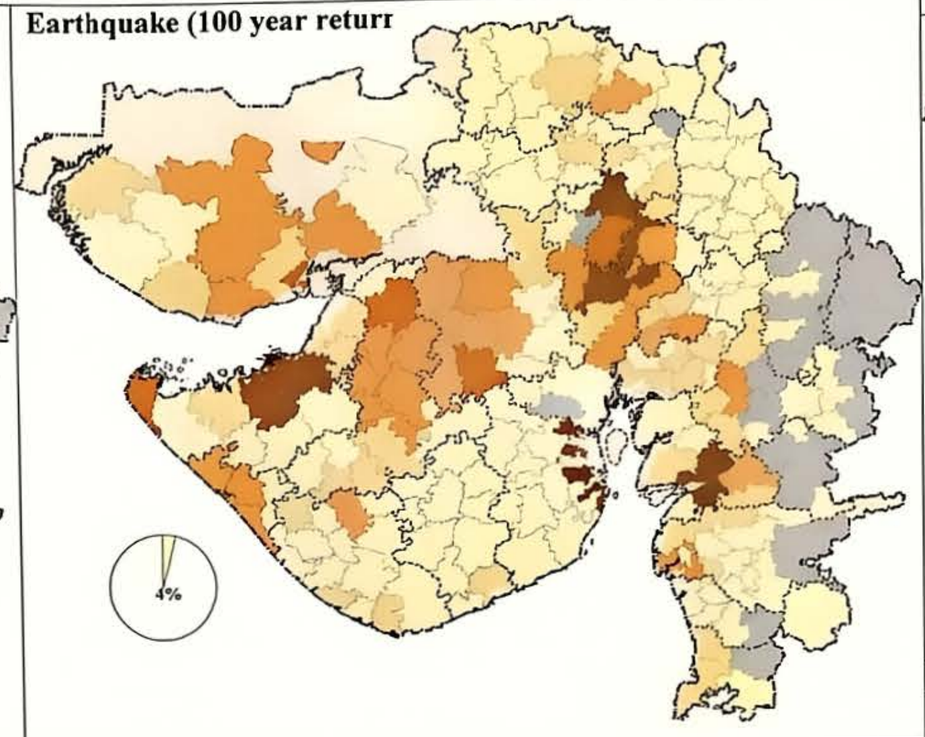
Gujarat Economic Risk Zonation: Manufacturing Sector Capital Stock Loss due to Cyclone & Earthquake
(Rs. Million 1999-2000 prices)

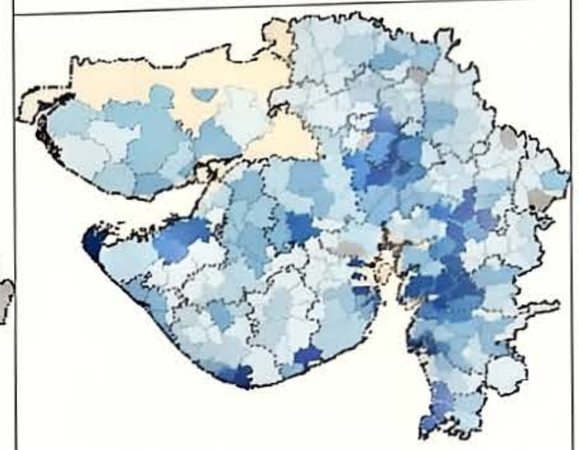
GSDMA

Earthquake (50 year return)



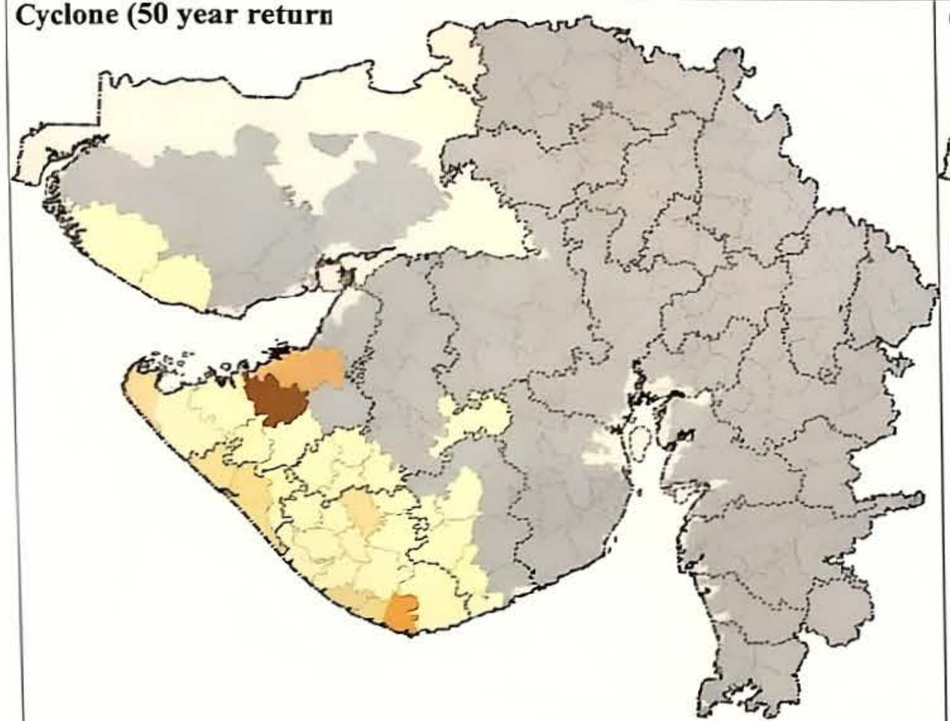
Earthquake (100 year return



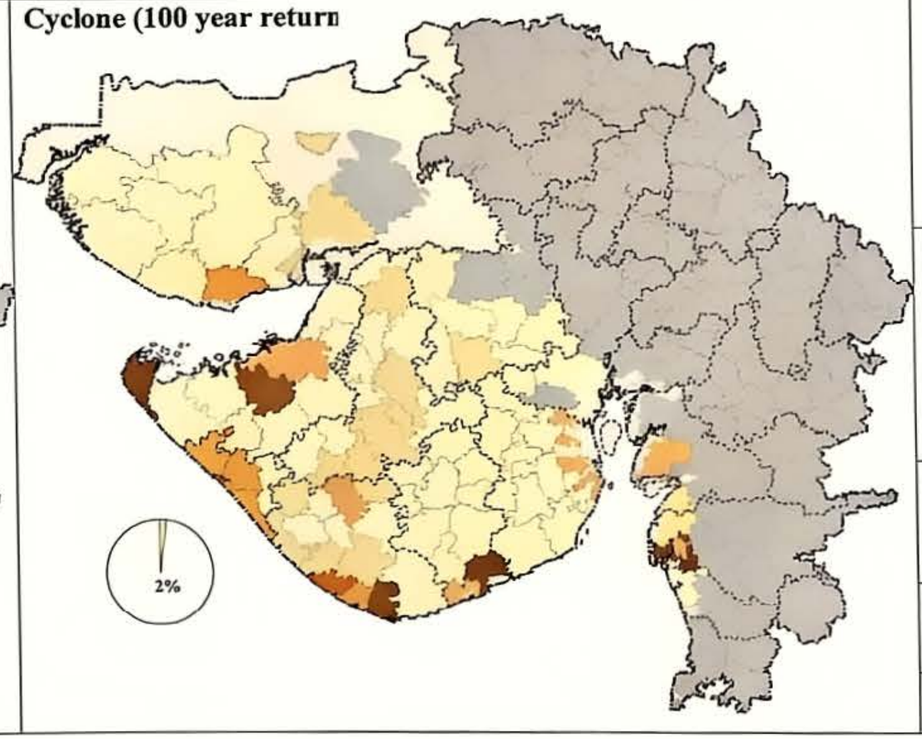


Total Capital Stock in Manufacturing Sector (Rs. Million)
> 0 to 100
> 100 to 500
> 500 to 1000
> 1000 to 5000
> 5000 to 10000
> 10000
No/insignificant loss

Cyclone (50 year return



Cyclone (100 year return



LEGEND

Capital Stock Loss (Rs. Million)
> 0 to 10
> 10 to 50
> 50 to 100
> 100 to 300
> 300 to 500
> 500
No/insignificant loss

Main map pie charts show the proportion of capital stock loss due to respective event to total capital stock in manufacturing sector.

Source: TARU Analysis, 2004; Census of Industries, 1999-2000, Department of Industries, GoG;
Annual Survey of Industries, 2000-2001,
Central Statistical Organisation, GoI, New Delhi;
NSS 56th Round, 2000-2001 and NSS 57th Round, 2001-2002,
National Sample Survey Organisation, GoI; BISAG, GoG.

0 100 km

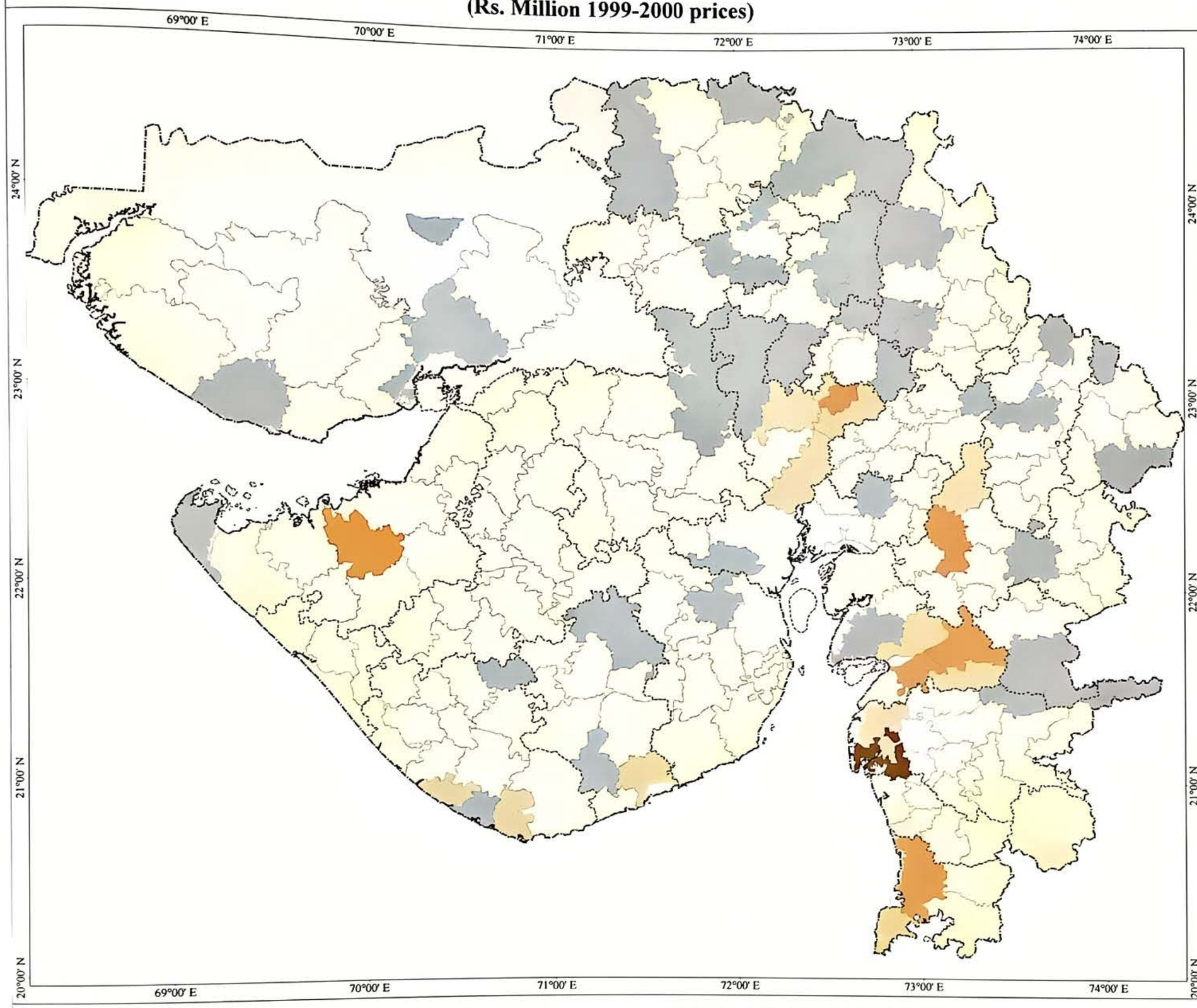
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Projection : Lambert Azimuthal Equal Area
Datum : WGS 84

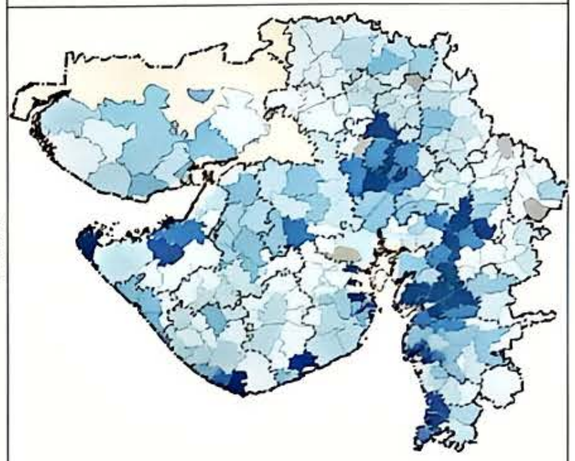
MAP No. : RECM - 03 OF 09

Date : 18/6/2005

Gujarat Economic Risk Zonation: Manufacturing Sector Capital Stock Loss due to Flood
(Rs. Million 1999-2000 prices)



GSDMA



Total Capital Stock in Manufacturing Sector (Rs. Million)

- > 0 to 100
- > 100 to 500
- > 500 to 1000
- > 1000 to 5000
- > 5000 to 10000
- > 10000
- No/insignificant loss

LEGEND

Capital Stock Loss (Rs. Million)

- > 0 to 10
- > 10 to 50
- > 50 to 100
- > 100 to 300
- > 300 to 500
- > 500
- No/insignificant loss

Source: TARU Analysis, 2004; Census of Industries, 1999-2000, Department of Industries, GoG;
Annual Survey of Industries, 2000-2001, Central Statistical Organisation, GoI, New Delhi;
NSS 56th Round, 2000-2001 and NSS 57th Round, 2001-2002, National Sample Survey Organisation, GoI; BISAG, GoG.

0 100 km

N

Projection : Lambert Azimuthal Equal Area
Datum : WGS 84

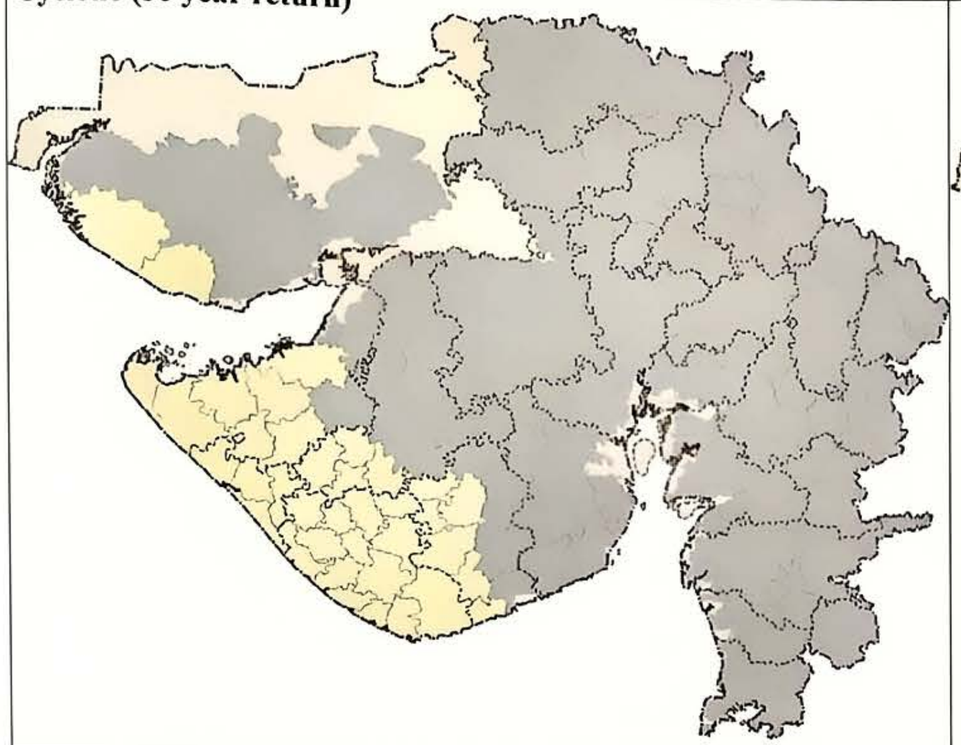
MAP No. : RECM - 04 OF 09

Date : 18/6/2005

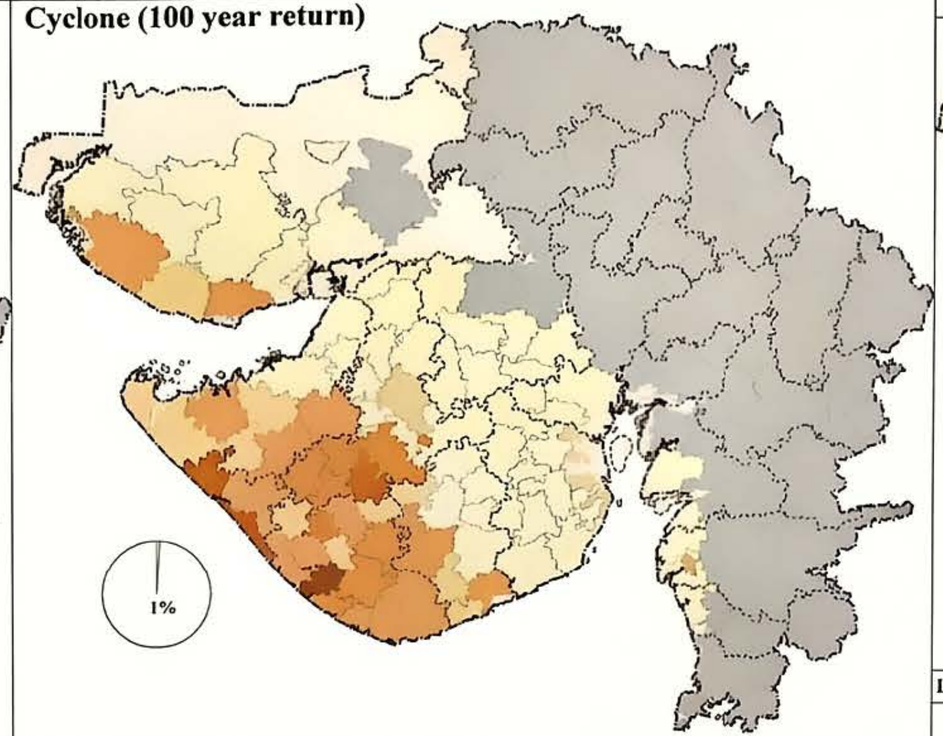
Gujarat Economic Risk Zonation: Trade & Hospitality Enterprises GVA Loss due to Cyclone & Earthquake
(Rs. Million 1998-1999 prices)

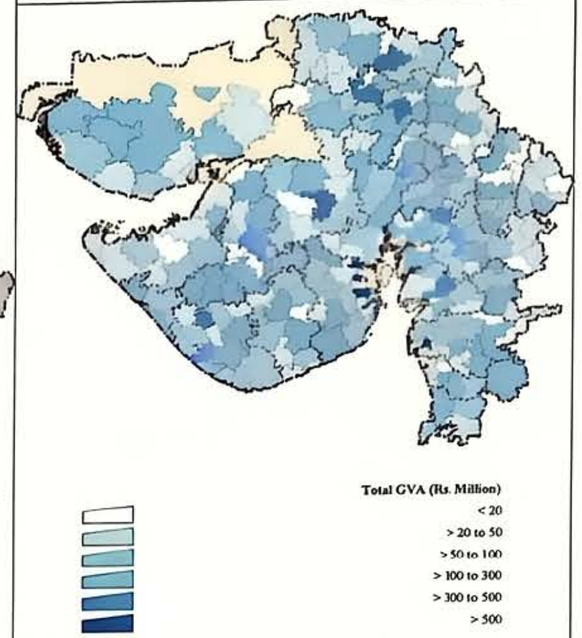
GSDMA

Cyclone (50 year return)



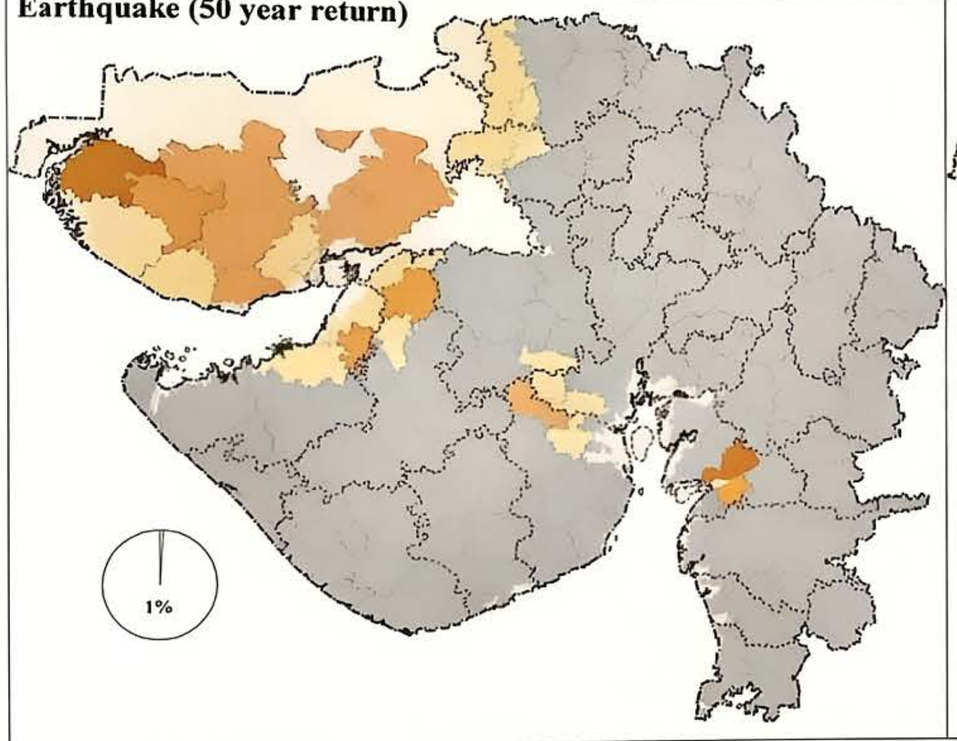
Cyclone (100 year return)



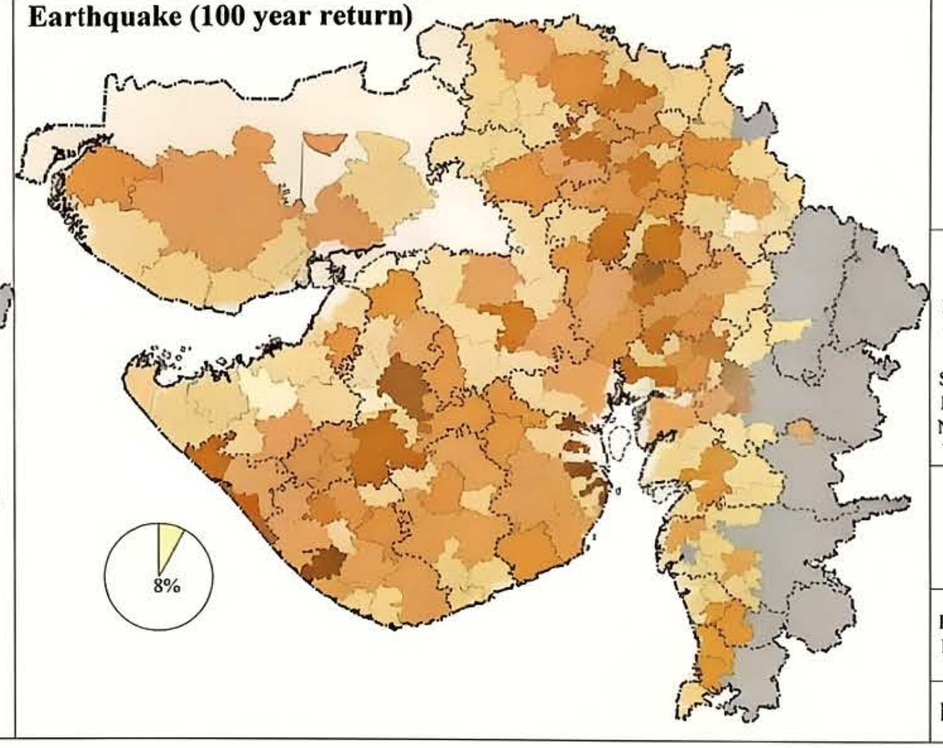


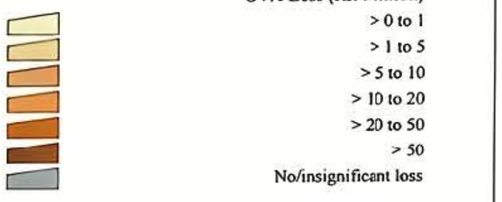
LEGEND

Earthquake (50 year return)



Earthquake (100 year return)





Main map pie charts show the proprtion of GVA loss due to respective event to total GVA in trade & hospitality enterprises.

Source: TARU Analysis, 2004;
Report on Fourth Economic Census-1998, GoG;
NSS 53rd Round (1997-1998),
National Sample Survey Organisation, GoI; BISAG, GoG.



Projection : Lambert Azimuthal Equal Area
Datum : WGS 84

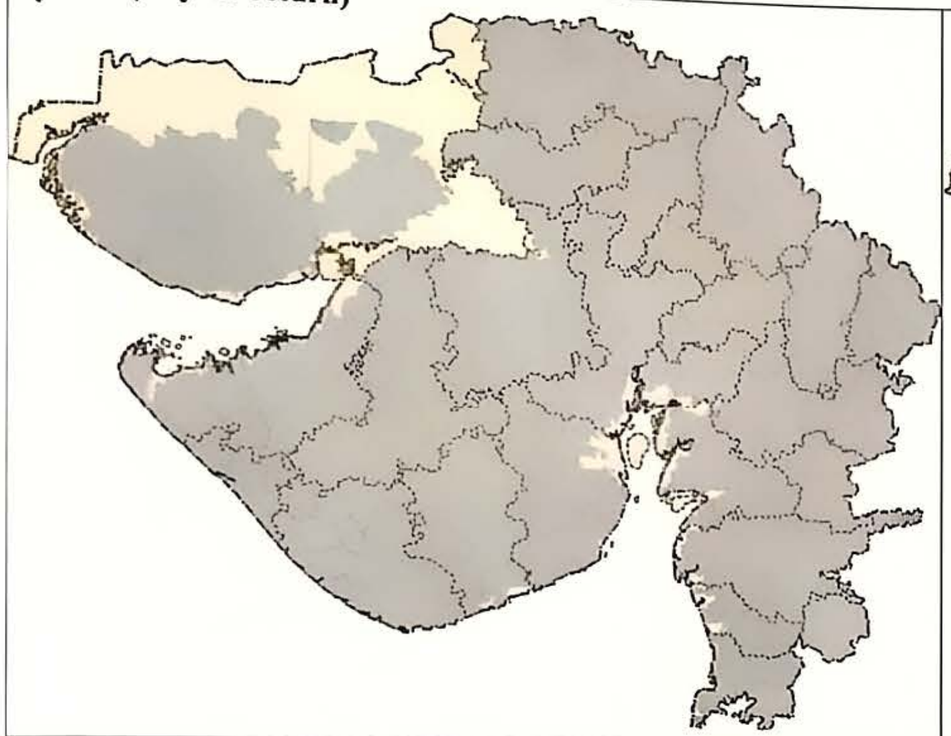
MAP No. : RECM - 05 OF 09

Date : 17/8/2005

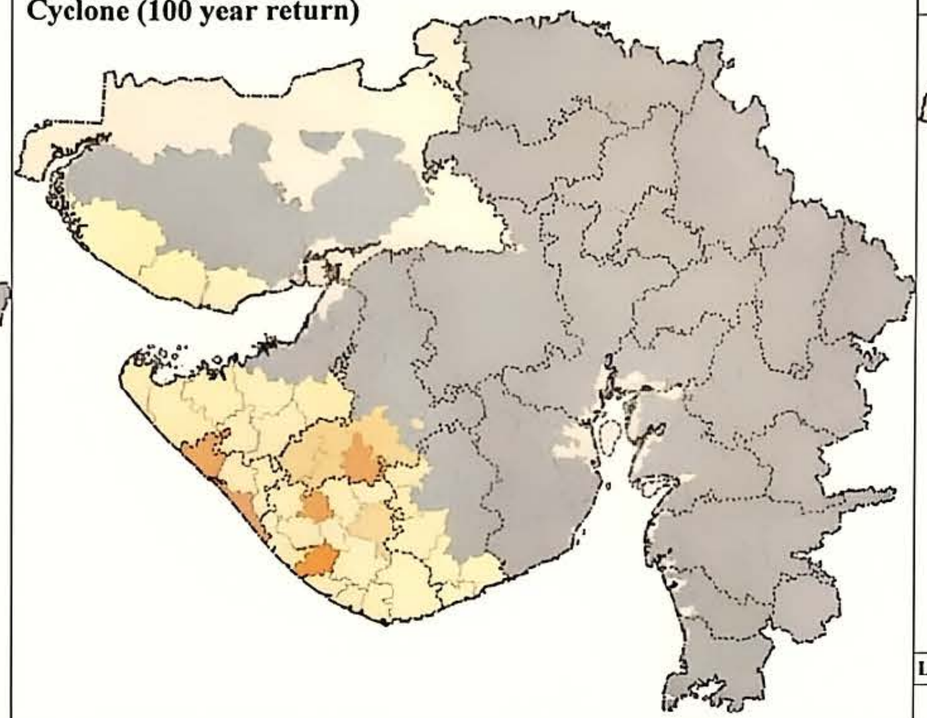
Gujarat Economic Risk Zonation: Trade & Hospitality Enterprises Capital Stock Loss due to Cyclone & Earthquake (Rs. Million 1998-1999 prices)

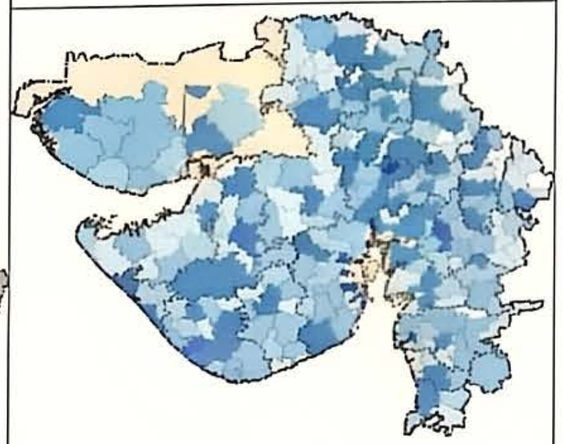
GSDMA

Cyclone (50 year return)



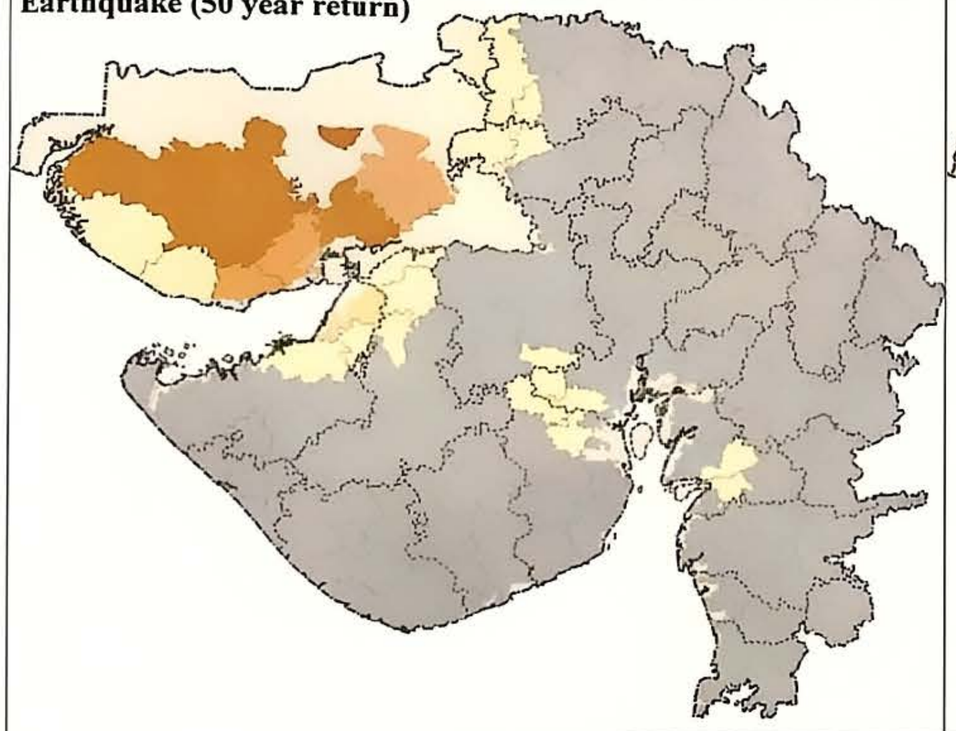
Cyclone (100 year return)



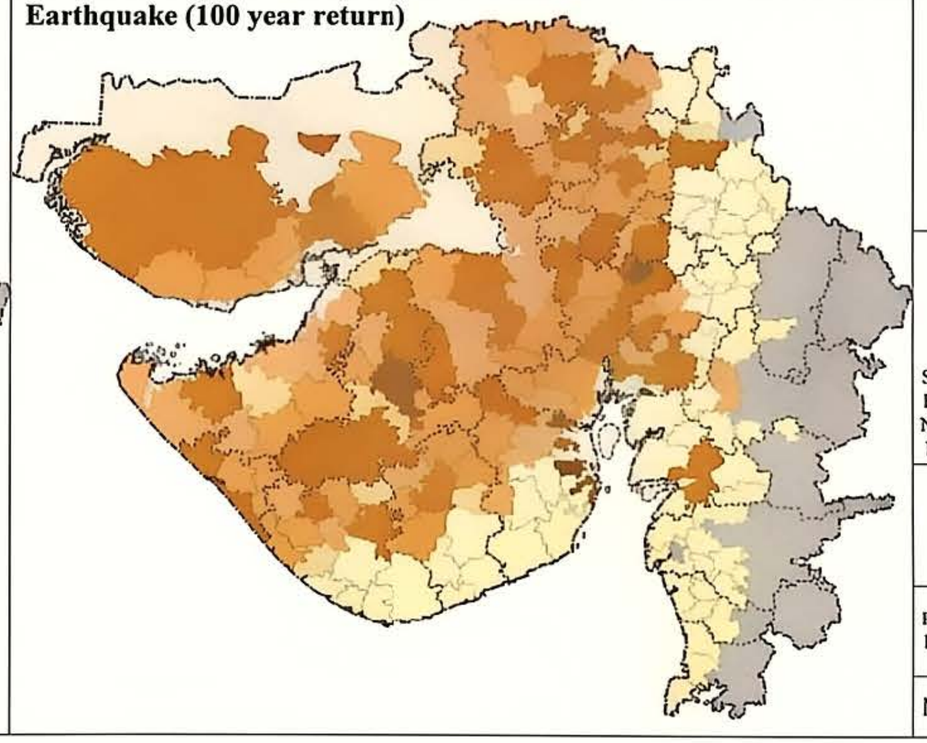


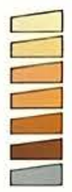
LEGEND

Earthquake (50 year return)



Earthquake (100 year return)





Source: TARU Analysis, 2004;
Report on Fourth Economic Census,1998, GoG;
NSS 53rd Round, 1997-1998,
National Sample Survey Organisation, GoI; BISAG, GoG.

0 100 km

N

Projection : Lambert Azimuthal Equal Area
Datum : WGS 84

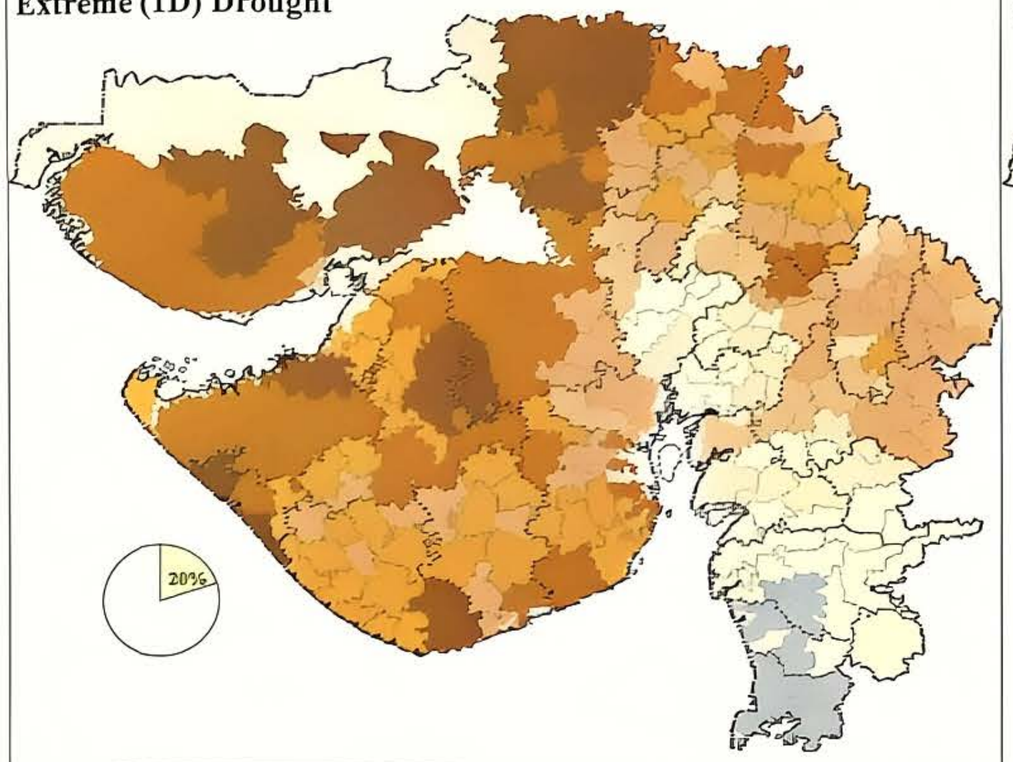
MAP No. : RECM - 06 OF 09

Date : 17/8/2005

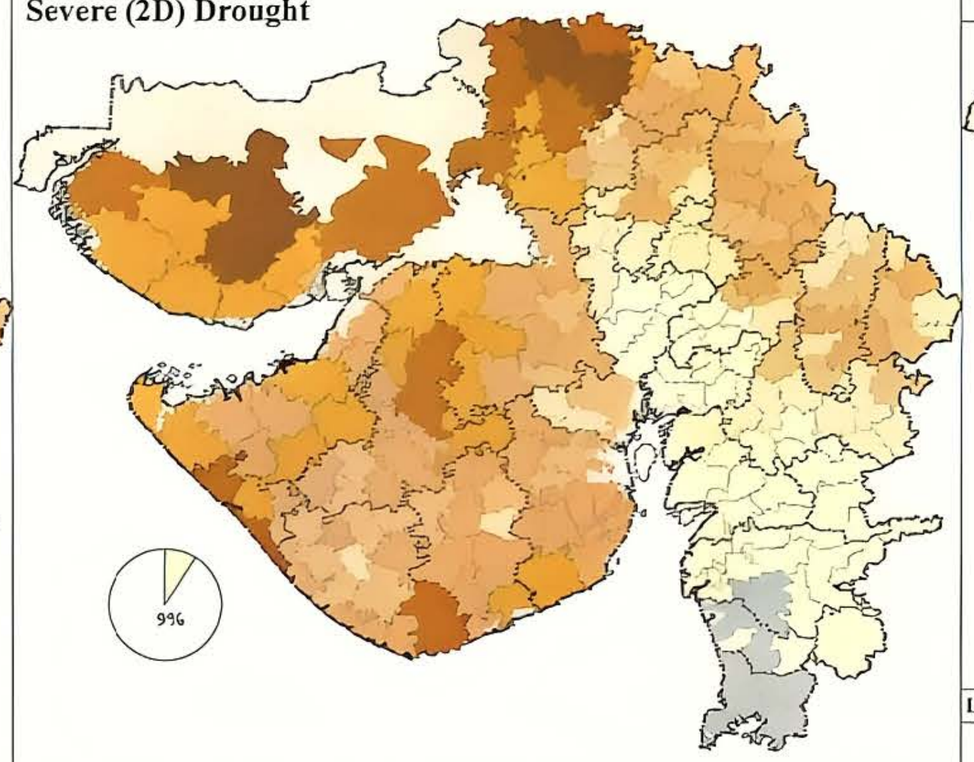
Gujarat Economic Risk Zonation: Animal Husbandry Sector GVA Loss due to Drought & Flood (Rs. Million 2002-2003)

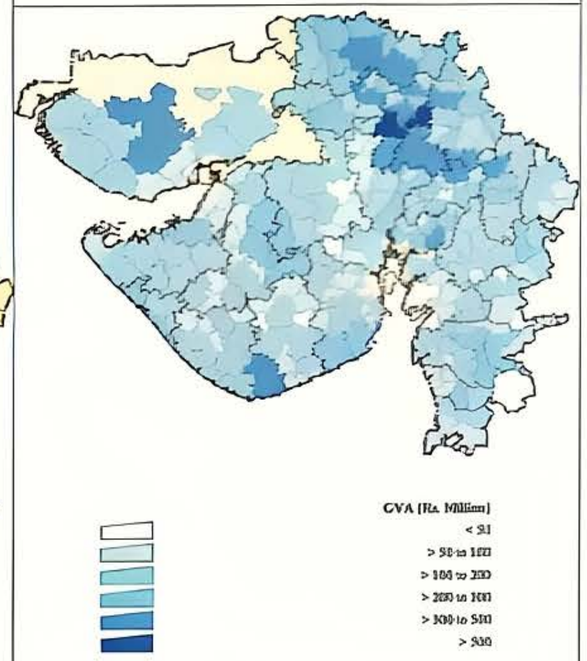
GSDMA

Extreme (1D) Drought

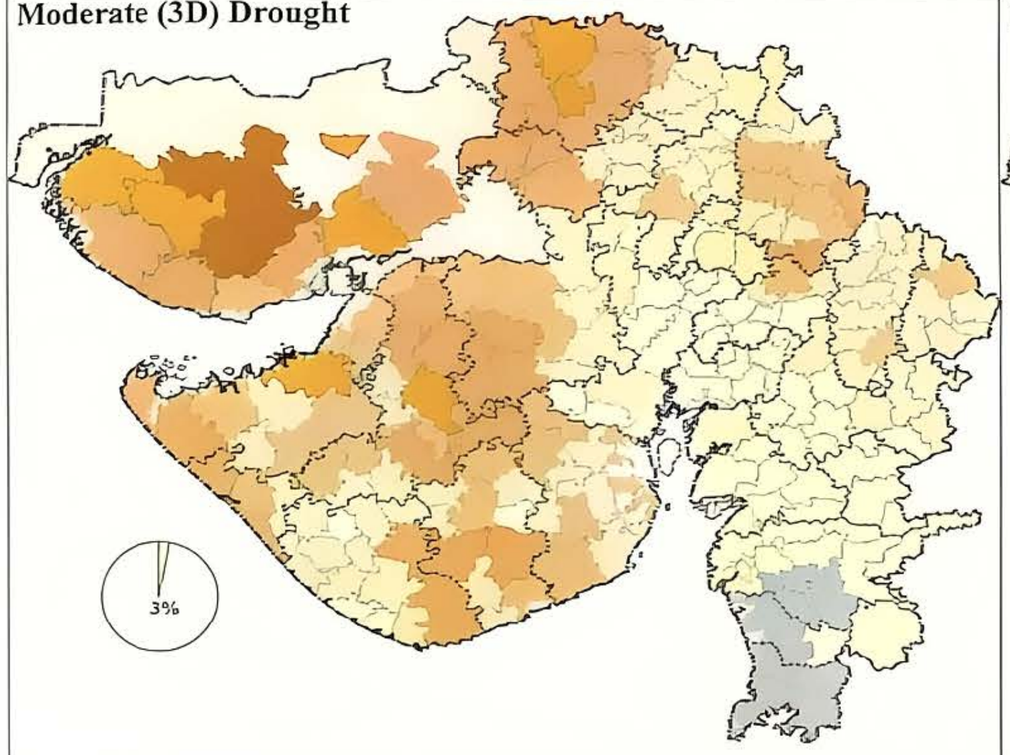


Severe (2D) Drought

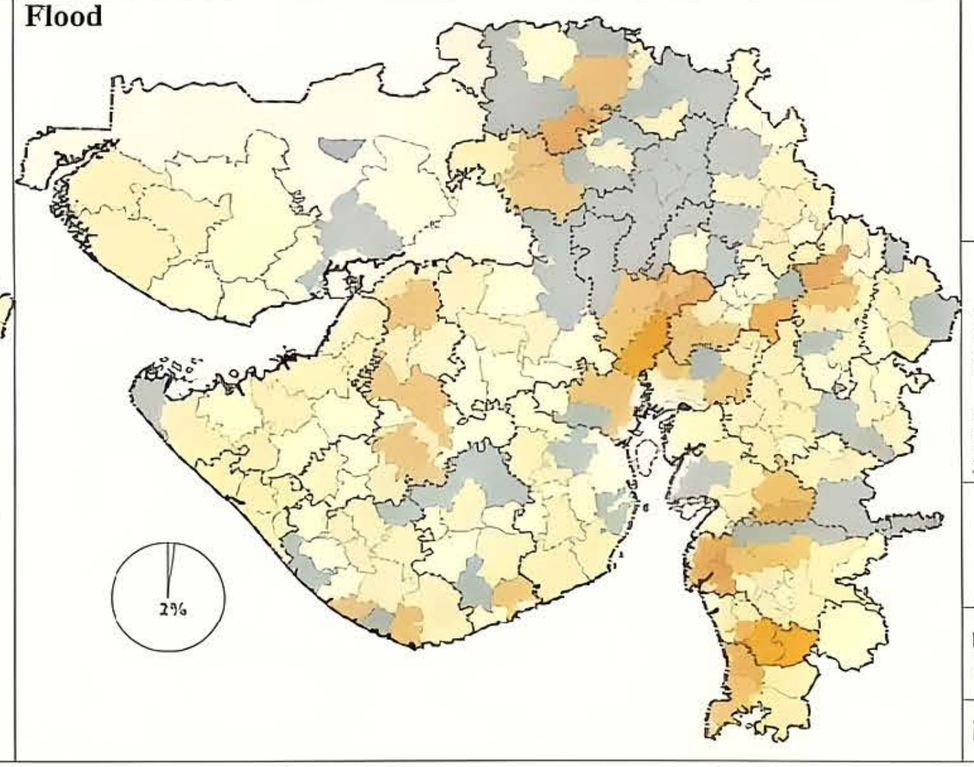




Moderate (3D) Drought



Flood



LEGEND

GVA Loss (Rs. Million)
- > 0 to 1
- > 1 to 5
- > 5 to 10
- > 10 to 25
- > 25 to 50
- > 50 to 100
- > 100
- No/insignificant loss

Main map pie charts show the proportion of animal husbandry GVA loss in respective parameter to total animal husbandry GVA loss.

Source: TARU Analysis, 2004; Livestock Census, 1997; 20th Survey Report on Estimates of Major Livestock Products, 2002-2003, DoAH, GoG; BISAG, GoG.

0 100 km

N

Projection : Lambert Azimuthal Equal Area
Datum : WGS 84

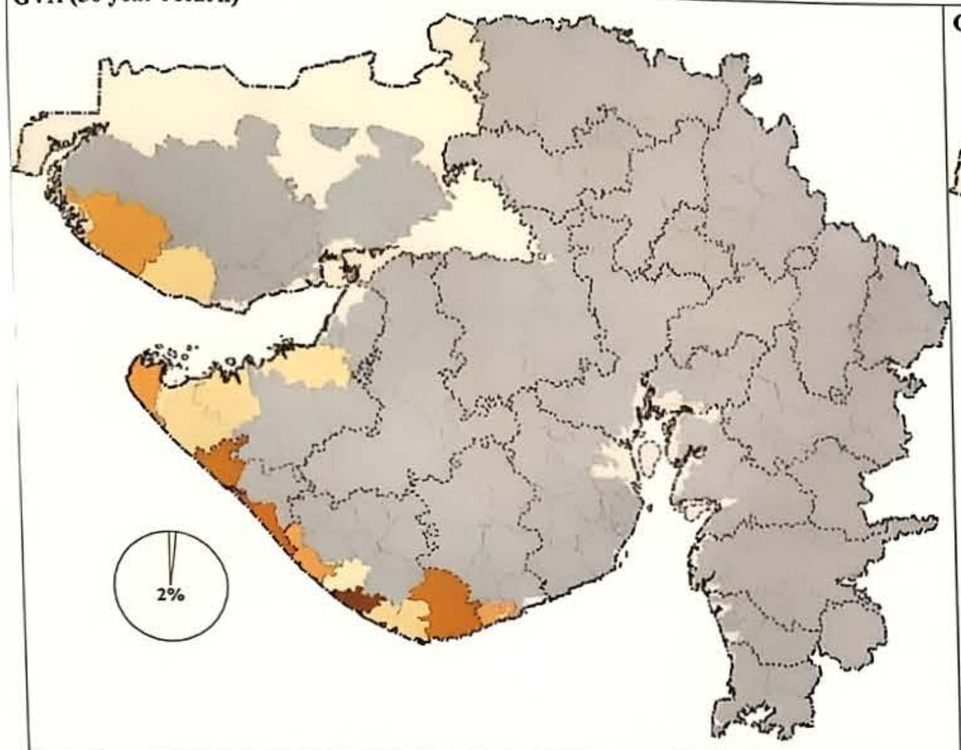
MAP No. : RECM - 07 OF 09

Date : 18/6/2005

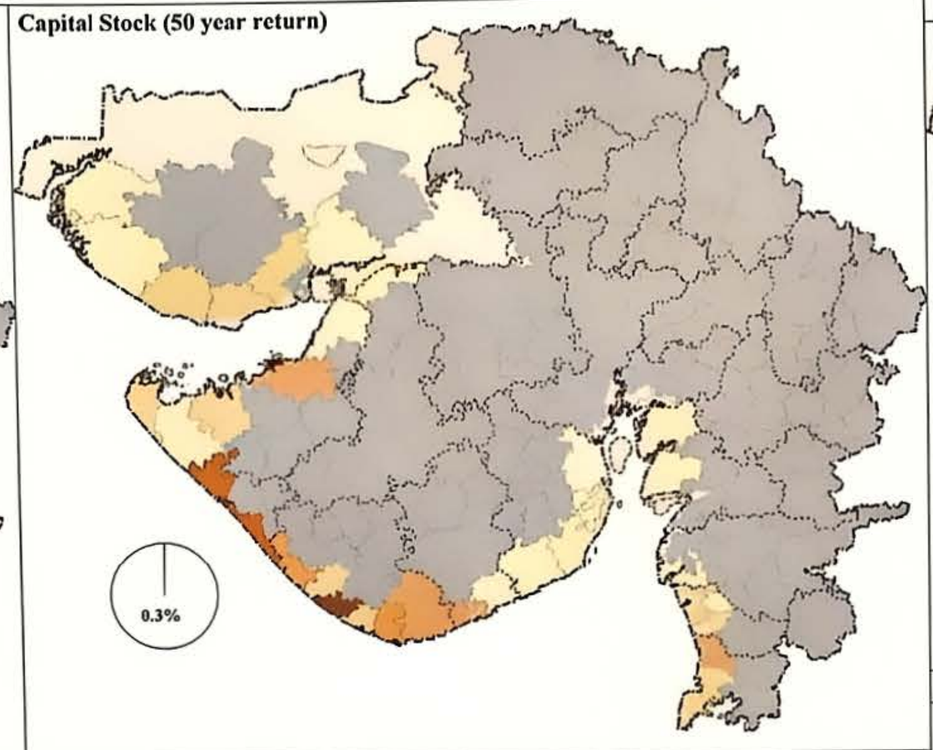
Gujarat Economic Risk Zonation: Marine Fishing Sector Loss due to Cyclone
(Rs. Million 2002-2003 prices)

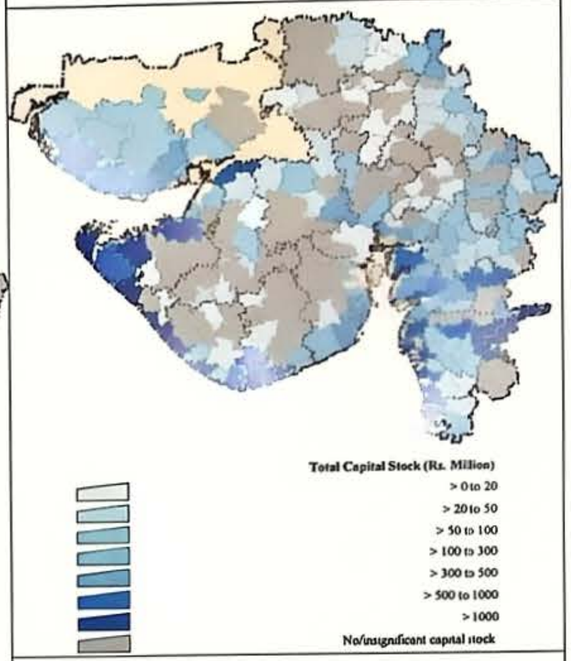
GSDMA

GVA (50 year return)

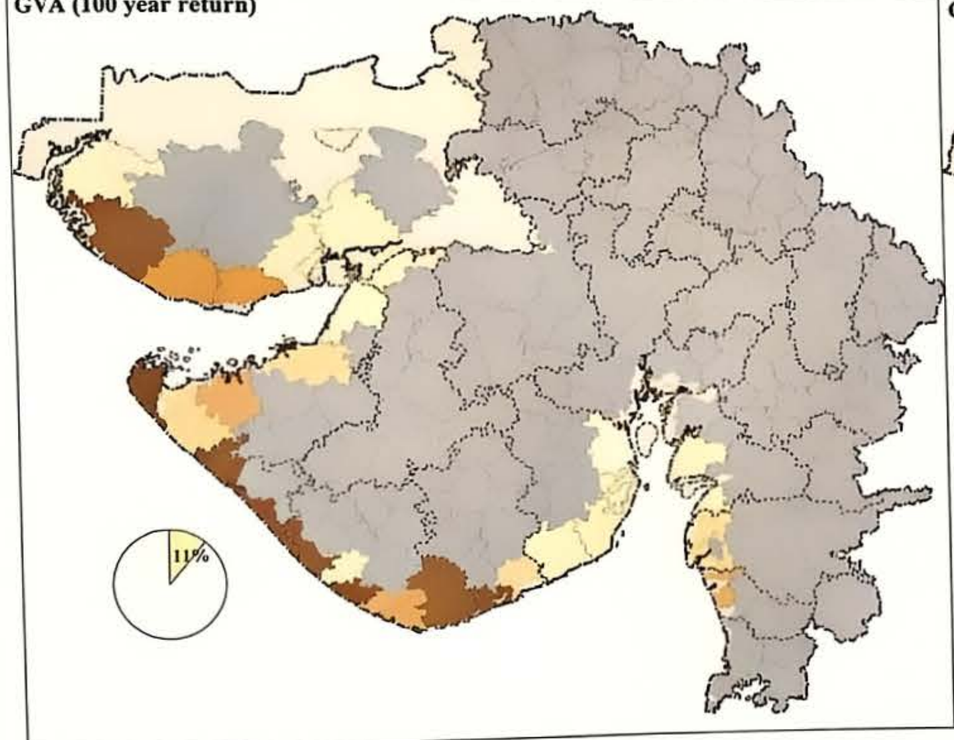


Capital Stock (50 year return)

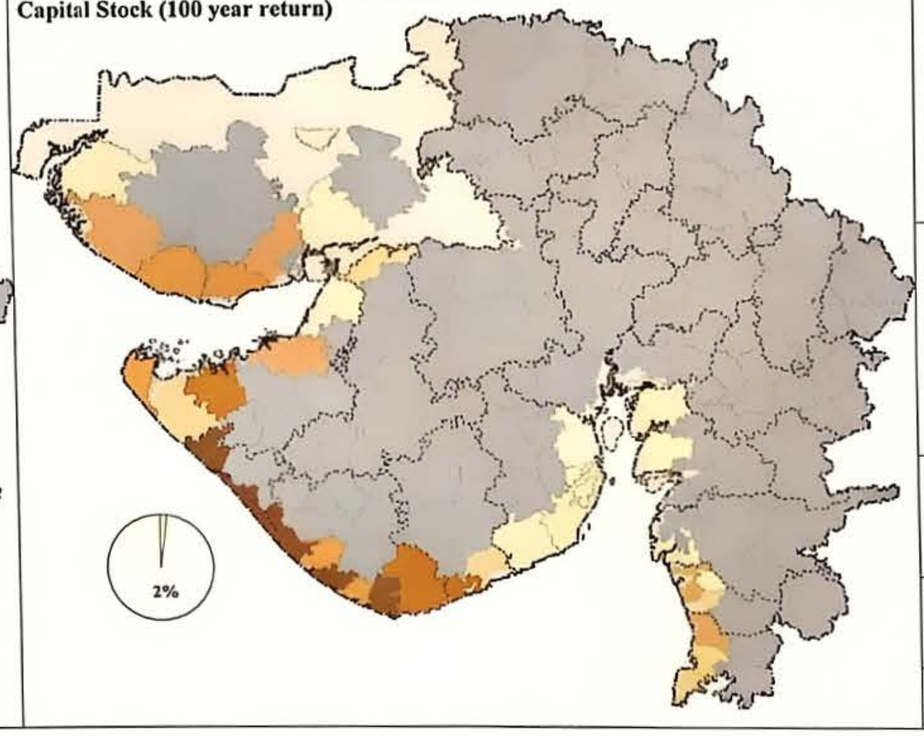




GVA (100 year return)



Capital Stock (100 year return)



LEGEND

Loss (Rs. Million)
- > 0 to 1
- > 1 to 5
- > 5 to 10
- > 10 to 25
- > 25 to 50
- > 50
- No/insignificant loss

Main map pie charts show the proportion of respective parameter loss in respective event to total loss value of that parameter.

Source: TARU Analysis, 2004;
Gujarat Fishery Statistics, 1999-2000 and 2001-2002;
BISAG, GoG.

0 100 km

N

Projection : Lambert Azimuthal Equal Area
Datum : WGS 84

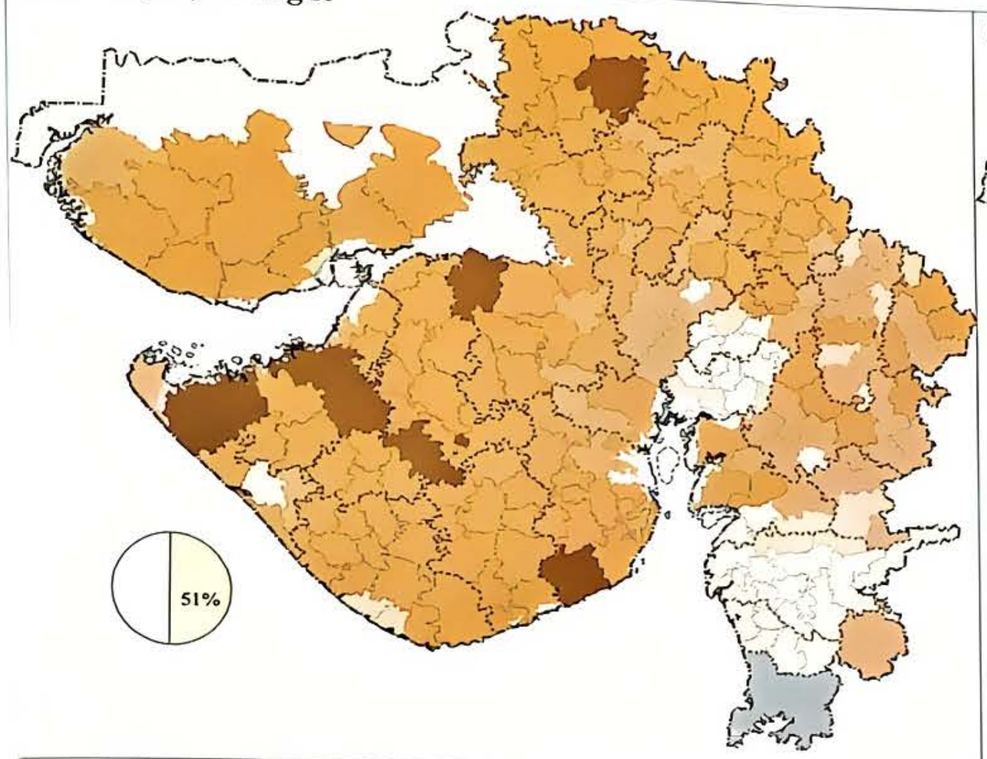
MAP No. : RECM - 08 OF 09

Date : 18/6/2005

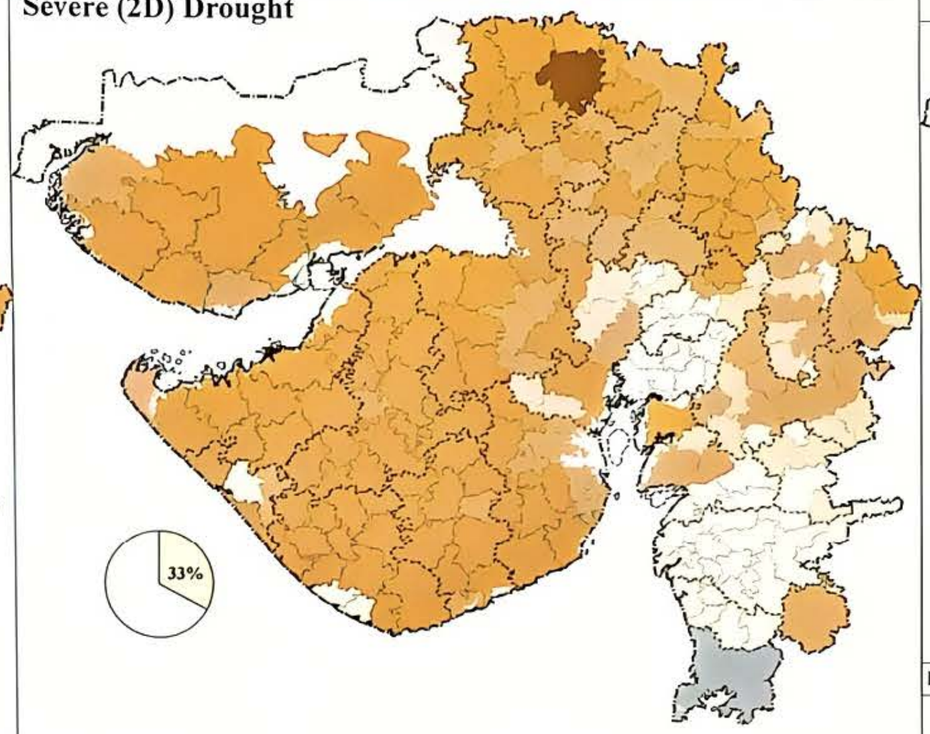
Gujarat Economic Risk Zonation: Agriculture GVA Loss due to Drought
(First to Fourth Decile Rainfall) (Rs. Million 2002-2003 prices)

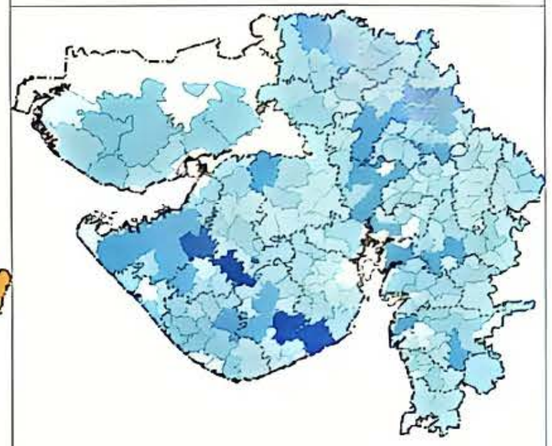
GSDMA

Extreme (1D) Drought



Severe (2D) Drought



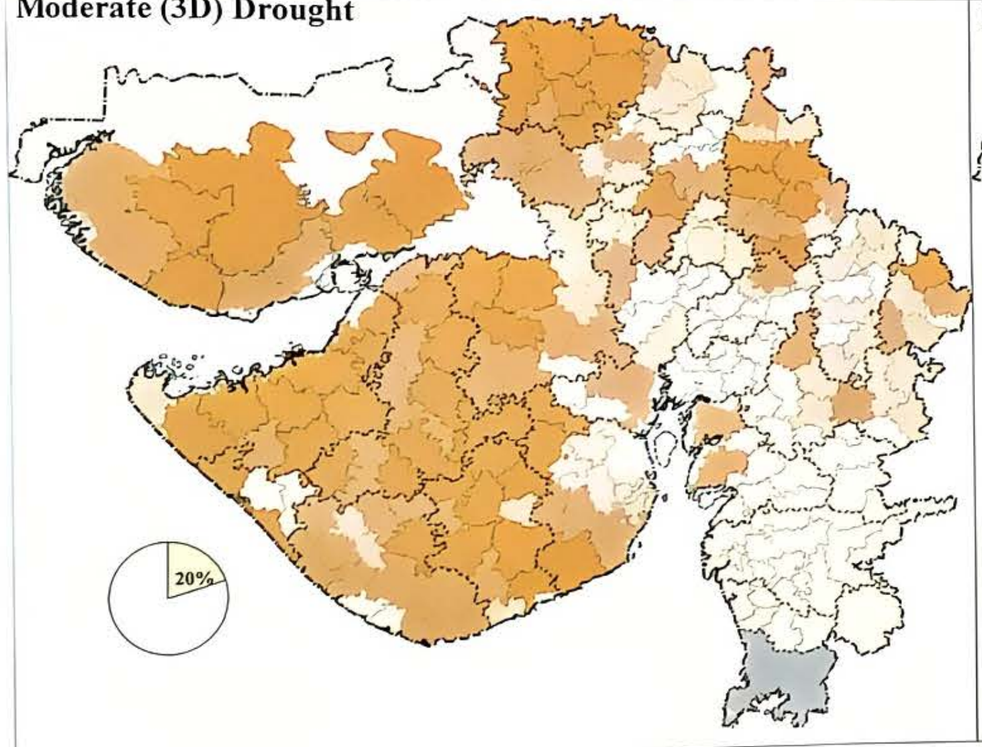


Total GVA (Rs. Million)
- < 50
- > 50 to 100
- > 100 to 300
- > 300 to 500
- > 500 to 700
- > 700

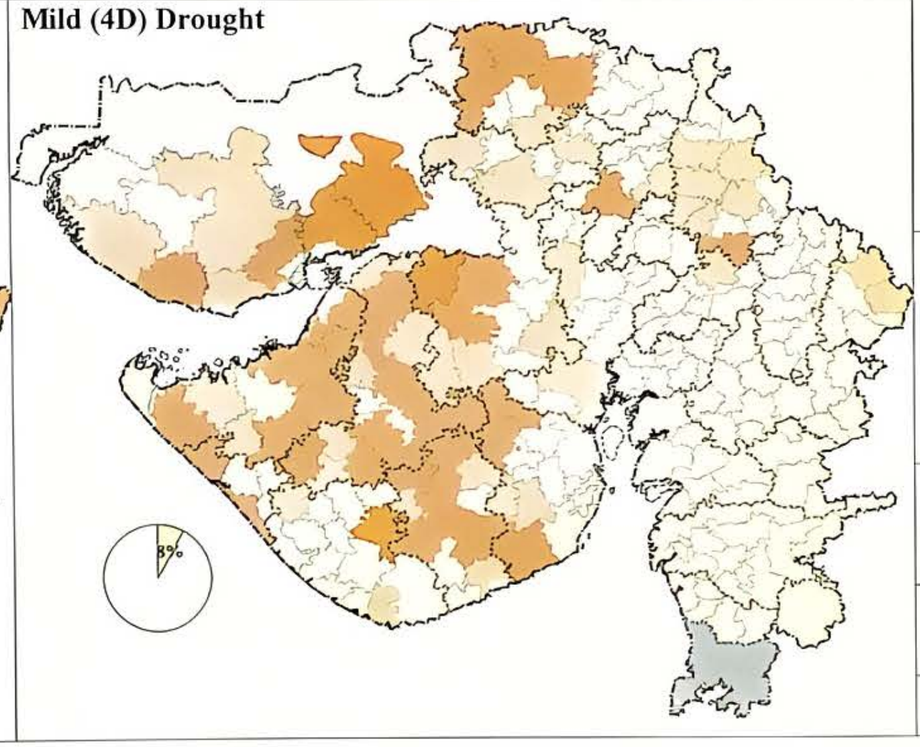
LEGEND

GVA Loss (Rs. Million)
- > 0 to 10
- > 10 to 30
- > 30 to 50
- > 50 to 100
- > 100 to 200
- > 200 to 500
- > 500
- No/insignificant loss

Moderate (3D) Drought



Mild (4D) Drought



Main map pie charts show the proportion of all crop GVA loss in respective decile to total agriculture GVA loss.

Source: TARU Analysis, 2004;
Department of Economics & Statistics, GoG;
Department of Agriculture, GoG; FAO/ICRISAT; GAU, Anand;
BISAG, GoG.

0 100 km

N

Projection : Lambert Azimuthal Equal Area
Datum : WGS 84

MAP No. : RECM - 09 OF 09

Date : 18/6/2005

GUJARAT ECONOMIC RISK ZONATION : MANUFACTURING SECTOR GVA LOSS DUE TO CYCLONE & EARTHQUAKE
(Rs. MILLION 1999-2000 PRICES) Table No. RECT - 01 of 02

GSDMA

Sr. No	District	Taluka	Earthquake (50 year return)	Earthquake (100 year return)	Cyclone (50 year return)	Cyclone (100 year return)	Total
1	Ahmadabad	Ahmadabad City	-	540 3	-	-	32,694
2	Ahmadabad	Barwala	-	-	-	-	-
3	Ahmadabad	Bavla	-	7 5	-	-	406
4	Ahmadabad	Daskroi	-	52.9	-	-	3,453
5	Ahmadabad	Detroj-Rampura	-	-	-	-	-
6	Ahmadabad	Dhandhuka	-	2 1	-	0.4	449
7	Ahmadabad	Dholka	-	24 6	-	-	1,901
8	Ahmadabad	Mandal	-	-	-	-	24
9	Ahmadabad	Ranpur	0.2	1.0	-	0 1	16
10	Ahmadabad	Sanand	-	106 1	-	-	4,517
11	Ahmadabad	Viramgam	-	42 7	-	-	2,214
12	Amreli	Amreli	-	1 7	0 3	0 3	303
13	Amreli	Babra	-	0 6	-	0 1	60
14	Amreli	Bagasara	-	0.4	0 1	0 7	172
15	Amreli	Dhari	-	1.6	0.4	1 8	256
16	Amreli	Jafrabad	-	2 9	1.6	7 3	327
17	Amreli	Khambha	-	0.2	0 1	0 5	102
18	Amreli	Kunkavav Vadia	-	0 2	-	0.4	212
19	Amreli	Lathi	-	0 7	-	0 1	216
20	Amreli	Lilia	-	0.1	-	-	58
21	Amreli	Rajula	-	33.4	-	83.6	3,390
22	Amreli	Savar Kundla	-	1.1	-	0 3	390
23	Anand	Anand	-	54.0	-	-	4,549
24	Anand	Anklav	-	0 3	-	-	90
25	Anand	Borsad	-	2 5	-	-	424
26	Anand	Khambhat	-	3.6	-	-	316
27	Anand	Petlad	-	6 0	-	-	510
28	Anand	Sojitra	-	1 5	-	-	69
29	Anand	Tarapur	-	0.4	-	-	36
30	Anand	Umreth	-	4.1	-	-	509
31	Banas Kantha	Amirgadh	-	0.9	-	-	46
32	Banas Kantha	Bhabhar	-	0.2	-	-	31
33	Banas Kantha	Danta	-	3.9	-	-	266
34	Banas Kantha	Dantiwada	-	-	-	-	18
35	Banas Kantha	Deesa	-	7 9	-	-	544
36	Banas Kantha	Deodar	0 3	0 5	-	-	58
37	Banas Kantha	Dhanera	-	0 7	-	-	115
38	Banas Kantha	Kankrej	-	0 3	-	-	87
39	Banas Kantha	Palanpur	-	24.2	-	-	1,283
40	Banas Kantha	Tharad	-	0.3	-	-	79
41	Banas Kantha	Vadgam	-	0 9	-	-	295
42	Banas Kantha	Vav	-	0.1	-	-	42
43	Bharuch	Amod	-	1.3	-	-	194
44	Bharuch	Anklesvar	75.2	227.1	-	-	8,884
45	Bharuch	Bharuch	107.8	268.4	-	-	11,132
46	Bharuch	Hansot	-	10.8	-	6.1	1,186
47	Bharuch	Jambusar	-	9.9	-	-	1,200
48	Bharuch	Jhagadia	-	156.1	-	-	15,555
49	Bharuch	Vagra	-	29.6	-	17.6	2,954
50	Bharuch	Valia	-	17.0	-	-	1,887
51	Bhavnagar	Bhavnagar	-	120.5	-	26.4	5,190
52	Bhavnagar	Botad	1 2	1 7	-	0.3	241
53	Bhavnagar	Gadhada	-	0.7	-	0.1	97
54	Bhavnagar	Gariadhar	-	0.5	-	0.1	78
55	Bhavnagar	Ghogha	-	5 5	-	2.1	375
56	Bhavnagar	Mahuva	-	3.5	-	1.1	806
57	Bhavnagar	Palitana	-	1.1	-	0.4	225
58	Bhavnagar	Sihor	-	4.6	-	1.5	717
59	Bhavnagar	Talaja	-	1 7	-	0 5	192
60	Bhavnagar	Umrala	-	0 2	-	-	122
61	Bhavnagar	Vallabhipur	-	0 1	-	-	53
62	Dohad	Devgadbaria	-	-	-	-	129
63	Dohad	Dhanpur	-	-	-	-	-
64	Dohad	Dohad	-	-	-	-	485
65	Dohad	Fatepura	-	-	-	-	16
66	Dohad	Garbada	-	-	-	-	41
67	Dohad	Jhalod	-	-	-	-	128
68	Dohad	Limkheda	-	-	-	-	37
69	Gandhinagar	Dehgam	-	3 1	-	-	562
70	Gandhinagar	Gandhinagar	-	113 2	-	-	4,993
71	Gandhinagar	Kalol	-	173 7	-	-	6,526
72	Gandhinagar	Mansa	-	4 7	-	-	258
73	Jamnagar	Bhanvad	-	0 3	-	0 3	150
74	Jamnagar	Dhrol	0 9	2 1	-	0 2	412
75	Jamnagar	Jamjodhpur	-	1.0	0 2	1 7	234
76	Jamnagar	Jamnagar	49.4	170.4	16 5	16 5	5,765
77	Jamnagar	Jodiya	1.6	3 9	-	0.4	323
78	Jamnagar	Kalavad	-	1.1	-	1.0	257
79	Jamnagar	Kalyanpur	-	1.1	0.2	1 3	184
80	Jamnagar	Khambhalia	-	2 8	0 3	2 1	223
81	Jamnagar	Lalpur	-	3,343 9	310 3	1,304 9	51,595
82	Jamnagar	Okhamandal	-	88 9	20.8	88.4	3,588
83	Junagadh	Bhesan	-	2 9	0 7	2 9	153
84	Junagadh	Junagadh	-	18.0	3.4	26 3	1,160
85	Junagadh	Keshod	-	1.6	0 3	2 7	207
86	Junagadh	Kodinar	-	41.6	24.4	104.3	4,142
87	Junagadh	Malia	-	1.6	0 7	3 9	198
88	Junagadh	Manavadar	-	3.4	0 6	4.8	277
89	Junagadh	Mangrol	-	1.0	0 1	1.5	110
90	Junagadh	Mendarda	-	0.1	-	0.2	56
91	Junagadh	Patan-Veraval	2 3	12.7	6 1	30 6	1,274
92	Junagadh	Sutrapada	-	16.1	9.6	40.3	1,591
93	Junagadh	Talala	-	1.1	0.5	2 8	205
94	Junagadh	Una	-	0 7	0.2	1 5	140
95	Junagadh	Vanthali	-	1 0	0.2	1.2	114
96	Junagadh	Visavadar	-	0 3	0 1	0 6	138
97	Kachchh	Abdasa	0 1	0 2	-	0 2	30
98	Kachchh	Anjar	3.5	3.5	-	0 3	402
99	Kachchh	Bhachau	23.1	23.1	-	2 2	483
100	Kachchh	Bhuj	11.3	11.3	-	1.1	602
101	Kachchh	Gandhidham	62.6	62.6	-	5 9	1,468
102	Kachchh	Lakhpat	0 1	0.3	-	-	19
103	Kachchh	Mandvi	0.2	2 0	0.1	1 5	192
104	Kachchh	Mundra	9.8	24.5	-	9 8	434
105	Kachchh	Nakhatrana	0.4	0 8	-	0 1	165
106	Kachchh	Rapar	-	0.1	-	-	40
107	Kheda	Balasinor	-	0 5	-	-	94
108	Kheda	Kapadvanj	-	2 0	-	-	264
109	Kheda	Kathlal	-	0.4	-	-	143
110	Kheda	Kheda	-	6 6	-	-	397
111	Kheda	Mahudha	-	0.1	-	-	72
112	Kheda	Matar	-	22.1	-	-	946
113	Kheda	Mehmedabad	-	7 5	-	-	443
114	Kheda	Nadiad	-	34 6	-	-	2,120

GUJARAT ECONOMIC RISK ZONATION : MANUFACTURING SECTOR GVA LOSS DUE TO CYCLONE & EARTHQUAKE
(Rs. MILLION 1999-2000 PRICES) Table No. RECT - 01 of 02

GSDMA

Sr. No	District	Taluka	Earthquake (50 year return)	Earthquake (100 year return)	Cyclone (50 year return)	Cyclone (100 year return)	Total
115	Kheda	Thasra	-	1.6	-		331
116	Kheda	Virpur	-	-	-	-	36
117	Mahesana	Becharaji	-	0.2	-	-	11
118	Mahesana	Kadi	-	65.0	-	-	2,625
119	Mahesana	Kheralu	-	0.7	-	-	212
120	Mahesana	Mahesana	-	105.8	-	-	4,592
121	Mahesana	Satlasana	-	-	-	-	-
122	Mahesana	Unjha	-	2.9	-	-	318
123	Mahesana	Vadnagar	-	0.3	-	-	149
124	Mahesana	Vijapur	-	3.2	-	-	359
125	Mahesana	Visnagar	-	2.0	-	-	253
126	Narmada	Dediapada	-	-	-	-	96
127	Narmada	Nandod	-	-	-	-	862
128	Narmada	Sagbara	-	0.1	-	-	55
129	Narmada	Tilakwada	-	0.1	-	-	71
130	Navsari	Bansda	-	-	-	-	304
131	Navsari	Chikhli	-	3.9	-	-	627
132	Navsari	Gandevi	-	8.1	-	-	838
133	Navsari	Jalalpore	-	2.4	-	1.0	328
134	Navsari	Navsari	-	15.1	-	-	1,723
135	Panch Mahals	Ghoghamba	-	-	-	-	42
136	Panch Mahals	Godhra	-	-	-	-	877
137	Panch Mahals	Halol	-	-	-	-	5,739
138	Panch Mahals	Jambughoda	-	-	-	-	70
139	Panch Mahals	Kadana	-	-	-	-	-
140	Panch Mahals	Kalol	-	7.2	0.7	-	723
141	Panch Mahals	Khanpur	-	-	-	-	32
142	Panch Mahals	Lunawada	-	-	-	-	339
143	Panch Mahals	Morwa (Hadaf)	-	-	-	-	38
144	Panch Mahals	Santrampur	-	-	-	-	59
145	Panch Mahals	Shehera	-	0.1	-	-	99
146	Patan	Chanasma	-	1.0	-	-	186
147	Patan	Harij	-	0.7	-	-	101
148	Patan	Patan	-	3.1	-	-	577
149	Patan	Radhanpur	0.5	1.2	-	-	147
150	Patan	Sami	-	0.7	-	-	94
151	Patan	Santalpur	0.1	0.1	-	-	47
152	Patan	Sidhpur	-	1.9	-	-	269
153	Patan	Vagdod	-	-	-	-	41
154	Porbandar	Kutiyana	-	0.1	-	0.2	20
155	Porbandar	Porbandar	-	34.2	7.9	35.6	1,499
156	Porbandar	Ranavav	-	21.2	4.8	23.0	880
157	Rajkot	Dhoraji	-	2.7	0.5	3.9	554
158	Rajkot	Gondal	-	3.8	-	5.8	821
159	Rajkot	Jamkandorna	-	0.5	0.1	0.8	198
160	Rajkot	Jasdan	0.7	1.0	0.2	0.2	470
161	Rajkot	Jetpur	-	5.2	0.9	8.5	2,055
162	Rajkot	Kotda Sangani	-	40.2	-	7.5	1,197
163	Rajkot	Lodhika	-	23.2	-	2.3	462
164	Rajkot	Maliya	-	0.8	-	0.1	329
165	Rajkot	Morvi	9.5	46.3	-	4.5	1,565
166	Rajkot	Paddhari	-	12.5	-	1.2	473
167	Rajkot	Rajkot	-	79.7	-	14.3	5,158
168	Rajkot	Tankara	5.3	33.5	-	3.1	639
169	Rajkot	Upleta	-	0.8	0.1	1.1	289
170	Rajkot	Wankaner	-	15.5	-	1.5	1,002

Sr. No	District	Taluka	Earthquake (50 year return)	Earthquake (100 year return)	Cyclone (50 year return)	Cyclone (100 year return)	Total
171	Sabar Kantha	Bayad	-	1.9	-	-	220
172	Sabar Kantha	Bhiloda	-	0.4	-	-	377
173	Sabar Kantha	Dhansura	-	2.5	-	-	247
174	Sabar Kantha	Himatnagar	-	11.0	-	-	1,070
175	Sabar Kantha	Idar	-	2.7	-	-	728
176	Sabar Kantha	Khedbrahma	-	0.7	-	-	265
177	Sabar Kantha	Malpur	-	0.2	-	-	72
178	Sabar Kantha	Meghraj	-	0.1	-	-	74
179	Sabar Kantha	Modasa	-	1.5	-	-	284
180	Sabar Kantha	Prantij	-	7.4	-	-	880
181	Sabar Kantha	Talod	-	1.0	-	-	132
182	Sabar Kantha	Vadali	0.4	0.5	-	-	161
183	Sabar Kantha	Vijaynagar	-	-	-	-	71
184	Surat	Bardoli	-	9.4	-	-	1,141
185	Surat	Chorasi	-	496.9	-	288.5	51,017
186	Surat	Kamrej	-	2.9	-	-	413
187	Surat	Mahuva	-	3.6	-	-	449
188	Surat	Mandvi	-	0.1	-	-	1,090
189	Surat	Mangrol	-	40.0	-	-	2,536
190	Surat	Nizar	-	-	-	-	22
191	Surat	Olpad	-	16.7	-	7.6	1,369
192	Surat	Palsana	-	14.8	-	-	1,520
193	Surat	Songadh	-	-	-	-	446
194	Surat	Surat City	65.4	5.5	-	23.4	12,113
195	Surat	Uchchhal	-	-	-	-	15
196	Surat	Umarpada	-	-	-	-	1
197	Surat	Valod	-	0.3	-	-	159
198	Surat	Vyara	-	0.4	-	-	362
199	Surendranagar	Chotila	-	13.2	-	2.5	498
200	Surendranagar	Chuda	-	0.1	-	-	33
201	Surendranagar	Dasada	-	2.2	-	-	311
202	Surendranagar	Dhrangadhra	-	19.4	-	-	556
203	Surendranagar	Halvad	-	6.3	-	0.6	223
204	Surendranagar	Lakhtar	-	1.1	-	-	112
205	Surendranagar	Limbdi	-	1.7	-	0.3	384
206	Surendranagar	Muli	-	6.4	-	0.6	229
207	Surendranagar	Sayla	-	62.9	-	14.7	2,478
208	Surendranagar	Wadhwan	-	23.4	-	4.3	1,459
209	The Dangs	The Dangs	-	0.1	-	-	54
210	Vadodara	Chhota Udaipur	-	-	-	-	271
211	Vadodara	Dabhoi	-	-	-	-	163
212	Vadodara	Jetpur Pavi	-	0.1	-	-	100
213	Vadodara	Karjan	-	42.5	-	-	4,285
214	Vadodara	Kavant	-	-	-	-	12
215	Vadodara	Nasvadi	-	-	-	-	59
216	Vadodara	Padra	-	30.6	-	-	2,990
217	Vadodara	Sankheda	-	0.1	-	-	188
218	Vadodara	Savli	-	38.6	-	-	3,594
219	Vadodara	Sinor	-	0.1	-	-	44
220	Vadodara	Vadodara	-	356.1	-	-	32,371
221	Vadodara	Vaghodia	-	-	-	-	2,205
222	Valsad	Dharampur	-	-	-	-	443
223	Valsad	Kaprada	-	-	-	-	121
224	Valsad	Pardi	-	87.0	-	-	7,267
225	Valsad	Umbergaon	-	40.8	-	-	2,795
226	Valsad	Valsad	-	43.8	-	-	4,263

GUJARAT ECONOMIC RISK ZONATION : AGRICULTURE GVA LOSS DUE TO DROUGHT
(FIRST to FOURTH DECILE RAINFALL) (Rs. MILLION 2002-2003 PRICES) Table No. RECT - 02 of 02

GSDMA

Sr. No	District	Taluka	Extreme (1D)	Severe (2D)	Moderate (3D)	Mild (4D)	Total GVA
1	Ahmadabad	Ahmadabad City	2.2	1.3	0.6	0.2	26
2	Ahmadabad	Barwala	88.3	49.7	27.8	14.8	145
3	Ahmadabad	Bavla	75.3	47.9	24.6	12.4	450
4	Ahmadabad	Daskroi	73.8	43.0	19.1	5.9	688
5	Ahmadabad	Detroj-Rampura	75.2	50.7	31.1	17.4	147
6	Ahmadabad	Dhandhuka	295.8	166.4	93.0	49.6	485
7	Ahmadabad	Dholka	92.3	58.7	30.2	15.2	551
8	Ahmadabad	Mandal	107.0	72.1	44.2	24.8	209
9	Ahmadabad	Ranpur	80.5	45.3	25.3	13.5	132
10	Ahmadabad	Sanand	54.1	34.0	18.0	5.0	663
11	Ahmadabad	Viramgam	200.7	135.2	83.0	46.5	392
12	Amreli	Amreli	435.8	292.5	191.2	81.7	630
13	Amreli	Babra	307.7	205.1	165.0	87.4	444
14	Amreli	Bagasara	168.5	112.7	71.4	38.1	245
15	Amreli	Dhari	402.7	283.4	205.7	96.0	575
16	Amreli	Jafrabad	103.6	85.2	44.0	19.4	161
17	Amreli	Khambha	116.0	100.3	57.7	19.1	211
18	Amreli	Kunkavav Vadia	279.0	184.9	114.0	62.6	407
19	Amreli	Lathi	291.5	152.5	106.7	47.3	402
20	Amreli	Lilia	167.5	99.5	42.4	13.8	248
21	Amreli	Rajula	322.9	250.3	104.2	41.1	485
22	Amreli	Savar Kundla	433.3	320.0	237.3	81.4	730
23	Anand	Anand	18.7	10.3	5.1	1.8	202
24	Anand	Anklav	40.1	23.3	10.0	3.8	333
25	Anand	Borsad	6.9	4.0	1.7	0.7	58
26	Anand	Khambhat	39.4	22.7	11.8	3.8	527
27	Anand	Petlad	22.8	13.0	6.9	2.0	306
28	Anand	Sojitra	12.0	6.9	3.7	1.1	161
29	Anand	Tarapur	16.4	9.4	4.9	1.6	219
30	Anand	Umreth	10.2	5.6	2.8	1.0	110
31	Banas Kantha	Amirgadh	173.4	97.5	40.6	14.0	350
32	Banas Kantha	Bhabhar	221.1	146.1	96.7	21.1	243
33	Banas Kantha	Danta	161.4	93.6	29.9	12.0	271
34	Banas Kantha	Dantiwada	200.4	132.7	63.9	11.6	243
35	Banas Kantha	Deesa	804.5	564.9	269.4	60.8	959
36	Banas Kantha	Deodar	285.5	188.7	124.9	27.2	314
37	Banas Kantha	Dhanera	427.8	287.7	140.1	23.7	483
38	Banas Kantha	Kankrej	395.5	265.7	120.4	49.2	467
39	Banas Kantha	Palanpur	203.8	114.6	47.8	16.5	411
40	Banas Kantha	Tharad	462.4	374.2	261.7	89.8	518
41	Banas Kantha	Vadgam	194.3	118.3	46.5	24.1	433
42	Banas Kantha	Vav	291.7	204.3	132.9	64.4	300
43	Bharuch	Amod	56.3	35.9	20.6	7.6	357
44	Bharuch	Anklesvar	17.8	9.6	3.8	1.3	171
45	Bharuch	Bharuch	108.7	62.3	27.4	10.0	437
46	Bharuch	Hansot	6.6	3.6	1.9	0.6	192
47	Bharuch	Jambusar	223.1	142.6	82.3	29.5	548
48	Bharuch	Jhagadia	50.7	26.1	11.2	4.2	330
49	Bharuch	Vagra	144.3	89.2	54.5	21.6	369
50	Bharuch	Valia	33.6	18.0	8.2	4.7	266
51	Bhavnagar	Bhavnagar	126.5	76.4	42.7	26.0	194
52	Bhavnagar	Botad	215.0	134.3	100.9	50.5	322
53	Bhavnagar	Gadhada	266.4	167.3	123.4	62.0	390
54	Bhavnagar	Gariadhar	273.1	175.1	92.7	31.2	406
55	Bhavnagar	Ghogha	127.6	80.5	45.4	24.1	185
56	Bhavnagar	Mahuva	538.9	407.4	169.5	60.4	828
57	Bhavnagar	Palitana	198.4	133.9	65.8	40.9	318
58	Bhavnagar	Sihor	165.5	106.7	49.8	28.7	264
59	Bhavnagar	Talaja	188.6	113.2	50.0	0.9	347
60	Bhavnagar	Umrala	109.9	60.5	44.8	13.0	174
61	Bhavnagar	Vallabhipur	84.8	50.2	33.9	12.6	140
62	Dohad	Devgadbaria	109.9	77.4	52.7	19.1	241
63	Dohad	Dhanpur	74.2	50.4	36.7	11.8	156
64	Dohad	Dohad	155.9	105.8	74.2	44.3	358
65	Dohad	Fatepura	43.7	32.6	25.2	9.2	133
66	Dohad	Garbada	62.5	42.5	29.8	17.8	144
67	Dohad	Jhalod	176.1	134.0	101.5	41.4	476
68	Dohad	Limkheda	90.1	61.1	44.5	14.4	189
69	Gandhinagar	Dehgam	100.3	60.8	42.4	15.1	335
70	Gandhinagar	Gandhinagar	108.3	65.6	45.7	16.3	361
71	Gandhinagar	Kalol	93.1	56.5	41.2	14.3	415
72	Gandhinagar	Mansa	96.4	65.2	48.1	21.6	348
73	Jamnagar	Bhanvad	286.8	159.7	76.9	32.4	372
74	Jamnagar	Dhrol	290.5	188.0	143.8	75.5	373
75	Jamnagar	Jamjodhpur	434.0	289.2	159.4	52.0	548
76	Jamnagar	Jamnagar	525.2	349.7	263.5	75.0	610
77	Jamnagar	Jodiya	318.2	265.5	177.2	61.7	364
78	Jamnagar	Kalavad	614.2	364.5	223.5	54.2	726
79	Jamnagar	Kalyanpur	547.2	349.8	256.1	54.1	612
80	Jamnagar	Khambhalia	542.6	300.5	181.3	45.0	597
81	Jamnagar	Lalpur	469.3	275.8	110.1	20.1	533
82	Jamnagar	Okhamandal	77.5	63.4	34.9	20.0	81
83	Junagadh	Bhesan	251.6	140.9	74.9	13.6	353
84	Junagadh	Junagadh	290.7	143.6	69.5	21.3	405
85	Junagadh	Keshod	367.2	192.1	82.6	17.2	497
86	Junagadh	Kodinar	267.2	140.6	68.9	47.3	403
87	Junagadh	Malia	329.9	171.3	62.7	22.2	449
88	Junagadh	Manavadar	258.0	172.4	79.5	49.9	422
89	Junagadh	Mangrol	325.6	202.6	71.8	16.4	443
90	Junagadh	Mendarda	233.0	108.4	49.4	16.0	312
91	Junagadh	Patan-Veraval	43.0	28.5	7.2	6.8	72
92	Junagadh	Sutrapada	38.3	25.4	6.4	6.1	65
93	Junagadh	Talala	300.6	153.8	73.4	29.2	435
94	Junagadh	Una	164.7	112.5	64.4	27.3	240
95	Junagadh	Vanthali	193.8	119.3	46.3	12.5	284
96	Junagadh	Visavadar	424.4	268.6	228.7	106.6	683
97	Kachchh	Abdasa	160.4	121.1	91.7	33.6	186
98	Kachchh	Anjar	192.2	140.0	76.1	57.0	188
99	Kachchh	Bhachau	336.6	268.7	224.0	133.9	340
100	Kachchh	Bhuj	435.8	303.9	261.2	49.8	456
101	Kachchh	Gandhidham	31.3	22.8	12.4	9.3	31
102	Kachchh	Lakhpat	76.9	75.7	55.1	15.8	90
103	Kachchh	Mandvi	326.8	254.4	126.7	93.9	323
104	Kachchh	Mundra	134.8	97.8	55.3	38.7	132
105	Kachchh	Nakhatrana	435.7	290.9	269.0	9.3	453
106	Kachchh	Rapar	372.6	266.4	169.8	104.5	381
107	Kheda	Balasinor	81.8	47.3	30.2	17.9	165
108	Kheda	Kapadvanj	222.3	128.0	75.9	41.7	426
109	Kheda	Kathlal	121.5	70.0	41.5	22.8	233
110	Kheda	Kheda	19.0	10.1	5.1	1.9	268
111	Kheda	Mahudha	17.5	10.4	5.1	1.7	187
112	Kheda	Matar	17.8	8.6	4.7	1.8	350
113	Kheda	Mehmedabad	37.2	21.5	10.3	3.9	343
114	Kheda	Nadiad	28.6	17.1	8.3	2.8	306

GUJARAT ECONOMIC RISK ZONATION : AGRICULTURE GVA LOSS DUE TO DROUGHT
(FIRST to FOURTH DECILE RAINFALL) (Rs. MILLION 2002-2003 PRICES) Table No. RECT - 02 of 02

GSDMA

Sr. No	District	Taluka	Extreme (1D)	Severe (2D)	Moderate (3D)	Mild (4D)	Total GVA
115	Kheda	Thasra	79 7	48.5	28.0	12.2	343
116	Kheda	Virpur	70 3	40.6	26.0	15.4	142
117	Mahesana	Becharaji	120.2	70.2	40.2	20 1	227
118	Mahesana	Kadi	137.4	86.4	63.4	25 5	503
119	Mahesana	Kheralu	97.0	59.4	23.2	12.7	211
120	Mahesana	Mahesana	240.5	145 0	105.1	55 0	569
121	Mahesana	Satlasana	92.3	56.5	22.1	12.0	201
122	Mahesana	Unjha	82.4	57.3	28.1	12.7	200
123	Mahesana	Vadnagar	92.5	56 6	22 1	12.1	201
124	Mahesana	Vijapur	155.5	105.3	77.6	35.0	560
125	Mahesana	Visnagar	133.7	88.0	61.3	25 2	421
126	Narmada	Dediapada	39.6	17.0	9 3	3.9	169
127	Narmada	Nandod	93 9	41.9	21.5	10.6	352
128	Narmada	Sagbara	75.7	38.3	23.7	9.3	259
129	Narmada	Tilakwada	50 8	28.3	15.0	8.3	150
130	Navsari	Bansda	2 6	1.5	0.8	0.3	176
131	Navsari	Chikhli	0.6	0.2	0.1	0.1	480
132	Navsari	Gandevi	2.2	0.9	0.3	0.2	227
133	Navsari	Jalalpore	0 9	0.4	0.2	0.1	347
134	Navsari	Navsari	0.5	0.2	0.1	0.0	174
135	Panch Mahals	Ghoghamba	93 8	66.0	45.0	16.3	206
136	Panch Mahals	Godhra	100.1	68.5	44.8	23.7	280
137	Panch Mahals	Halol	51.1	44 0	32.4	14.3	187
138	Panch Mahals	Jambughoda	11.3	9.3	6.1	3.0	45
139	Panch Mahals	Kadana	58.3	43.5	33.7	12.2	177
140	Panch Mahals	Kalol	44.4	34.2	24.7	11.2	193
141	Panch Mahals	Khanpur	37.4	25.7	17.9	8.9	178
142	Panch Mahals	Lunawada	73.7	50 6	35.2	17.4	351
143	Panch Mahals	Morwa (Hadaf)	42.2	28.9	18.9	10 0	118
144	Panch Mahals	Santrampur	79.3	59.2	45.9	16.6	241
145	Panch Mahals	Shehera	68.1	43.6	27.3	13.7	240
146	Patan	Chanasma	135.2	79.0	45.2	22.6	256
147	Patan	Harij	142.5	82.1	42.8	19.5	166
148	Patan	Patan	236.2	150.8	81.2	40.1	480
149	Patan	Radhanpur	143.1	94.5	60.9	9.4	161
150	Patan	Sami	320.4	205.0	96.9	31.5	356
151	Patan	Santalpur	155.2	124.1	68 1	30.9	172
152	Patan	Sidhpur	95.2	66.2	32.5	14.6	231
153	Patan	Vagdod	80.4	51 3	27.6	13.6	163
154	Porbandar	Kutiyana	71.7	67.4	18 9	15.6	118
155	Porbandar	Porbandar	355 5	256.5	151.9	61.7	428
156	Porbandar	Ranavav	23.8	16 8	9.6	4.0	29
157	Rajkot	Dhoraji	229.5	144.8	75.2	41.1	345
158	Rajkot	Gondal	515 5	329.5	237 8	87.0	724
159	Rajkot	Jamkandorna	234.0	129.4	88.6	31.1	291
160	Rajkot	Jasdan	333.0	210.6	166.5	76.0	482
161	Rajkot	Jetpur	416.2	220.1	108.9	53.6	489
162	Rajkot	Kotda Sangani	176.6	122.2	89.3	24.9	237
163	Rajkot	Lodhika	151.7	99.1	68.4	19.7	198
164	Rajkot	Maliya	169.6	139.3	82.1	46 6	179
165	Rajkot	Morvi	312 5	254 5	159.0	86.7	429
166	Rajkot	Paddhari	245.6	154.2	91.3	48.7	325
167	Rajkot	Rajkot	328.1	223.1	154.7	69.7	423
168	Rajkot	Tankara	195 8	155.5	96.7	52.6	268
169	Rajkot	Upleta	342 5	220.3	151.0	54.0	503
170	Rajkot	Wankaner	247.1	166 0	106.9	49.6	293
171	Sabar Kantha	Bayad	274.3	183.2	130.2	71 0	562
172	Sabar Kantha	Bhiloda	278 5	190 1	124 6	44.5	540
173	Sabar Kantha	Dhansura	155 6	106.2	76.1	29.4	301
174	Sabar Kantha	Himatnagar	315.4	212.6	132.9	48.8	701
175	Sabar Kantha	Idar	356.9	215.7	119.3	35.1	762
176	Sabar Kantha	Khedbrahma	254.4	155.7	69.9	29.8	428
177	Sabar Kantha	Malpur	97.0	62.8	47.9	15.4	219
178	Sabar Kantha	Meghraj	175.5	120.9	90.3	25.1	336
179	Sabar Kantha	Modasa	274.7	190.0	136.8	40 5	513
180	Sabar Kantha	Prantij	173.7	120.7	70.4	32.3	446
181	Sabar Kantha	Talod	181.2	125.9	73.5	33.8	465
182	Sabar Kantha	Vadali	138.7	83.9	46 2	13 7	295
183	Sabar Kantha	Vijaynagar	100.6	68.4	41.0	17.4	202
184	Surat	Bardoli	0.3	0.1	0.1	-	239
185	Surat	Chorasi	4.4	1.4	0.8	0 3	115
186	Surat	Kamrej	0.7	0.3	0.1	-	85
187	Surat	Mahuva	0.5	0 3	0.1	0.1	278
188	Surat	Mandvi	25 2	11.5	5.4	1.7	365
189	Surat	Mangrol	49.0	22.6	9.9	4.9	378
190	Surat	Nizar	21.3	10.4	5 0	2.0	181
191	Surat	Olpad	5.0	2.2	1.1	0.4	576
192	Surat	Palsana	0.1	-	-	-	61
193	Surat	Songadh	29.3	15 8	6 6	2.2	404
194	Surat	Surat City	0.9	0.3	0.2	0 1	24
195	Surat	Uchchhal	2.3	1.2	0 4	0.1	80
196	Surat	Umarpada	35.2	16.3	7.1	3.5	271
197	Surat	Valod	2.6	1.3	0.7	0.2	147
198	Surat	Vyara	8.8	4.9	1.9	0.4	570
199	Surendranagar	Chotila	198.6	111.3	87.1	41.3	232
200	Surendranagar	Chuda	78.7	51.5	29.1	19.1	120
201	Surendranagar	Dasada	193.8	114.1	50.0	22.2	228
202	Surendranagar	Dhrangadhra	390.4	164.0	116.6	54.3	428
203	Surendranagar	Halvad	535.8	328.0	149.9	104.4	593
204	Surendranagar	Lakhtar	88.5	51.0	38.4	20.1	118
205	Surendranagar	Limbdi	175.3	114.7	64.8	42.4	268
206	Surendranagar	Muli	310.5	202.8	124.6	59.2	361
207	Surendranagar	Sayla	221.0	117 7	95.0	36.0	267
208	Surendranagar	Wadhwan	164.1	82.7	66.3	27.2	196
209	The Dangs	The Dangs	98.4	55 7	20.0	5.8	403
210	Vadodara	Chhota Udaipur	108.1	62.9	39.1	18.8	272
211	Vadodara	Dabhoi	98.5	61.8	35.2	13.2	512
212	Vadodara	Jetpur Pavi	79.4	51.4	31.5	15.8	408
213	Vadodara	Karjan	60.3	33.2	18.6	6 0	516
214	Vadodara	Kavant	84.5	49.1	30.5	14.7	212
215	Vadodara	Nasvadi	79.8	41.7	22.7	11.5	242
216	Vadodara	Padra	80.6	50.3	29.4	7.6	303
217	Vadodara	Sankheda	137.2	94.8	56.4	28.5	451
218	Vadodara	Savli	139.7	84.1	51.8	21 8	359
219	Vadodara	Sinor	27.4	14.7	7.9	3 6	279
220	Vadodara	Vadodara	74.7	38.7	21.1	5 6	283
221	Vadodara	Vaghodia	112.4	79 6	46 8	19 0	317
222	Valsad	Dharampur	-	-	-	-	125
223	Valsad	Kaprada	-	-	-	-	161
224	Valsad	Pardi	-	-	-	-	152
225	Valsad	Umbergaon	-	-	-	-	83
226	Valsad	Valsad	-	-	-	-	187

HIGHWAY INFRASTRUCTURE VULNERABILITY & RISK

GUJARAT'S HIGHWAY TRANSPORTATION SYSTEMS

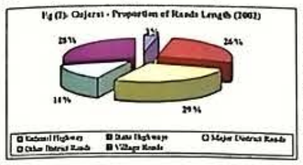
At the time of its creation as a separate state in 1960, Gujarat had 11,930 km. of surfaced roads and 10,699 km. of unsurfaced roads.

In March 2002, the total length of roads (except municipal roads) was 74,031 kms, of which the bulk 95 percent was surfaced. The total road length per 100 sq.km.was 38 km. in 2002.The total number of vehicles registered in Gujarat were 6.5 million in March 2003 and vehicle density was estimated at 33 (vehicles per sq.km.).

TABLE (1): GUJARAT ROAD AND VEHICLES (MARCH 2003)

Item	Unit	Value
Highways (except urban and project roads) (March 2002)		
Total Length **		
Surfaced Roads	Km	74,031
National Highways	Km	70,688
State Highways	Km	2,343
Road per 100 Sq Km	Km	13,180
No. of Motor Vehicles Registered (March, 2003)	Km	37.77
Vehicle Density per Sq Km (March, 2003)	'000	6,508
** Total length of Highways includes National highways, State highways, other PWD, Zilla Parishad, Village Panchayat and CIV Panchayat samitee Roads	Nos	33

Source: < http://gujarat.gov.in > 27th November 2004



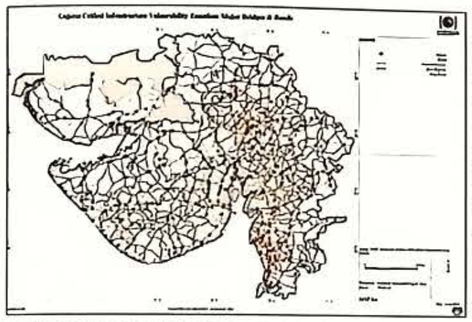
The total length of Panchayat Highways (i.e. rural roads) in Gujarat is 30,019 kms. National highways are owned and funded by the Ministry of Surface Transport, GoI, but are maintained by the GoG, R&B Department on an agency basis. In additional there are 26,902 km. non-plan roads.

Gujarat had 408 bridges at the time of its formation in 1960 including more than 200 bridges inherited from erstwhile princely States.

TABLE (6): MAJOR BRIDGES IN GUJARAT (2002)

Category	BSSL	SSSL	SDL	SML	Total
National Highway	0	8	155	30	193
State Highway	15	348	545	5	913
Other Roads	46	122	37	0	205
Total	61	478	737	35	1,311

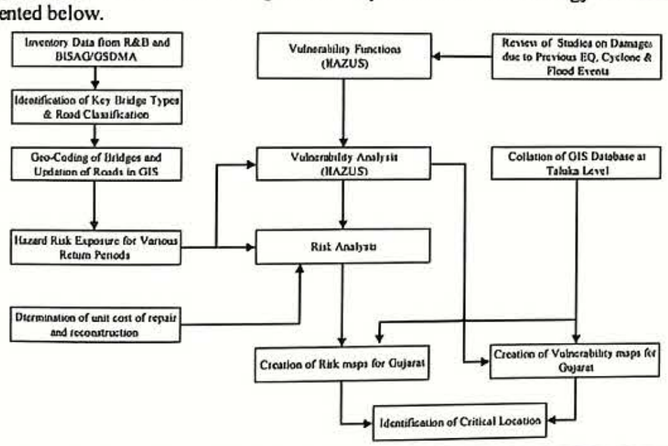
Source: Road Statistics Part-1 R & B Department, Government of Gujarat, Gandhinagar



The total number of major bridges (length > 60 m) stands at 1,311 in 2002 across all categories of roads, of which nearly 45 percent are on national and state highways. The total number of minor bridges is 4,282,of which 13 percent are on national highways and about 54 percent on state highways. Roads are spatially well-distributed across Gujarat as presented in the adjoining figure.

HIGHWAY TRANSPORTATION VULNERABILITY AND RISK METHODOLOGY

The primary risk to roads and bridges is earthquakes. The methodology for assessment is presented below.



DATA SOURCES

- District Level Road Maps (2003) (Scale: 1cm = 2.5 km)
- Road Statistics compiled by Roads & Buildings Department.
- Statistical information on existing road length, bridges and culverts etc. (F-1 & F-2) (2004).
- Bridges in Gujarat. Roads & Buildings Department, (1989)
- Gujarat Earthquake State Highways and Structures Preliminary Damage Report, (2002) Review of Literature
- A wide range of national and international research articles, documents and books on highway transportation vulnerability due to natural disasters.

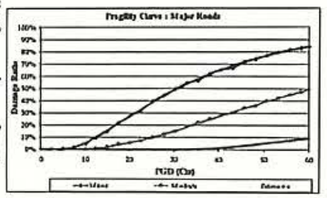
EARTHQUAKE DAMAGE FUNCTIONS

Fragility curves for highway system components are modelled as lognormal-distributed functions that estimate the probability of reaching or exceeding specified damage states for a given level of ground motion or ground failure. Each fragility curve is characterized by a median value of ground motion or ground failure and an associated dispersion factor (lognormal standard deviation). Ground motion is quantified in terms of Peak Ground Acceleration (PGA) and Spectral Acceleration (SA), and ground failure is quantified in terms of Permanent Ground Displacement (PGD).

- Fragility curves are defined in terms of PGD for roads
- Fragility curves are defined in terms of PGA for bridges

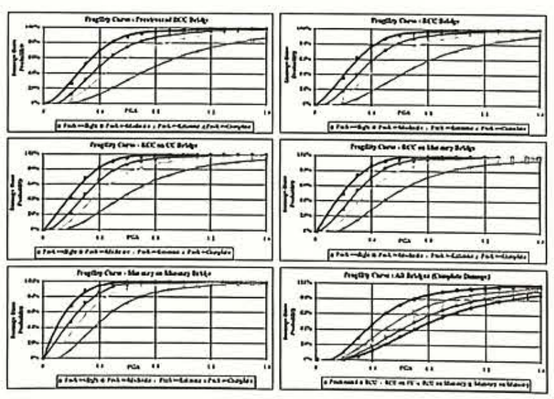
DAMAGE FUNCTIONS FOR ROADS

Fragility curves for major roads are presented in the adjoining figure. Equivalent PGAs are converted to PGDs using the following functions.



- For a competent alluvium site with Vs (shear wave velocity) < 3500 ft/sec,
  Peak Ground Velocity (PGV) is estimated in 'in/sec' and Peak Ground Displacement (PGD) in 'in' by the following formulae:
  PGV = 48 PGA PGD = 36 PGA
- For a rock site with Vs > 3500 ft/sec, PGV and PGD are determined using the following formulae:
  PGV = 36 PGA PGD = 20 PGA

DAMAGE FUNCTIONS FOR BRIDGES



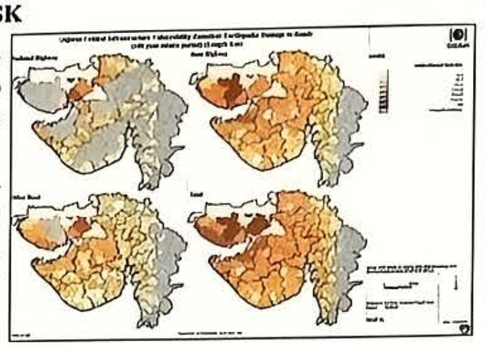
Fragility curves for different bridge types (prestressed RCC, PCC, RCC with CC substitution, PCC with masonry substitution) are presented in the adjoining figure.

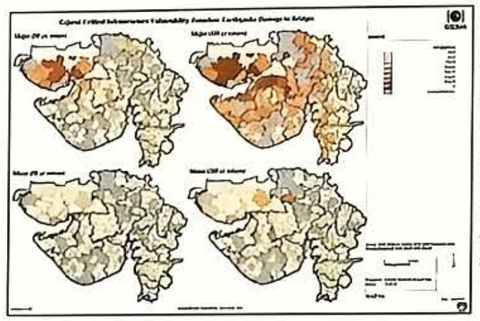
Scaling factors were used to derive the damage functions based on the observed damage to bridges during the 2001 Kachchh earthquake.

VULNERABILITY AND RISK

Road vulnerability is determined by the PGD and soil type, with the PGD in soft alluvium being twice as high as on a rock surface.

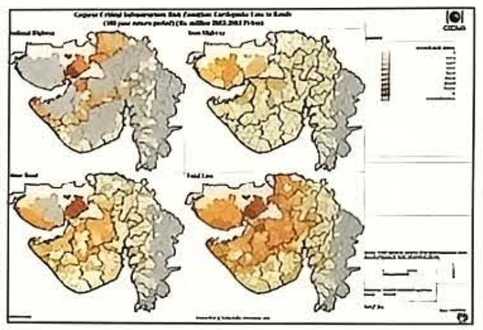
Damage to roads due to 100-year return earthquake is distributed across the state with significant damage in Kachchh and almost no damage to the rocky areas of eastern Gujarat.





Earthquake vulnerability of the bridges is directly proportion to PGA, Spectral Acceleration (SA) and material of construction. Vulnerability more or less follows the similar pattern as the earthquake hazard zonation. Damage to old bridges with older construction techniques is significant as most of them have outlived their service lives.

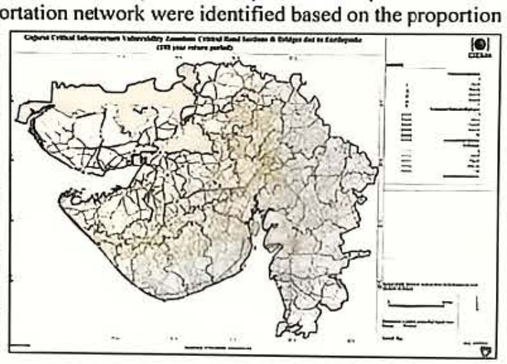
Road losses due to 100-year return period earthquake exhibit similar pattern to the earthquake hazard risk zonation map, with talukas on Gujarat's eastern border suffering little or no loss due to their rocky character. The total estimated loss to roads for 100-year return earthquake is Rs. 1,000 million (1% of capital cost). Major bridges suffer losses to the tune of Rs. 6,500 million which is 17% of total capital cost of analysed bridges for a 100-year return period earthquake.



CONCLUSIONS

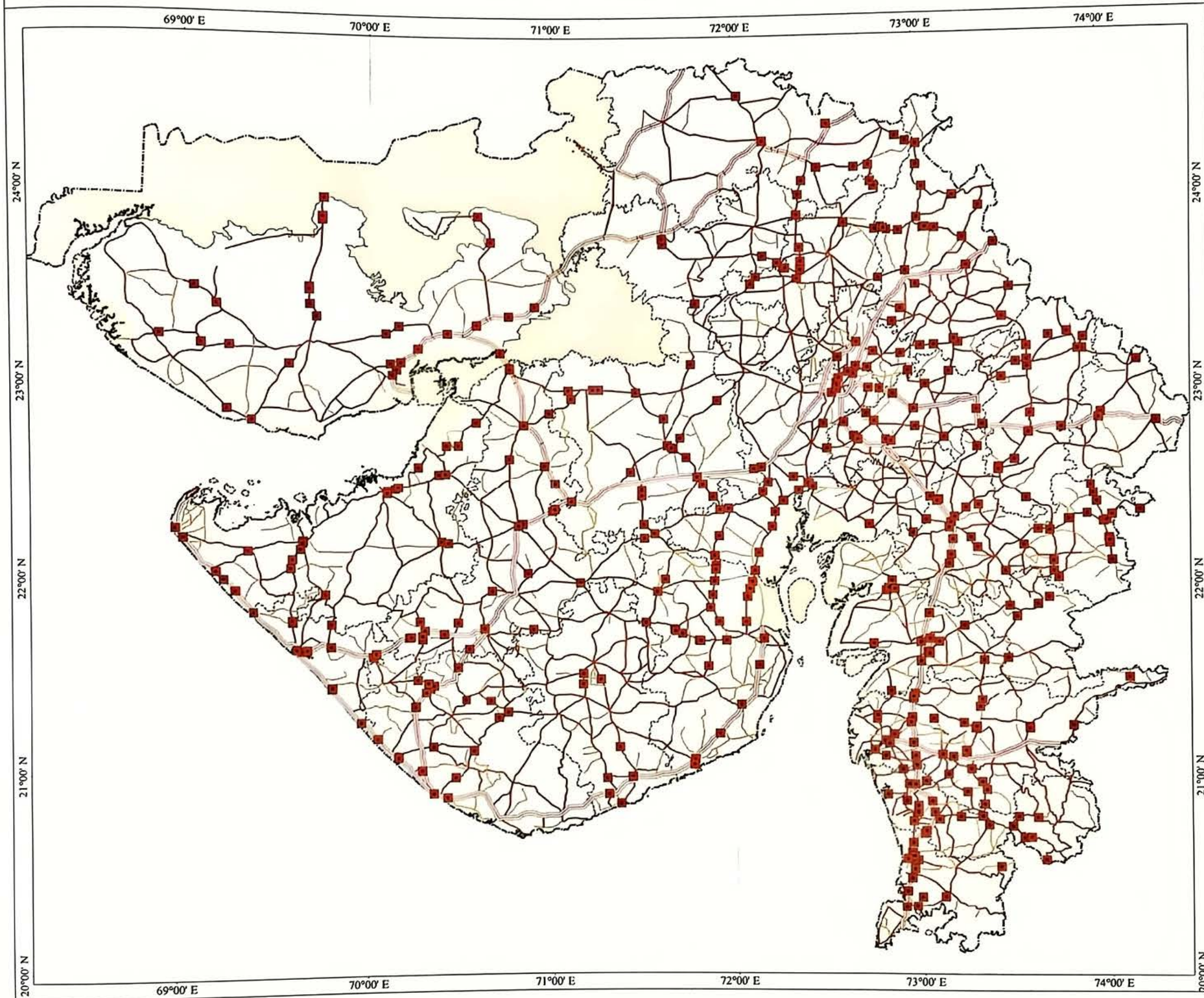
Based on the vulnerability due to 50 and 100-year return period earthquakes, critical locations within Gujarat's transportation network were identified based on the proportion of damage suffered to roads and bridges. These maps help in identifying possible bottlenecks to assist in future mitigation planning.

There are few critical sections for 50-year return period earthquakes apart from some roads and bridges in the Kachchh region. However, citical masonry bridges located in Saurashtra near Kachchh will need to be addressed for 100-year return period earthquakes.



Gujarat Critical Infrastructure Vulnerability Zonation: Major Bridges & Roads

GSDMA



LEGEND

- Bridges
- **Roads**
- National Highway
- State Highway
- Other Roads

Source: TARU Studies & Analysis, 2004;
District Level Maps, 2003 (Scale 1cm = 2.5 km), R&B Department, GoG;
Road statistics, 2002-2003, R&B Department, GoG;
Statistical information on road length & bridges etc. (F-1 & F-2), 2004, NH circle, R&B Department, GoG;
Bridges in Gujarat, 1989, R&B Department, GoG; BISAG, GoG

0 100 km

N

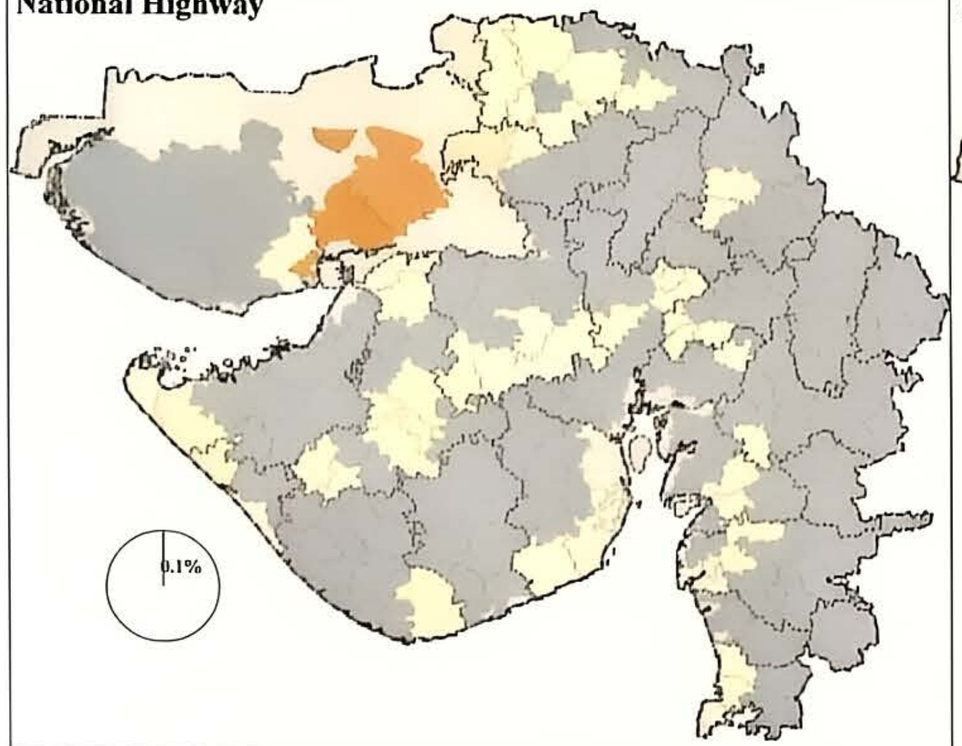
Projection : Lambert Azimuthal Equal Area
Datum : WGS 84

MAP No. : VIRM - 01 OF 01

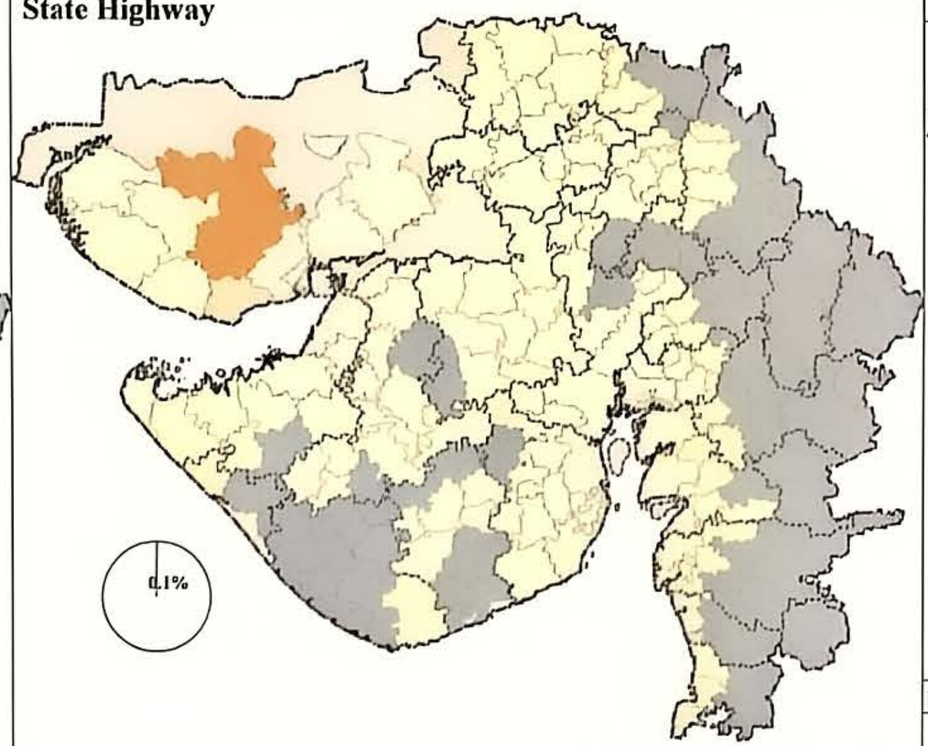
Date . 24/6/2005

Gujarat Critical Infrastructure Risk Zonation: Earthquake Loss to Roads
(50 year return period) (Rs. Million 2002-2003 prices)

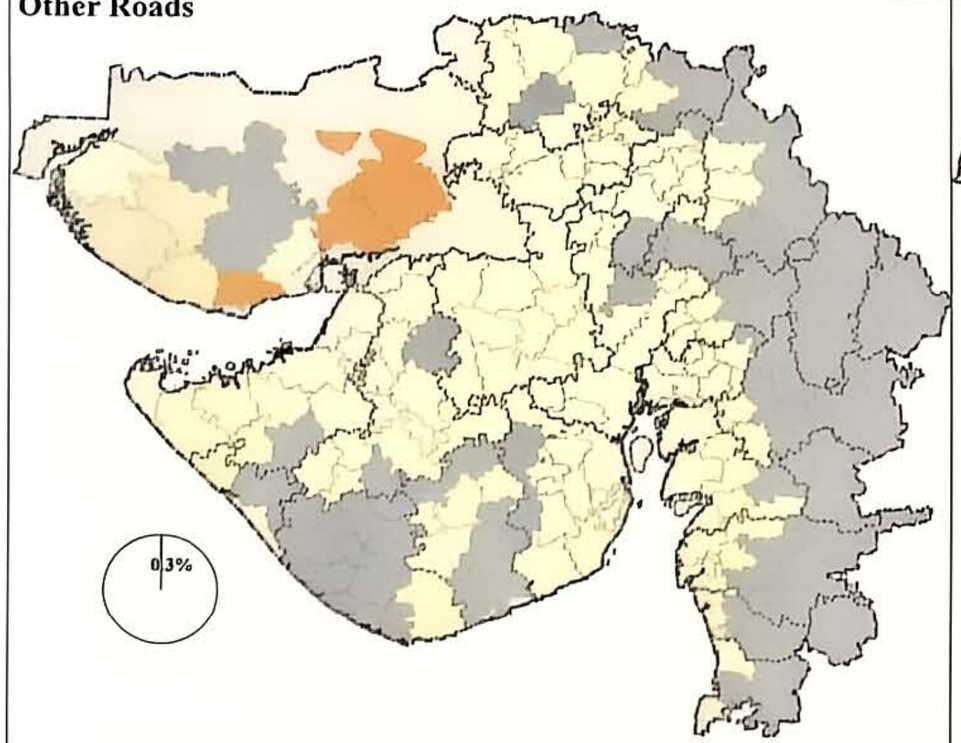
National Highway



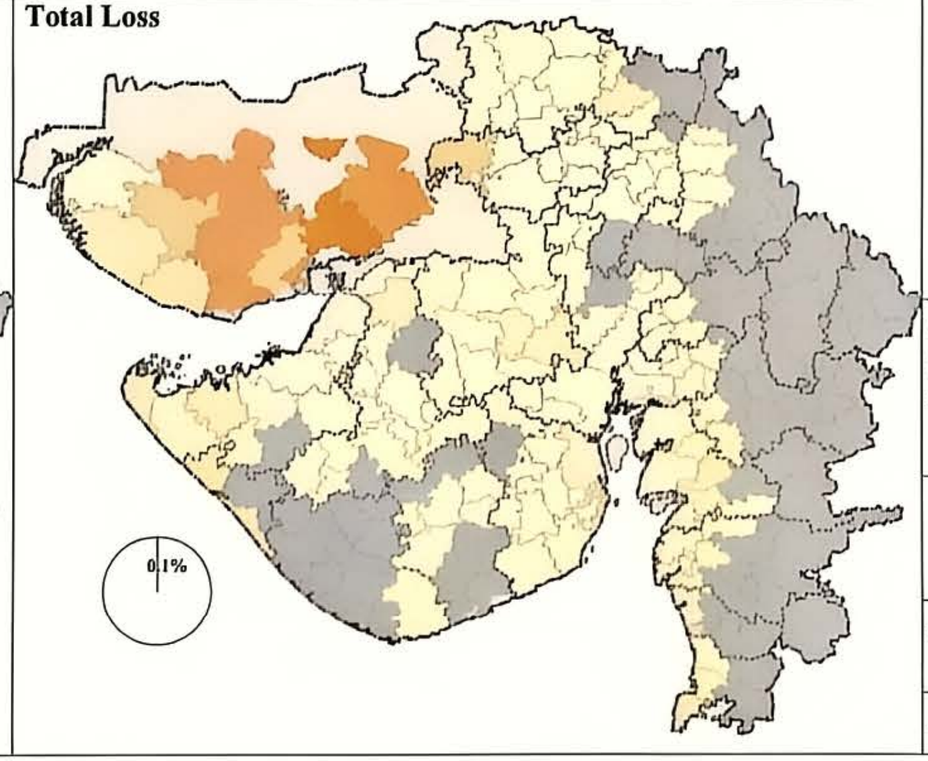
State Highway



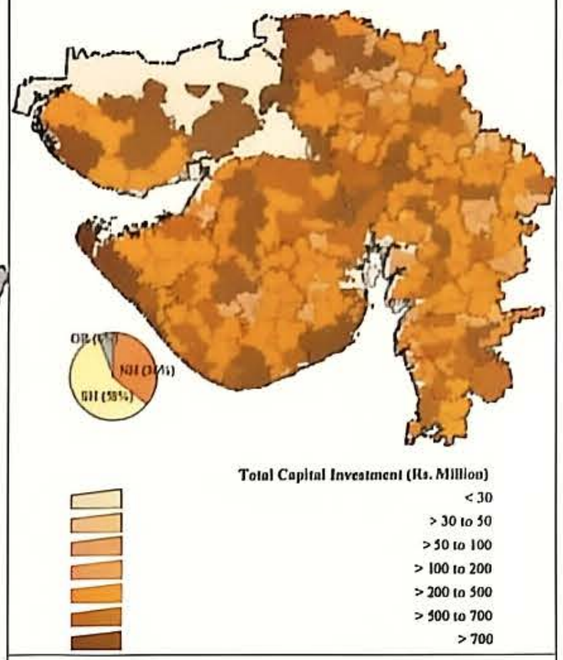
Other Roads



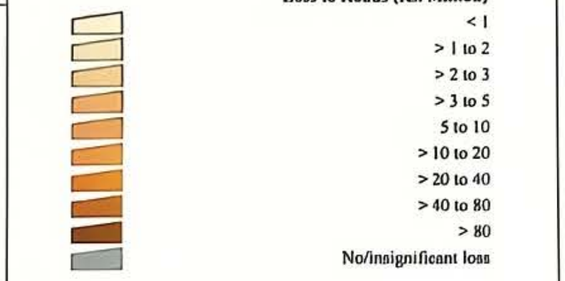
Total Loss



GSDMA

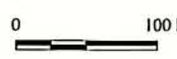


LEGEND



Inset map pie chart shows the proportion of road class capital investment. The first three main map pie charts show the proportion of respective road class loss to total capital cost of that class. The fourth pie chart shows the proportion of road loss to total road capital cost.

Source: TARU Studies & Analysis, 2004; R&B Department, GoG; Revenue Department, GoG; HAZUS-99, BISAG, GoG





Projection : Lambert Azimuthal Equal Area
Datum : WGS 84

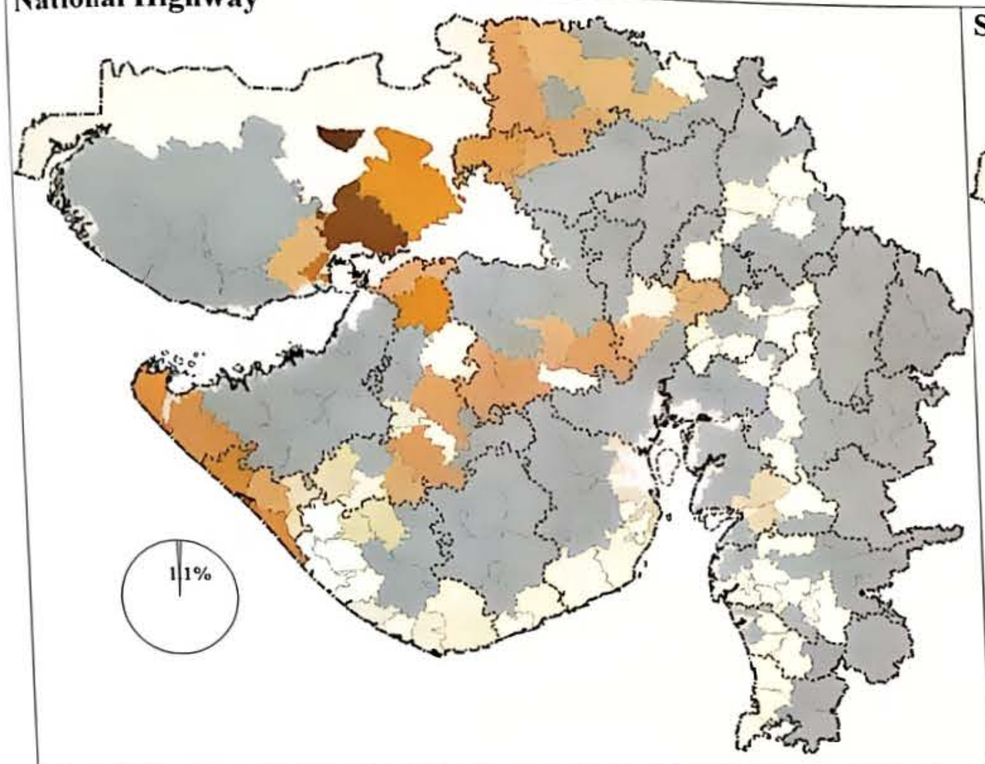
MAP No. : RIRM - 01 OF 03

Date : 18/6/2005

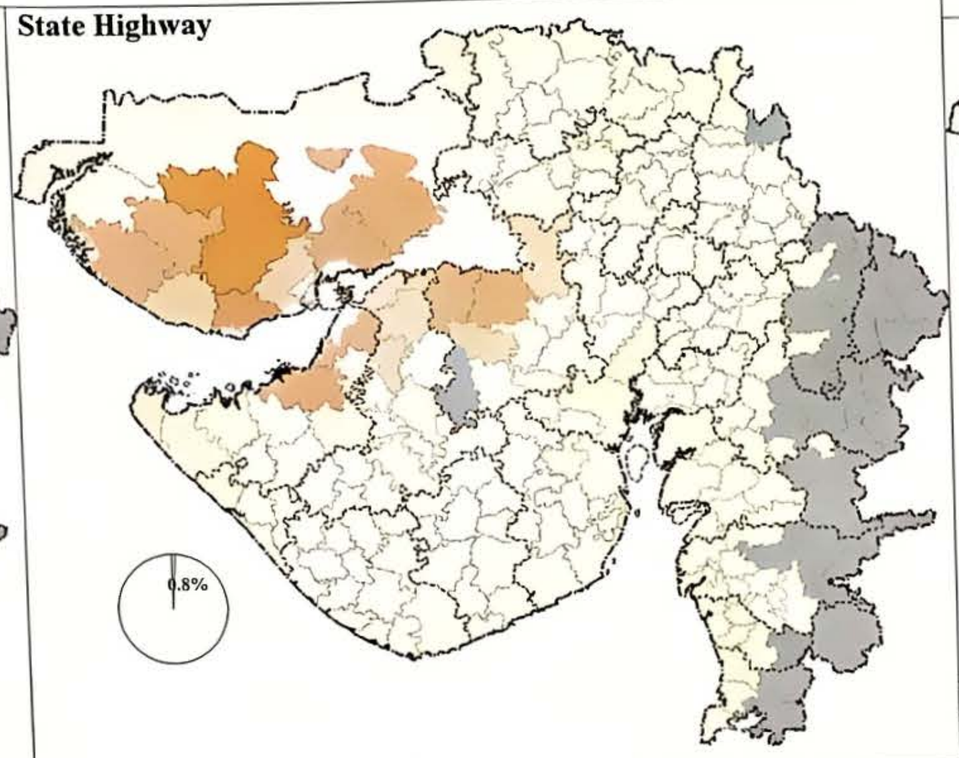
Gujarat Critical Infrastructure Risk Zonation: Earthquake Loss to Roads
(100 year return period) (Rs. Million 2002-2003 prices)

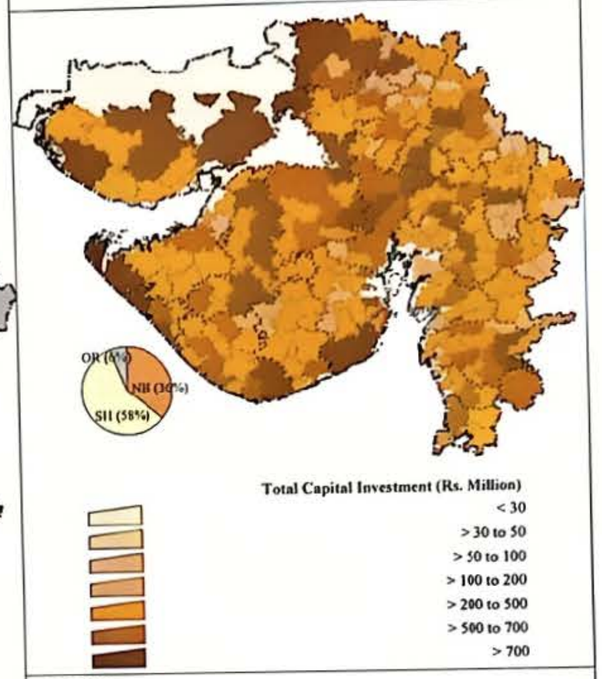
GSDMA

National Highway



State Highway

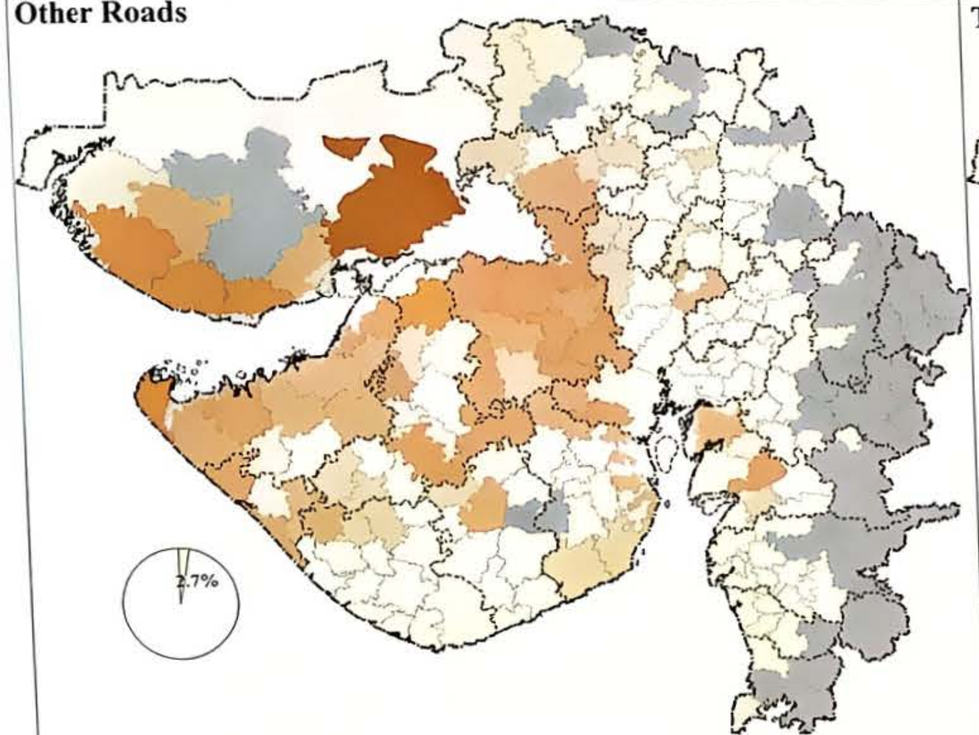




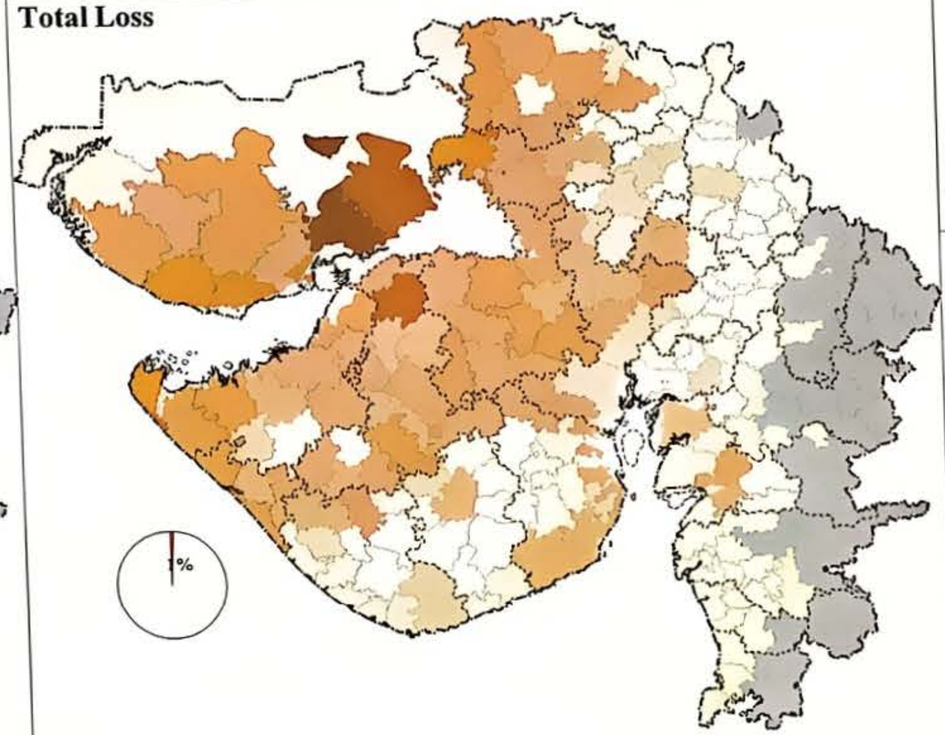
LEGEND

Loss to Roads (Rs. Million)
< 1
> 1 to 2
> 2 to 3
> 3 to 5
> 5 to 10
> 10 to 20
> 20 to 40
> 40 to 80
> 80
No/insignificant loss

Other Roads



Total Loss



Inset map pie charts show the proportion of road class capital investment. The first three main map pie charts show the proportion of respective road class loss to total capital cost of that class. The fourth pie chart shows the proportion of road loss to total road capital cost.

Source: TARU Studies & Analysis, 2004; R&B Department, GoG; Revenue Department, GoG; HAZUS-99; BISAG, GoG.

0 100 km

N

Projection : Lambert Azimuthal Equal Area
Datum : WGS 84

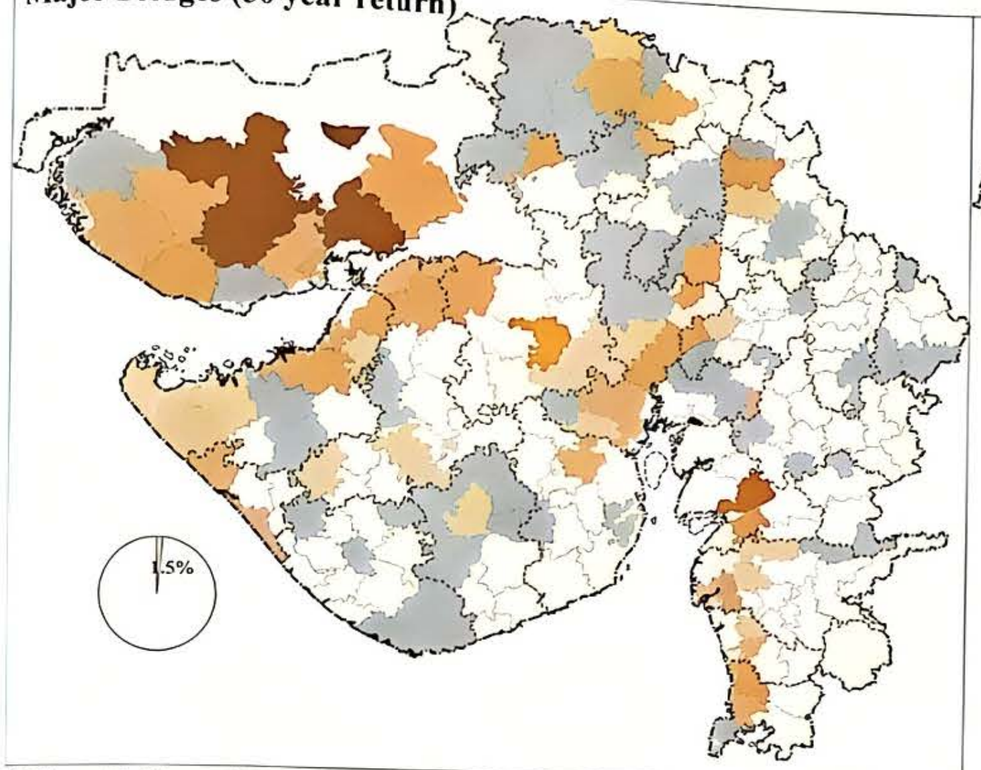
MAP No. : RIRM - 02 OF 03

Date : 18/6/2005

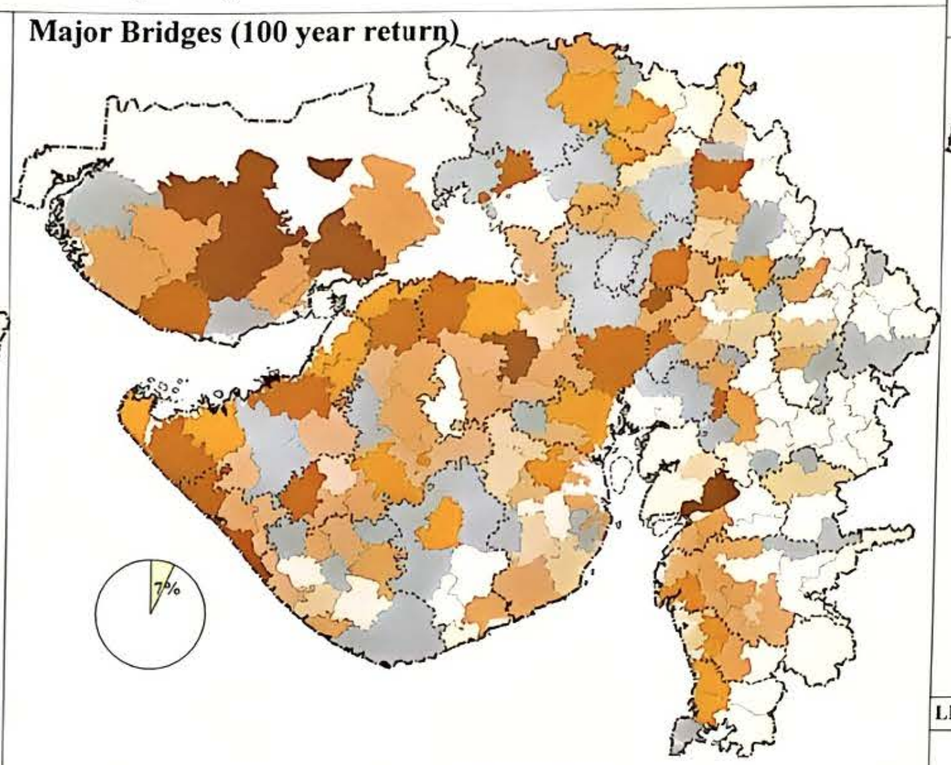
Gujarat Critical Infrastructure Risk Zonation: Earthquake Loss to Key Bridges
(Rs. Million 2002-2003 prices)

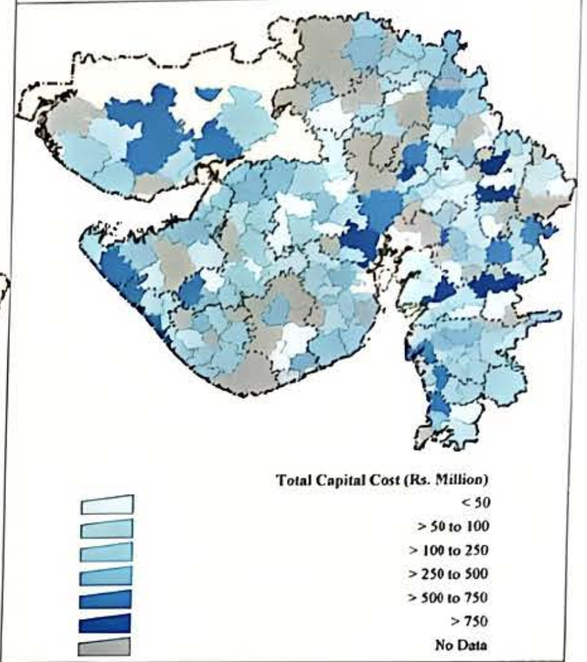
GSDMA

Major Bridges (50 year return)



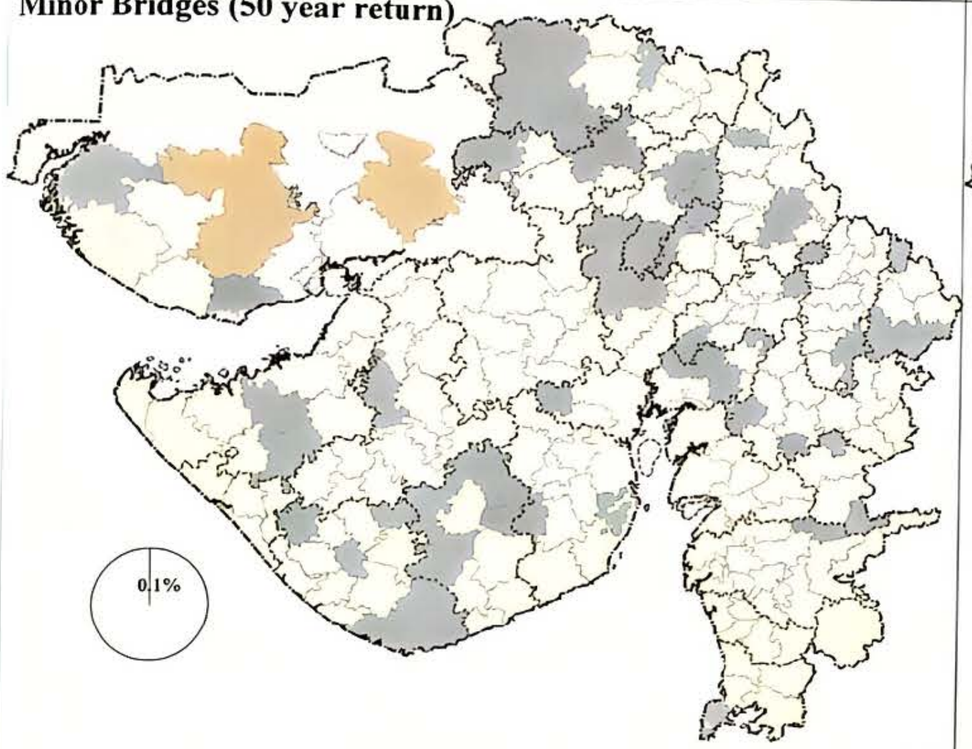
Major Bridges (100 year return)



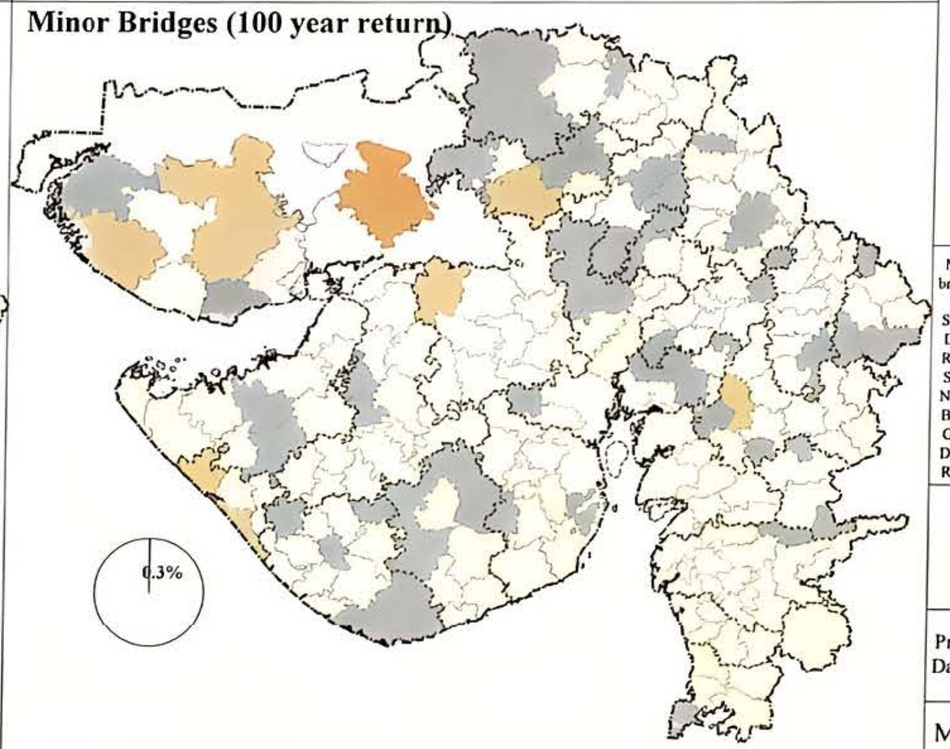


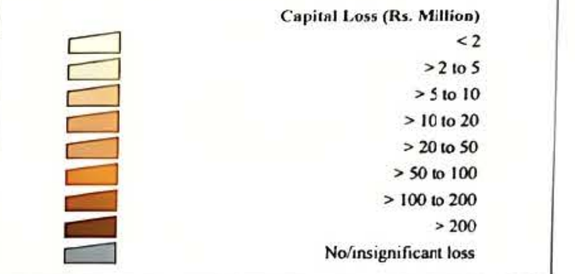
LEGEND

Minor Bridges (50 year return)



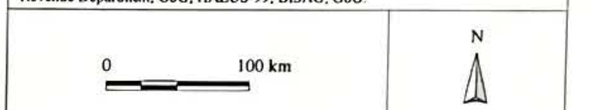
Minor Bridges (100 year return)





Main map pie charts show the proportion of bridge loss to the total capital cost of bridges.

Source: TARU Studies & Analysis, 2004;
District Level Maps, 2003 (Scale 1cm = 2.5 km), R&B Department, GoG;
Road statistics, 2002-2003, R&B Department, GoG;
Statistical information on road length & bridges etc. (F-1 & F-2), 2004, NH circle, R&B Department, GoG;
Bridges in Gujarat, 1989, R&B Department, GoG;
Gujarat Earthquake 26 Jan 2001 State Highways and Structures Preliminary Damage Report, 2001, R&B Department, GoG;
Revenue Department, GoG; HAZUS-99; BISAG, GoG.



Projection : Lambert Azimuthal Equal Area
Datum : WGS 84

MAP No. : RIRM - 03 OF 03

Date : 18/6/2005

GUJARAT CRITICAL INFRASTRUCTURE RISK ZONATION : EARTHQUAKE LOSS TO ROADS
(50 YEAR & 100 YEAR RETURN PERIOD) (Rs. MILLION 2002-2003 PRICES) Table No. VIRT - 01 of 02

GSDMA

Sr. No	District	Taluka	EQ. (50 Year return)				EQ. (100 Year return)			
			NH	SH	OR	Total	NH	SH	OR	Total
1	Ahmadabad	Ahmadabad City	0.3	-	-	0.4	4.4	0.5	0.6	5.5
2	Ahmadabad	Barwala	-	0.1	0.6	0.6	-	0.7	6.1	6.7
3	Ahmadabad	Bavla	0.3	-	0.1	0.4	4.9	0.6	0.8	6.2
4	Ahmadabad	Daskroi	0.3	0.1	0.3	0.7	4.7	0.8	4.4	9.9
5	Ahmadabad	Detroj-Rampura	-	0.1	0.1	0.2	-	1.4	1.4	2.8
6	Ahmadabad	Dhandhuka	-	-	0.1	0.1	-	0.9	2.9	3.8
7	Ahmadabad	Dholka	-	0.1	0.9	1.0	-	0.5	4.8	5.3
8	Ahmadabad	Mandal	-	-	-	-	1.6	0.8	1.7	4.1
9	Ahmadabad	Ranpur	-	0.1	0.1	0.2	-	1.2	2.1	3.3
10	Ahmadabad	Sanand	-	-	0.2	0.2	-	0.2	2.3	2.5
11	Ahmadabad	Viramgam	-	0.2	0.2	0.4	-	1.2	1.5	2.7
12	Amreli	Amreli	-	0.1	0.2	0.3	-	0.8	3.5	4.3
13	Amreli	Babra	-	-	-	-	-	0.6	1.2	1.8
14	Amreli	Bagasara	-	-	-	0.1	-	0.4	0.6	1.0
15	Amreli	Dhari	-	0.1	0.1	0.1	-	0.3	0.4	0.7
16	Amreli	Jafrabad	-	-	-	-	0.9	0.1	0.6	1.7
17	Amreli	Khambha	-	-	-	-	-	-	0.1	0.2
18	Amreli	Kunkavav Vadia	-	-	-	-	-	0.3	2.2	2.4
19	Amreli	Lathi	-	0.0	0.1	0.1	-	0.6	0.9	1.5
20	Amreli	Lilia	-	0.0	-	0.0	-	0.6	-	0.6
21	Amreli	Rajula	-	-	-	-	1.2	0.2	0.6	2.0
22	Amreli	Savar Kundla	-	-	-	-	-	0.3	0.2	0.5
23	Anand	Anand	0.2	0.1	0.1	0.3	0.9	0.3	0.4	1.6
24	Anand	Anklav	-	-	0.1	0.1	-	0.1	0.3	0.4
25	Anand	Borsad	-	0.1	0.1	0.1	-	0.9	1.2	2.0
26	Anand	Khambhat	-	0.1	0.1	0.2	-	0.3	0.7	1.0
27	Anand	Petlad	-	0.1	-	0.1	-	0.3	0.1	0.4
28	Anand	Sojitra	-	-	0.1	0.1	-	0.3	0.6	0.8
29	Anand	Tarapur	-	-	0.2	0.2	-	0.2	0.9	1.0
30	Anand	Umreth	-	-	-	-	-	0.2	0.2	0.4
31	Banas Kantha	Amirgadh	-	-	-	-	0.4	-	-	0.5
32	Banas Kantha	Bhabhar	0.6	-	-	0.6	6.2	0.3	-	6.5
33	Banas Kantha	Danta	-	-	-	-	-	-	0.1	0.2
34	Banas Kantha	Dantiwada	-	-	0.1	0.1	-	0.2	1.4	1.6
35	Banas Kantha	Deesa	0.8	0.1	-	0.9	4.6	0.8	0.3	5.7
36	Banas Kantha	Deodar	-	-	-	-	-	0.4	-	0.4
37	Banas Kantha	Dhanera	-	-	-	-	-	0.5	-	0.5
38	Banas Kantha	Kankrej	0.3	-	-	0.3	8.0	0.3		8.3
39	Banas Kantha	Palanpur	0.6	0.1	0.3	1.0	3.8	0.5	1.8	6.0
40	Banas Kantha	Tharad	0.3	-	0.1	0.4	4.6	0.6	1.2	6.4
41	Banas Kantha	Vadgam	-	0.1	-	0.1	-	0.4	-	0.4
42	Banas Kantha	Vav	0.8	0.1	0.1	1.0	8.3	0.8	1.3	10.5
43	Bharuch	Amod	-	-	0.3	0.3	-	0.2	1.5	1.7
44	Bharuch	Anklesvar	0.7	0.1	0.9	1.7	2.1	0.3	2.6	5.0
45	Bharuch	Bharuch	0.4	0.1	0.8	1.3	2.3	0.5	5.0	7.8
46	Bharuch	Hansot	-	-	0.4	0.4	-	0.1	0.8	0.9
47	Bharuch	Jambusar	-	-	0.7	0.7	-	-	3.4	3.4
48	Bharuch	Jhagadia	-	-	-	-	-	-	0.3	0.4
49	Bharuch	Vagra	-	-	0.2	0.2	-	0.2	1.0	1.2
50	Bharuch	Valia	-	-	0.2	0.3	-	0.1	0.6	0.7
51	Bhavnagar	Bhavnagar	0.4	0.2	0.7	1.3	2.6	1.2	3.9	7.7
52	Bhavnagar	Botad	-	0.1	0.8	0.9	-	0.6	5.0	5.6
53	Bhavnagar	Gadhada	-	-	-	-	-	0.1	0.2	0.3
54	Bhavnagar	Gariadhar	-	-	-	-	-	0.1	-	0.1
55	Bhavnagar	Ghogha	0.1	-	0.3	0.4	0.4	0.1	1.7	2.2
56	Bhavnagar	Mahuva	0.3	0.1	0.4	0.7	1.4	0.3	2.1	3.7
57	Bhavnagar	Palitana	-	0.1	0.3	0.3	-	0.3	1.3	1.6
58	Bhavnagar	Sihor	-	-	0.2	0.2	-	0.2	1.0	1.2
59	Bhavnagar	Talaja	0.3	-	0.4	0.7	1.4	0.2	2.0	3.6
60	Bhavnagar	Umrala	-	0.1	0.2	0.3	-	0.4	1.3	1.7
61	Bhavnagar	Vallabhipur	-	0.1	-	0.1	-	1.1	0.5	1.6
62	Dohad	Devgadbaria	-	-	-	-	-	-	-	-
63	Dohad	Dhanpur	-	-	-	-	-	-	-	-
64	Dohad	Dohad	-	-	-	-	-	-	-	-
65	Dohad	Fatepura	-	-	-	-	-	-	-	-
66	Dohad	Garbada	-	-	-	-	-	-	-	-
67	Dohad	Jhalod	-	-	-	-	-	-	-	-
68	Dohad	Limkheda	-	-	-	-	-	-	-	-
69	Gandhinagar	Dehgam	-	-	-	-	-	0.3	1.4	1.7
70	Gandhinagar	Gandhinagar	-	-	-	-	1.0	0.3	1.9	3.2
71	Gandhinagar	Kalol	-	-	-	-	-	1.0	3.0	4.0
72	Gandhinagar	Mansa	-	0.0	0.2	0.2	-	0.2	0.8	1.0
73	Jamnagar	Bhanvad	-	0.1	0.1	0.2	-	0.9	1.8	2.7
74	Jamnagar	Dhrol	-	0.1	0.2	0.2	-	1.7	4.7	6.4
75	Jamnagar	Jamjodhpur	-	-	-	-	-	0.1	0.1	0.2
76	Jamnagar	Jamnagar	-	0.2	0.2	0.4	-	4.2	3.9	8.0
77	Jamnagar	Jodiya	-	0.2	0.5	0.7	-	3.4	9.2	12.6
78	Jamnagar	Kalavad	-	-	0.2	0.2	-	1.3	4.4	5.7
79	Jamnagar	Kalyanpur	0.2	0.1	0.1	0.4	6.0	1.8	4.1	11.8
80	Jamnagar	Khambhalia	-	0.1	0.9	1.0	-	1.4	9.7	11.1
81	Jamnagar	Lalpur	-	0.1	0.3	0.4	-	1.0	3.6	4.6
82	Jamnagar	Okhamandal	0.4	-	0.5	1.0	11.5	1.2	14.8	27.6
83	Junagadh	Bhesan	-	-	-	-	-	0.3	1.0	1.3
84	Junagadh	Junagadh	-	-	-	-	3.0	0.7	2.2	5.8
85	Junagadh	Keshod	-	-	-	-	0.9	0.2	1.0	2.0
86	Junagadh	Kodinar	-	-	-	-	1.0	0.2	0.5	1.7
87	Junagadh	Malia	-	-	-		0.7	0.2	0.4	1.2
88	Junagadh	Manavadar	-	-	-	-	0.3	0.5	3.3	4.1
89	Junagadh	Mangrol	-	-	-	-	0.8	0.2	0.5	1.4
90	Junagadh	Mendarda	-	-	-	-	-	0.2	0.8	0.9
91	Junagadh	Patan-Veraval	-	-	-	-	1.6	0.1	0.2	1.9
92	Junagadh	Sutrapada	-	-	-	-	0.9	0.1	0.9	1.8
93	Junagadh	Talala	-	-	-	-	-	-	0.3	0.3
94	Junagadh	Una	0.3	0.1	0.1	0.4	1.3	0.4	0.4	2.1
95	Junagadh	Vanthali	-	-	-	-	2.1	0.3	2.0	4.5
96	Junagadh	Visavadar	-	-	-	-	-	0.3	0.5	0.7
97	Kachchh	Abdasa	-	0.5	1.3	1.8	-	4.2	11.8	16.0
98	Kachchh	Anjar	0.9	0.7	0.8	2.5	3.3	2.7	3.0	9.0
99	Kachchh	Bhachau	15.2	0.7	7.0	22.9	93.4	4.6	43.2	141.1
100	Kachchh	Bhuj	-	5.8	-	5.8	-	19.0	-	19.0
101	Kachchh	Gandhidham	13.0	0.8	1.0	14.8	31.6	1.9	2.4	35.9
102	Kachchh	Lakhpat	-	0.1	0.7	0.8	-	0.2	1.3	1.6
103	Kachchh	Mandvi	-	0.2	1.6	1.9	-	2.3	18.1	20.4
104	Kachchh	Mundra	-	1.4	5.1	6.5		5.4	19.8	25.2
105	Kachchh	Nakhatrana	-	0.8	1.2	2.1	-	3.0	4.5	7.6
106	Kachchh	Rapar	5.3	0.5	6.9	12.8	32.1	3.1	41.3	76.6
107	Kheda	Balasinor	-	-	-	-	0.1	-	-	0.1
108	Kheda	Kapadvanj	-	-	-	-		0.3	0.4	0.7
109	Kheda	Kathlal	-	-	-	-	0.3	-	-	0.4
110	Kheda	Kheda	0.3	0.1	-	0.4	1.8	0.5	0.1	2.3
111	Kheda	Mahudha	-	-	-	-	-	0.2	0.1	0.3
112	Kheda	Matar	0.1	0.1	-	0.3	0.9	0.7	0.3	1.8
113	Kheda	Mehmedabad	-	-	0.1	0.1		0.4	1.6	2.0
114	Kheda	Nadiad	0.2	-	-	0.3	1.0	0.2	0.2	1.4

GUJARAT CRITICAL INFRASTRUCTURE RISK ZONATION : EARTHQUAKE LOSS TO ROADS
(50 YEAR & 100 YEAR RETURN PERIOD) (Rs. MILLION 2002-2003 PRICES) Table No. VIRT - 01 of 02

GSDMA

Sr. No	District	Taluka	EQ. (50 Year return)				EQ. (100 Year return)			
			NH	SH	OR	Total	NH	SH	OR	Total
115	Kheda	Thasra	-	-	-	-	0.3	0.1	0.4	0.8
116	Kheda	Virpur	-	-	-	-	-	-	0.1	0.1
117	Mahesana	Becharaji	-	-	-	0.1	-	0.4	0.4	0.8
118	Mahesana	Kadi	-	-	-	-	-	1.0	0.9	1.9
119	Mahesana	Kheralu	-	-	0.1	0.1	-	0.4	0.9	1.3
120	Mahesana	Mahesana	-	0.1	0.1	0.2	-	1.1	1.3	2.5
121	Mahesana	Satlasana	-	-	-	-	-	-	-	-
122	Mahesana	Unjha	-	-	-	-	-	0.4	0.2	0.6
123	Mahesana	Vadnagar	-	-	0.1	0.2	-	0.3	2.1	2.4
124	Mahesana	Vijapur	-	-	0.2	0.2	-	0.2	0.8	0.9
125	Mahesana	Visnagar	-	0.1	0.1	0.2	-	0.9	1.7	2.6
126	Narmada	Dediapada	-	-	-	-	-	-	-	-
127	Narmada	Nandod	-	-	-	-	-	-	-	-
128	Narmada	Sagbara	-	-	-	-	-	-	-	-
129	Narmada	Tilakwada	-	-	-	-	-	-	0.1	0.1
130	Navsari	Bansda	-	-	-	-	-	-	-	-
131	Navsari	Chikhli	-	-	-	-	0.3	0.1	0.4	0.8
132	Navsari	Gandevi	-	-	-	-	0.1	0.1	0.1	0.3
133	Navsari	Jalalpore	-	-	-	0.1	-	0.1	0.1	0.2
134	Navsari	Navsari	-	-	-	-	0.4	0.0	0.1	0.5
135	Panch Mahals	Ghoghamba	-	-	-	-	-	-	-	-
136	Panch Mahals	Godhra	-	-	-	-	-	-	-	-
137	Panch Mahals	Halol	-	-	-	-	-	-	-	-
138	Panch Mahals	Jambughoda	-	-	-	-	-	-	-	-
139	Panch Mahals	Kadana	-	-	-	-	-	-	-	-
140	Panch Mahals	Kalol	-	-	-	-	-	0.1	0.1	0.1
141	Panch Mahals	Khanpur	-	-	-	-	-	-	-	-
142	Panch Mahals	Lunawada	-	-	-	-	-	0.1	0.1	0.2
143	Panch Mahals	Morwa (Hadaf)	-	-	-	-	-	-	-	-
144	Panch Mahals	Santrampur	-	-	-	-	-	-	-	-
145	Panch Mahals	Shehera	-	-	-	-	-	-	-	-
146	Patan	Chanasma	-	-	0.1	0.2	-	0.6	1.7	2.4
147	Patan	Harij	-	0.1	0.1	0.1	-	1.6	2.1	3.7
148	Patan	Patan	-	0.1	0.2	0.2	-	1.0	2.5	3.6
149	Patan	Radhanpur	0.4	-	0.1	0.5	6.3	0.8	1.0	8.1
150	Patan	Sami	-	0.1	0.1	0.2	-	1.8	3.4	5.3
151	Patan	Santalpur	1.8	0.1	0.2	2.0	19.4	0.8	2.2	22.4
152	Patan	Sidhpur	-	-	0.2	0.3	-	0.3	1.3	1.6
153	Patan	Vagdod	-	-	0.1	0.1	-	0.3	0.6	0.9
154	Porbandar	Kutiyana	-	-	-	-	2.6	0.2	3.1	6.0
155	Porbandar	Porbandar	0.7	0.1	0.4	1.2	11.2	1.3	5.5	18.0
156	Porbandar	Ranavav	-	-	-	-	3.3	0.2	1.2	4.8
157	Rajkot	Dhoraji	0.1	-	0.1	0.3	1.6	0.3	2.1	4.0
158	Rajkot	Gondal	0.3	0.1	0.3	0.6	7.0	1.9	8.2	17.1
159	Rajkot	Jamkandorna	-	-	-	-	-	0.8	-	0.8
160	Rajkot	Jasdan	-	0.1	0.3	0.4	-	0.8	5.1	5.9
161	Rajkot	Jetpur	-	-	-	-	4.9	0.7	2.0	7.6
162	Rajkot	Kotda Sangani	-	-	0.1	0.1	0.9	0.6	1.6	3.0
163	Rajkot	Lodhika	-	-	0.1	0.1	1.0	0.7	1.6	3.3
164	Rajkot	Maliya	0.3	0.2	-	0.5	5.6	2.8	0.0	8.4
165	Rajkot	Morvi	0.8	0.1	0.7	1.5	21.3	2.1	19.6	42.9
166	Rajkot	Paddhari	-	0.1	0.2	0.3	-	1.5	5.1	6.5
167	Rajkot	Rajkot	0.3	0.1	-	0.4	7.1	1.7	1.0	9.8
168	Rajkot	Tankara	-	0.1	0.1	0.2	-	2.0	2.8	4.8
169	Rajkot	Upleta	0.2	-	0.2	0.4	2.8	0.4	2.7	5.9
170	Rajkot	Wankaner	-	-	-	-	1.6	0.1	1.4	3.1
171	Sabar Kantha	Bayad	-	-	-	-	-	0.2	0.2	0.4
172	Sabar Kantha	Bhiloda	-	-	-	-	0.2	-	-	0.3
173	Sabar Kantha	Dhansura	-	-	-	-	-	0.2	-	0.2
174	Sabar Kantha	Himatnagar	0.2	-	0.2	0.4	1.2	0.2	0.8	2.2
175	Sabar Kantha	Idar	-	0.1	0.3	0.4	-	0.2	0.6	0.8
176	Sabar Kantha	Khedbrahma	-	-	-	-	-	-	0.1	0.2
177	Sabar Kantha	Malpur	-	-	-	-	-	-	-	-
178	Sabar Kantha	Meghraj	-	-	-	-	-	-	-	0.1
179	Sabar Kantha	Modasa	-	-	-	-	0.1	0.1	-	0.1
180	Sabar Kantha	Prantij	0.2	-	-	0.2	0.9	0.1	0.2	1.2
181	Sabar Kantha	Talod	-	-	-	-	-	0.3	0.1	0.4
182	Sabar Kantha	Vadali	-	-	-	-	-	0.2	-	0.2
183	Sabar Kantha	Vijaynagar	-	-	-	-	-	-	-	-
184	Surat	Bardoli	-	-	-	-	0.4	0.1	0.3	0.8
185	Surat	Chorasi	-	0.1	0.1	0.2	0.2	0.3	0.5	1.0
186	Surat	Kamrej	0.1	-	0.2	0.4	0.4	-	0.5	0.9
187	Surat	Mahuva	-	-	-	-	-	0.1	0.2	0.3
188	Surat	Mandvi	-	-	-	-	-	-	-	-
189	Surat	Mangrol	0.2	-	0.1	0.3	0.4	0.1	0.2	0.7
190	Surat	Nizar	-	-	-	-	-	-	-	-
191	Surat	Olpad	-	-	0.1	0.2	-	0.2	0.7	0.9
192	Surat	Palsana	-	-	-	-	0.6	-	-	0.7
193	Surat	Songadh	-	-	-	-	-	-	-	-
194	Surat	Surat City	-	-	-	0.1	0.1	0.1	0.2	0.4
195	Surat	Uchchhal	-	-	-	-	-	-	-	-
196	Surat	Umarpada	-	-	-	-	-	-	-	-
197	Surat	Valod	-	-	-	-	0.1	0.1	0.1	0.2
198	Surat	Vyara	-	-	-	-	0.3	0.1	0.6	1.0
199	Surendranagar	Chotila	0.2	-	0.4	0.5	5.3	-	9.6	14.9
200	Surendranagar	Chuda	0.1	0.1	0.6	0.9	0.7	1.2	5.7	7.7
201	Surendranagar	Dasada	-	0.1	0.2	0.3	-	2.7	5.2	7.9
202	Surendranagar	Dhrangadhra	-	0.1	0.2	0.3	-	3.3	8.3	11.6
203	Surendranagar	Halvad	-	0.2	0.3	0.4	-	3.8	5.5	9.4
204	Surendranagar	Lakhtar	-	-	0.1	0.2	-	1.3	3.4	4.7
205	Surendranagar	Limbdi	0.8	0.1	0.9	1.7	8.4	0.6	9.8	18.8
206	Surendranagar	Muli	-	0.1	0.1	0.1	-	2.6	4.0	6.7
207	Surendranagar	Sayla	0.5	0.1	0.2	0.8	5.7	0.9	2.5	9.1
208	Surendranagar	Wadhwan	0.3	0.1	0.7	1.2	3.8	1.4	7.6	12.7
209	The Dangs	The Dangs	-	-	-	-	-	-	-	-
210	Vadodara	Chhota Udaipur	-	-	-	-	-	-	-	-
211	Vadodara	Dabhoi	-	-	-	-	-	-	-	-
212	Vadodara	Jetpur Pavi	-	-	-	-	-	-	-	-
213	Vadodara	Karjan	0.2	-	0.3	0.5	0.5	0.1	0.8	1.3
214	Vadodara	Kavant	-	-	-	-	-	-	-	-
215	Vadodara	Nasvadi	-	-	-	-	-	-	-	-
216	Vadodara	Padra	-	0.0	0.1	0.1	-	0.2	0.5	0.6
217	Vadodara	Sankheda	-	-	-	-	-	-	-	-
218	Vadodara	Savli	-	-	-	-	0.0	0.1	0.2	0.3
219	Vadodara	Sinor	-	-	-	-	-	-	0.1	0.1
220	Vadodara	Vadodara	-	-	-	-	0.8	0.1	0.2	1.0
221	Vadodara	Vaghodia	-	-	-	-	-	-	-	
222	Valsad	Dharampur	-		-	-	-	-	-	
223	Valsad	Kaprada	-	-	-	-	-	-	-	-
224	Valsad	Pardi	0.2	-	-	0.2	0.4	0.1	-	0.5
225	Valsad	Umbergaon	0.1	-	0.1	0.2	0.2	0.1	0.2	0.5
226	Valsad	Valsad	0.2	-	0.2	0.4	0.4	0.1	0.5	1.0

GUJARAT CRITICAL INFRASTRUCTURE RISK ZONATION : EARTHQUAKE LOSS TO BRIDGES
(50 YEAR & 100 YEAR RETURN PERIOD) (Rs. MILLION 2002-2003 PRICES) Table No. - VIRT - 02 of 02

GSDMA

Sr. No	District	Taluka	Capital Cost	EQ (50 year return)		EQ (100 year return)	
				Minor	Major	Minor	Major
1	Ahmadabad	Ahmadabad City	1,416.2	0.1	44.7	327.4	1 5
2	Ahmadabad	Darwala	135.5	-	5.1	18.5	-
3	Ahmadabad	Bavla	704.5	-	7.5	106.3	-
4	Ahmadabad	Daskrol	114.3	-	3.8	25 8	-
5	Ahmadabad	Dholka	714.2	0 5	24.4	171.1	3.8
6	Ahmadabad	Dhandhuka	782.7	-	15.2	99.5	-
7	Amreli	Amreli	387.7	-	6.8	58.3	-
8	Amreli	Jafrabad	91.9	-	0.1	2.5	0 6
9	Amreli	Khambha	36.6	-	0.1	1.7	-
10	Amreli	Rajula	450.8	-	1.8	36.2	-
11	Amreli	Savar Kundla	15 1	-	-	-	0.8
12	Anand	Anand	278.0	-	3.5	34 2	-
13	Anand	Anklav	764.4	-	13.5	101.1	-
14	Anand	Khambhat	30.5	-	0.2	2.1	-
15	Banas Kantha	Amirgadh	176.1	-	0.2	4.6	-
16	Banas Kantha	Danta	162.3	0.1	0.2	2.5	0.7
17	Banas Kantha	Deesa	269.9	-	16.2	82.5	-
18	Banas Kantha	Dhanera	140.0	-	7.5	38 6	-
19	Banas Kantha	Palanpur	158.2	-	14.4	58.2	-
20	Banas Kantha	Vadgam	77.3	-	4.5	21.4	-
21	Bharuch	Amod	78.5	0.3	1.2	7.1	1.9
22	Bharuch	Anklesvar	166.0	-	26.3	41.3	-
23	Bharuch	Bharuch	1,401.7	1.0	126.8	308.5	2.4
24	Bharuch	Hansot	60.7	-	4.1	10.0	-
25	Bharuch	Jambusar	60.0	-	0.2	2.5	-
26	Bharuch	Jhagadia	189.0	-	0.2	1.7	-
27	Bharuch	Vagra	59.7	-	0.4	3.4	-
28	Bharuch	Valia	45.7	-	0.4	1.5	-
29	Bhavnagar	Bhavnagar	217.4	0.2	4.2	28.3	1.3
30	Bhavnagar	Botad	61.0	-	1.5	6.2	-
31	Bhavnagar	Gadhada	140.5	-	0.4	5.7	0.3
32	Bhavnagar	Mahuva	148.0	-	1.2	12.5	-
33	Bhavnagar	Palitana	56.0	-	0.9	8.1	-
34	Bhavnagar	Sihor	114.5	0.3	0.3	2.9	3.2
35	Bhavnagar	Talaja	120.0	-	0.8	7.8	-
36	Bhavnagar	Umrala	95.5	0.5	3.3	17.2	2.8
37	Bhavnagar	Vallabhipur	282.7	0 3	16.1	69.7	1.9
38	Dohad	Dohad	48.8	-	-	-	-
39	Dohad	Jhalod	62.5	-	-	0.1	-
40	Dohad	Limkheda	88.4	-	-	0.1	-
41	Gandhinagar	Dehgam	177.0	-	1.4	24.2	-
42	Gandhinagar	Gandhinagar	705.8	0.1	13.4	159.4	1.6
43	Jamnagar	Bhanvad	75.0	-	0.4	10.4	-
44	Jamnagar	Dhrol	184.3	-	7.5	51.2	-
45	Jamnagar	Jamnagar	388.1	-	31.7	162.0	
46	Jamnagar	Jodiya	228.1	-	27.9	96.9	-
47	Jamnagar	Kalavad	76.2	-	0.7	12.5	-
48	Jamnagar	Kalyanpur	554.2	0 1	5.9	106.6	1.9
49	Jamnagar	Khambhalia	384.5	-	5.6	76.2	-
50	Jamnagar	Okhamandal	209.8	-	7.3	73.5	
51	Junagadh	Junagadh	165.0	-	0.3	17.8	-
52	Junagadh	Keshod	51.6		-	2.5	1.0
53	Junagadh	Malia	122.0	-	0 1	8.9	-
54	Junagadh	Mangrol	133.1	-	0.2	11.2	-
55	Junagadh	Patan-Veraval	117.8	-	0.5	20.1	-
56	Junagadh	Talala	112.0	-	-	2.4	
57	Junagadh	Vanthali	409.2	-	0 8	40.3	-
58	Junagadh	Visavadar	134.2		0.9	20.5	-
59	Kachchh	Abdasa	112.2	2.2	14.7	38.8	6.2
60	Kachchh	Anjar	143.1	1.6	16.6	40.1	4.1
61	Kachchh	Bhachau	746.6	-	323.6	459.3	-
62	Kachchh	Bhuj	515.6	5.3	217.5	270.5	6 9
63	Kachchh	Gandhidham	63.2	-	20.7	34.5	-
64	Kachchh	Mandvi	160.1	-	49.9	110.7	-
65	Kachchh	Nakhatrana	82.3	-	19.8	42.7	-
66	Kachchh	Rapar	123.9	9.5	26.3	39.2	14.1
67	Kheda	Kapadvanj	79.6	-	0.3	6.7	-
68	Kheda	Kathlal	148.7	-	-	1.7	-
69	Kheda	Kheda	402.7	-	24.5	114.5	-
70	Kheda	Mahudha	59.5	-	1.0	8.3	-
71	Kheda	Mehmedabad	200.5	-	6.8	40.8	-
72	Kheda	Nadiad	75.7	-	2.5	14.5	-
73	Kheda	Thasra	94.2	-	0.2	6.2	1.3
74	Mahesana	Becharaji	76.2	-	1.7	20.6	
75	Mahesana	Kheralu	36.6	-	1.3	6.7	
76	Mahesana	Mahesana	121.9	-	4.0	33.6	-
77	Mahesana	Satlasana	94.5	-	0.5	3.8	
78	Mahesana	Unjha	30.5	-	1.8	8.6	-
79	Narmada	Dediapada	40.5	-	-	-	-
80	Narmada	Nandod	889.8	-	0.2	5.6	
81	Navsari	Bansda	112.0	-	-	0.1	-
82	Navsari	Chikhli	159.7	0.1	4.5	22.3	0.9
83	Navsari	Gandevi	504.7	-	10.8	65.8	
84	Navsari	Jalalpore	166.0	-	0.6	6 7	-
85	Navsari	Navsari	565.0	-	7.4	58 5	
86	Panch Mahals	Godhra	824.3	-	0.1	6.2	-
87	Panch Mahals	Halol	45.7	-	-	0.1	
88	Panch Mahals	Kadana	126.0	-	-	0.2	
89	Panch Mahals	Kalol	213.7	-	0.6	16.1	
90	Panch Mahals	Khanpur	210.4	-	-	0.3	
91	Panch Mahals	Lunawada	774.4	-	1.4	49.4	-
92	Panch Mahals	Morwa (Hadaf)	93.3	-	-	0.2	
93	Panch Mahals	Santrampur	96.3	-	-	0.1	
94	Panch Mahals	Shehera	41.2	-	-	0.1	-
95	Patan	Chanasma	107.8	0.4	2.2	22.1	4.0
96	Patan	Radhanpur	273.6	-	21.8	118.8	-
97	Patan	Sami	16.3	0.4	-	-	5.1
98	Patan	Sidhpur	171.5	-	13.2	58.1	
99	Porbandar	Kutiyana	119.8	-	0.3	13.5	
100	Porbandar	Porbandar	589.7	0.5	13.1	176.8	7 1
101	Porbandar	Ranavav	101.9	0.2	1.3	20.8	3.5
102	Rajkot	Dhoraji	308.0	-	1.3	47.3	-
103	Rajkot	Gondal	144.1	-	5.3	56.8	
104	Rajkot	Jamkandorna	39.0	-	0.2	6 0	
105	Rajkot	Jasdan	87.1	-	0.6	12.2	
106	Rajkot	Jetpur	137.2	-	1.7	36.8	
107	Rajkot	Kotda Sangani	35.2	-	2.0	14 0	
108	Rajkot	Maliya	121.2	-	16.3	53.0	
109	Rajkot	Morvi	275.6	-	29 7	150.1	-
110	Rajkot	Rajkot	179.9	0.1	1.0	30.3	1.0
111	Rajkot	Tankara	58.5	-	1.2	17 4	-
112	Rajkot	Upleta	538.6	-	7 1	119.1	-
113	Rajkot	Wankaner	239.4	-	0 3	21 3	-
114	Sabar Kantha	Bayad	319.1		4 3	56 4	-

GUJARAT CRITICAL INFRASTRUCTURE RISK ZONATION : EARTHQUAKE LOSS TO BRIDGES
(50 YEAR & 100 YEAR RETURN PERIOD) (Rs. MILLION 2002-2003 PRICES) Table No. - VIRT - 02 of 02

GSDMA

Sr. No	District	Taluka	Capital Cost	EQ (50 year return)		EQ (100 year return)	
				Minor	Major	Minor	Major
115	Sabar Kantha	Bhiloda	107.6	-	-	0.4	-
116	Sabar Kantha	Himatnagar	315.0	-	0.6	48.4	-
117	Sabar Kantha	Idar	544.5	0.6	29.8	103.8	2.3
118	Sabar Kantha	Khedbrahma	263.6	0.0	1.2	7.8	0.2
119	Sabar Kantha	Malpur	36.6	-	-	0.1	-
120	Sabar Kantha	Meghraj	48.0	-	-	0.7	-
121	Sabar Kantha	Prantij	60.0	-	1.0	9.4	-
122	Sabar Kantha	Talod	54.0	-	0.7	8.2	-
123	Sabar Kantha	Vijaynagar	126.5	-	0.1	1.8	-
124	Surat	Bardoli	141.2	0.1	3.8	21.6	1.1
125	Surat	Chorasi	504.0	-	11.3	64.6	-
126	Surat	Kamrej	407.9	0.2	5.4	37.3	1.5
127	Surat	Mahuva	132.9	-	2.7	18.5	-
128	Surat	Mandvi	432.7	-	-	0.7	-
129	Surat	Mangrol	110.1	0.9	5.1	13.6	2.2
130	Surat	Nizar	269.0	-	0.2	2.8	-
131	Surat	Olpad	96.0	-	2.5	12.8	-
132	Surat	Palsana	96.2	0.2	1.7	10.3	1.6
133	Surat	Songadh	225.1	-	-	0.2	-
134	Surat	Surat City	673.1	-	12.4	78.2	-
135	Surat	Uchchhal	90.0	-	-	0.1	-
136	Surat	Valod	70.4	-	0.7	6.1	-
137	Surat	Vyara	235.4	-	1.0	13.5	-
138	Surendranagar	Chotila	15.5	0.1	-	-	2.0
139	Surendranagar	Chuda	38.1	-	5.0	15.8	-
140	Surendranagar	Dasada	74.7	-	0.3	13.9	-
141	Surendranagar	Dhrangadhra	123.4	-	3.3	50.0	-
142	Surendranagar	Halvad	328.6	0.8	23.5	171.8	7.1
143	Surendranagar	Lakhtar	34.3	-	1.0	9.7	-
144	Surendranagar	Limbdi	116.7	-	5.8	29.1	-
145	Surendranagar	Muli	32.9	-	1.2	11.8	-
146	Surendranagar	Sayla	159.0	-	2.9	25.3	-
147	Surendranagar	Wadhwan	399.4	-	65.2	224.1	-
148	The Dangs	The Dangs	167.8	-	-	0.1	-
149	Vadodara	Chhota Udaipur	533.3	-	-	0.9	-
150	Vadodara	Dabhoi	245.3	-	0.1	2.7	-
151	Vadodara	Jetpur Pavi	126.7	-	-	0.9	-
152	Vadodara	Karjan	30.5	-	0.8	4.6	-
153	Vadodara	Kavant	196.5	-	-	0.2	-
154	Vadodara	Nasvadi	84.5	-	-	0.5	-
155	Vadodara	Sankheda	567.9	-	0.1	3.3	-
156	Vadodara	Savli	60.0	-	-	0.1	-
157	Vadodara	Vadodara	277.9	1.0	3.4	26.5	0.4
158	Vadodara	Waghodia	79.3	-	-	0.1	-
159	Valsad	Dharampur	30.0	-	-	0.1	-
160	Valsad	Kaprada	62.2	-	-	0.1	-
161	Valsad	Pardi	301.5	0.2	15.1	60.2	1.3
162	Valsad	Valsad	545.4	0.9	21.3	84.6	3.5

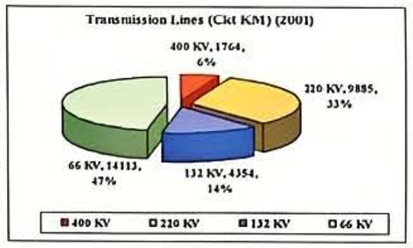
Note Damages are based on the geocoded database of 435 bridges

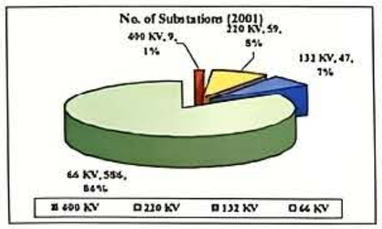
POWER INFRASTRUCTURE VULNERABILITY & RISK

GUJARAT'S PUBLIC POWER INFRASTRUCTURE

The power sector in Gujarat comprises three entities in the state sector % the Gujarat Electricity Board (GEB), Gujarat State Electricity Corporation Limited (GSECL) and Gujarat Energy Transmission Corporation Limited (GETCL). There are additional private power generation and local distribution companies. The GEB currently has a total installed generating capacity of 4,507 MW which includes a thermal generating capacity of 3,960 MW and hydel generating capacity of 547 MW. GETCL (incorporated in 1999) will take over power transmission function of up to 66 kV as a consequence of the proposed sector.

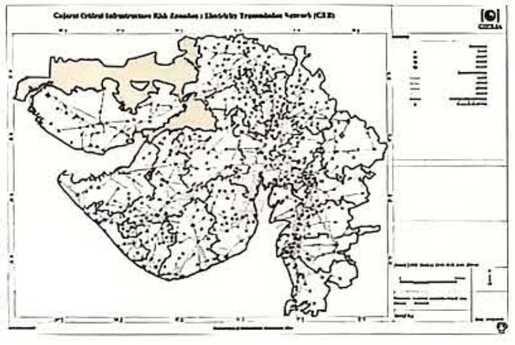
GEB caters to 7.13 million consumers spread across Gujarat via 705 substations and a T&D network of 30,266 Ckt-km of EHV/HV lines, 1,39,984 Ckt-km of 11/ 22 kV lines and 1,99,416 Ckt-km of LT distribution lines. 66 KVA lines contribute 47% of all transmission lines followed by 220 KVA (33%).



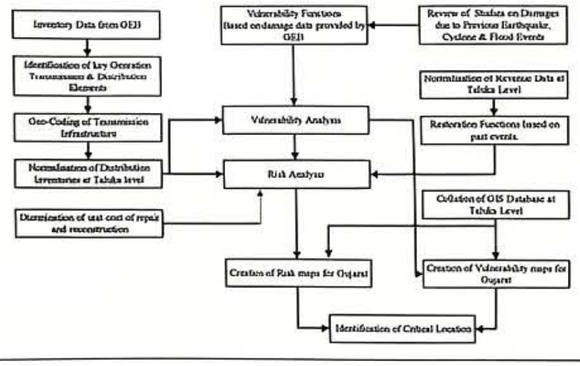


The transmission network is dominated by 66 KVA substations (84%), closely followed by 220 and 132 KVA substations at 8% and 7% respectively. A total of 586 substations of 66KVA form the hub of transmission network. Thereafter power is fed into 11KVA feeders for local distribution. These feeders along with high tension (HT) and low tension (LT) power lines constitute the distribution network.

The GEB power transmission network is presented in the adjoining figure. For the most part the network is evenly distributed spatially with higher concentration of substations and power lines in industrial locations along Gujarat's Golden Corridor. Peripheral areas of the state have a lower network density owing to the lower density of industrial and domestic consumers. There are 14 power generation stations currently operated by the GEB.



METHODOLOGY FOR VULNERABILITY AND RISK ANALYSIS

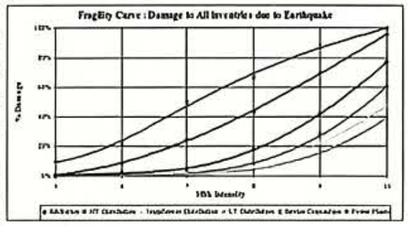


DATA SOURCES

- GEB Generation Transmission and Distribution Data and Inventory
- GEB Revenue Data
- GEB Damage Data and Power Restoration Timeline for Kachchh Earthquake
- Capital Cost of Infrastructure (from various sources)
- Revenue Dept. GoG. Memorandum to GoI on Kandla Cyclone (1998) and Kachchh Earthquake (2001)

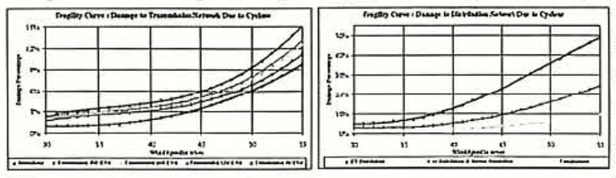
EARTHQUAKE DAMAGE FUNCTION

The ground motion related fragility curves for various GEB power inventory elements are presented in the adjoining figure. These curves are derived from normalised damage data of Kachchh Earthquake (GEB, 2002). Transmission lines have been excluded from the analysis due to negligible damage suffered. The sub-station damage function is derived from related building types normalised to the observed damage. Normalised standard HAZUS curves were utilised to estimate damage to generation plants owing to lack of local data.



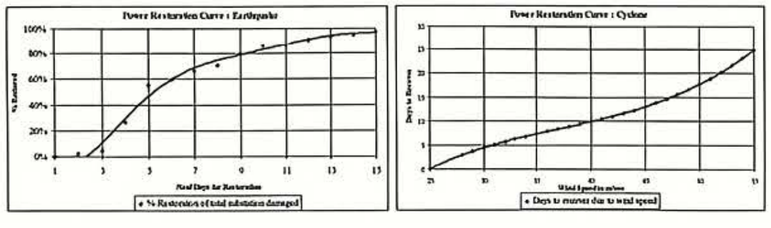
CYCLONE DAMAGE FUNCTION

The fragility curves for transmission and distribution were normalized and calibrated using the Saffir-Simpson Tropical Cyclone Scale (STCS) using actual damage data provided by GEB from the Kandla Cyclone of (1998). Fragility curves for other inventories were derived by scaling and validating field damage data.

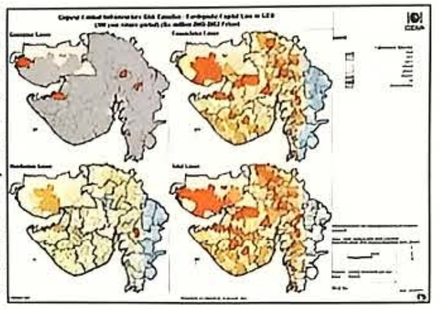


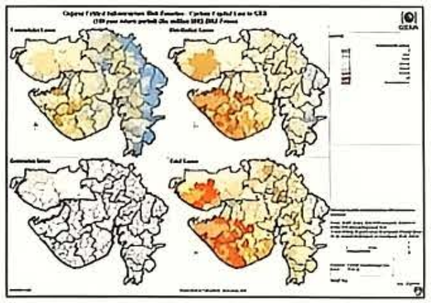
RESTORATION CURVES FOR EARTHQUAKE AND CYCLONE

Post-earthquakes power restoration curves were developed using the power restoration timelines provided by GEB for Kachhch (2001) and Kandla cyclone (1998) events, to estimate revenue loss due to service disruption. Substation damage data was utilised to benchmark the restoration time in case of an earthquakes, while windspeed zone based restoration times were used for cyclonic wind damage.



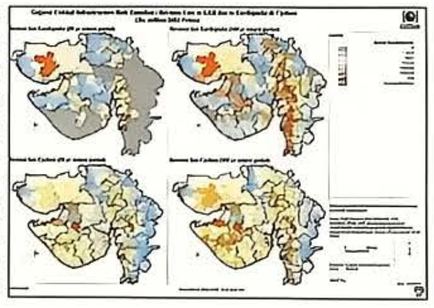
Capital loss estimates to GEB due to a 100-year return period earthquake is presented in the adjoining figure. The overall pattern that capital risk broadly follows is the earthquake hazard zonation with an exception that losses are compounded by the local density of inventories as well as their spatial distribution. Hence higher risks are visible in the Kachchh as well as the Golden Corridor where the concentration of power infrastructure is high. Distribution losses are more or less evenly distributed across the state.





Capital loss to GEB due to a 100-year return period cyclonic storm is presented in adjoining figure. The total capital loss broadly follows the cyclone hazard zonation with generation plants suffering no damage. Losses are more prominent in Saurashtra where the inventory density does not affect losses as much as in the case of earthquakes. This is because transmission systems are more vulnerable to cyclone damage than substation damage.

Revenue losses to GEB are presented in the adjoining figure. Revenue power losses are directly dependent on net revenue inflows. Hence revenue losses reflect the impact of interruption in consumption of power. Industrial consumption therefore is a key driver of the loss. Revenue risk due to earthquakes is high in Kachchh as well as along the Golden Corridor. Urban talukas also have significant revenue risk.



CONCLUSIONS

Based on the above analysis critical sections of Gujarat's power have been identified. These may be strengthened to reduce the overall future risk. Net vulnerability due to cyclone is 4% and 3% for capital revenue for assets and 8% and 3% respectively for a 100-year return period earthquake.

Capital & Revenue Risk & Vulnerability				
	Risk (Rs. million)		Vulnerability	
	Capital	Revenue	Capital	Revenue
Earthquake 50 yr return	4,157	1,190	2%	2%
Earthquake 100 yr return	15,533	2,220	8%	3%
Cyclone 50 yr return	4,163	1,441	2%	2%
Cyclone 100 yr return	8,080	2,337	4%	3%

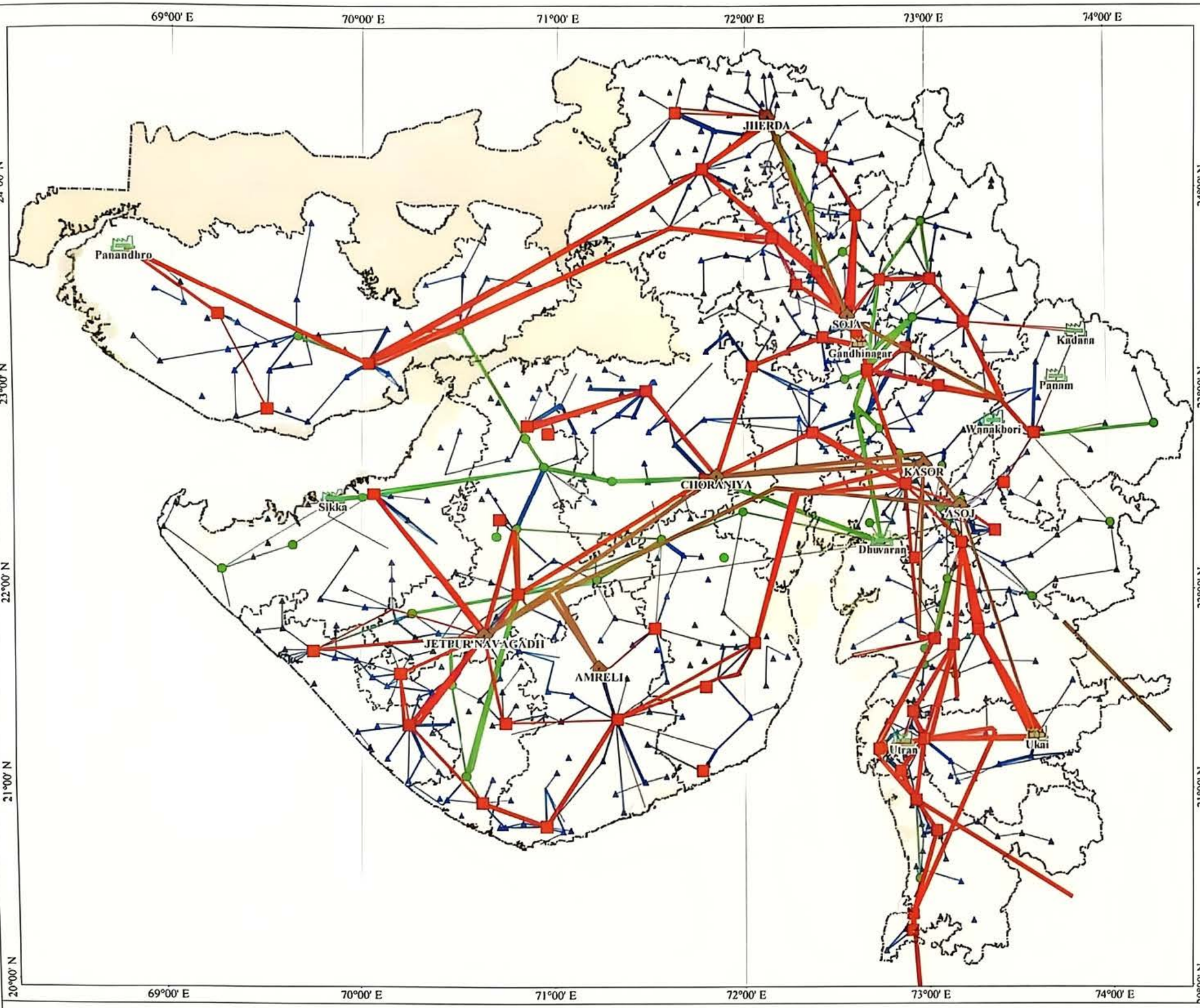
Note: Capital cost includes inventories from Generation, Transmission and Distribution networks only and does not include office buildings, staff quarters, store houses and other such assets

Since the approach is based on the benchmarking of the actual damage data, fragility functions can be further improved with the availability of better data. Long term risk mitigation would need to be based on the proper strengthening and retrofitting of the existing system.

Substations are more prone to damage due to earthquakes where as transmission lines are more prone to cyclones; hence upgraded design specifications for hazard prone areas will need to be defined.

Gujarat Critical Infrastructure Risk Zonation : Electricity Transmission Network (GEB)

GSDMA



LEGEND

Substations
- 66 KV
- 132 KV
- 220 KV
- 440 KV

Transmission lines
- 66 KV
- 132 KV
- 220 KV
- 440 KV
- GEB Distribution Circles
- Power Plants (GEB)

Note: Thickness of the Lines vary as per the annual load catered.
Transmission network exclude the Power Grid network.
Transmission Details for some Sub-station are not available.
This analysis is based on Gujarat Electricity Board (GEB) data for 2003.

Source: TARU Analysis, 2004; GEB, 2003, GoG; BISAG, GoG.

0 100 km

N

Projection : Lambert Azimuthal Equal Area
Datum : WGS 84

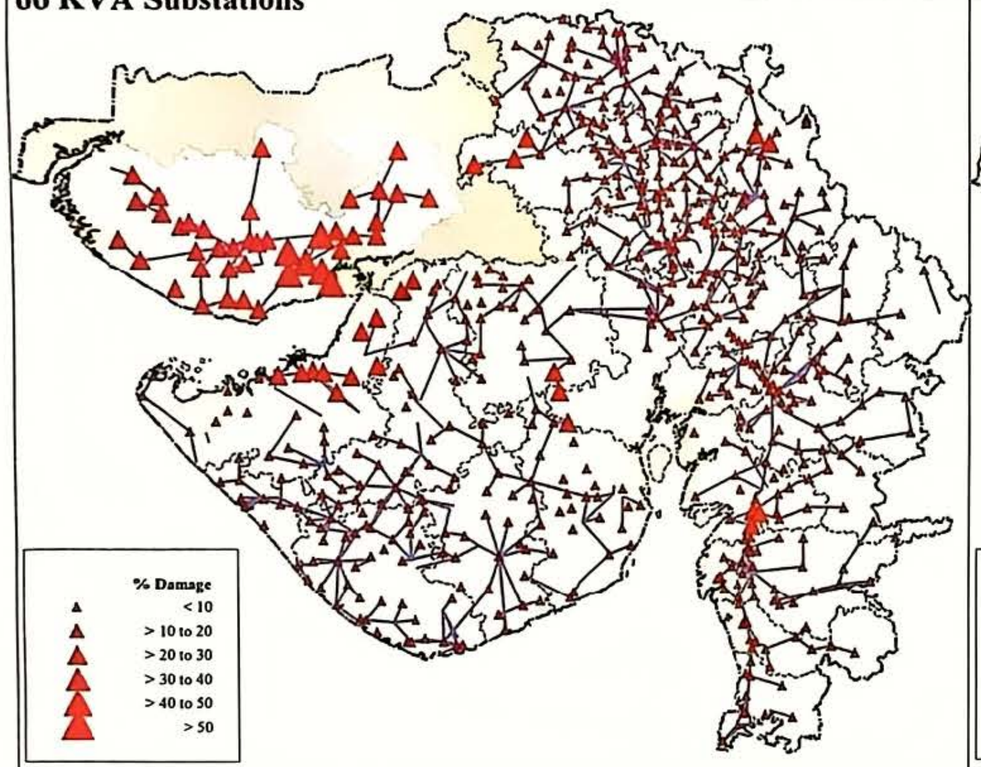
MAP No. :VIGM - 01 OF 05

Date : 18/6/2005

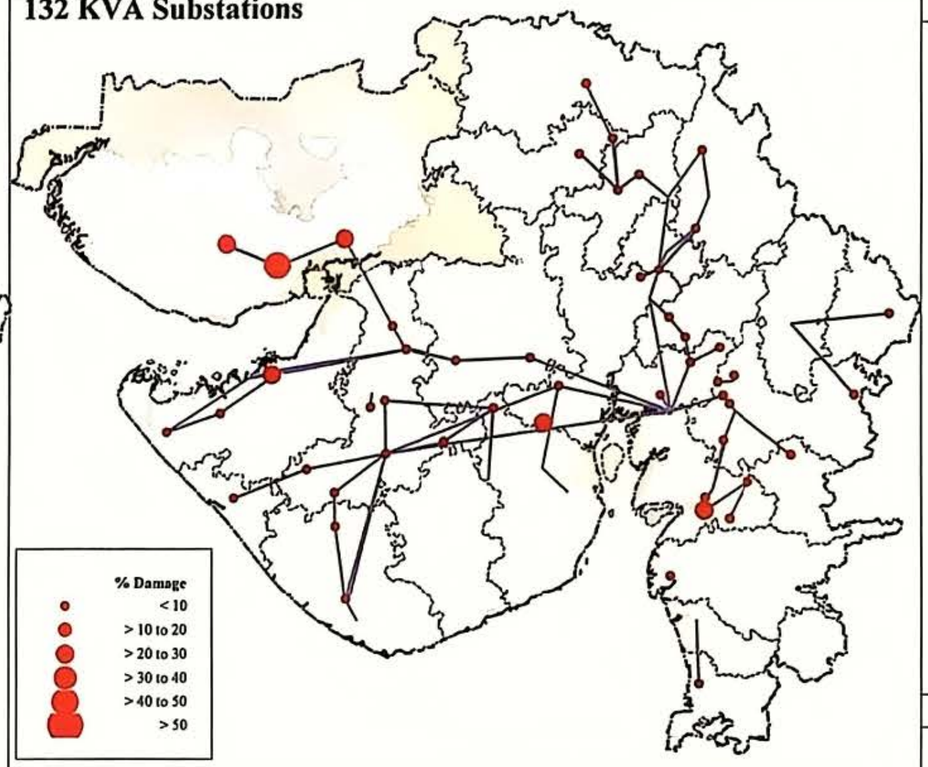
Gujarat Critical Infrastructure Vulnerability Zonation : Earthquake Damage to Substations
(50 year return period)

GSDMA

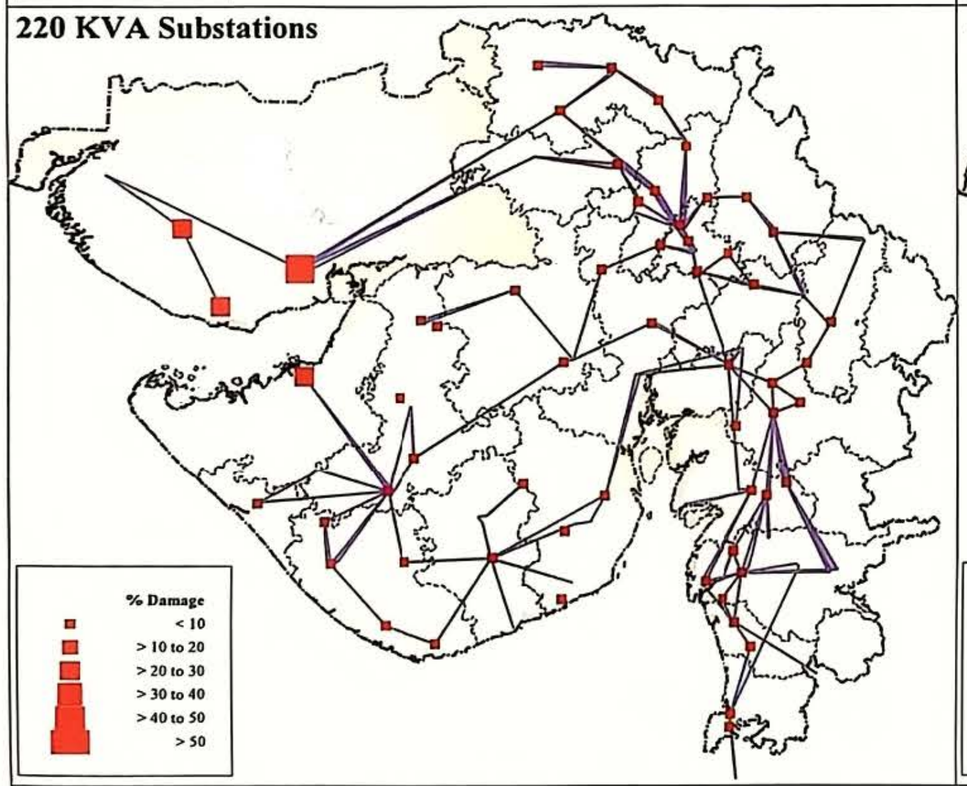
66 KVA Substations



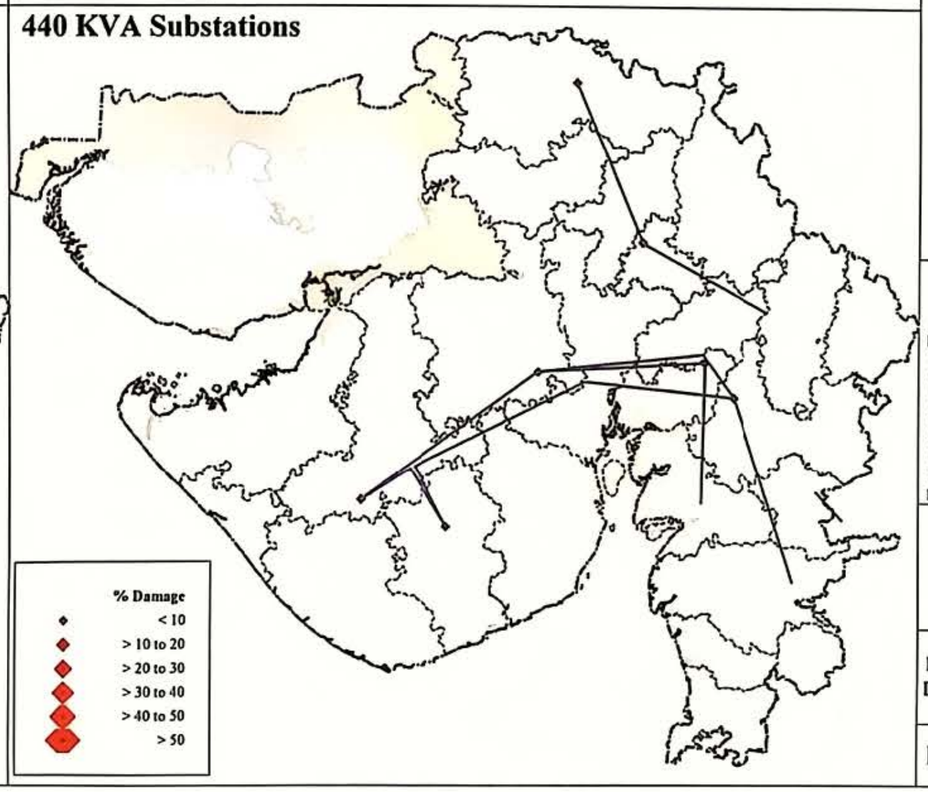
132 KVA Substations



220 KVA Substations



440 KVA Substations



Note: Total capital assets are exclusive of office buildings, staff housing, guest houses and other related assets.
This analysis is based on Gujarat Electricity Board (GEB) data for 2003.
Source: TARU Studies & Analysis, 2004; Generation, Transmission & Distribution data/inventory, 2003, GEB, GoG; Revenue data, 2001, GEB, GoG; Restoration timelines, Kachchh Earthquake, 2001, Kandla Cyclone, 1998, GEB, GoG; Damage data for Kachchh Earthquake, 2001, GEB, GoG; Capital Cost of Infrastructure, 2003, GEB, GoG; Memorandum to GoI, Kandla Cyclone, 1998, Kachchh Earthquake, 2001, Revenue Department, GoG; HAZUS-99; BISAG, GoG.

0 100 km

N

Projection : Lambert Azimuthal Equal Area
Datum : WGS 84

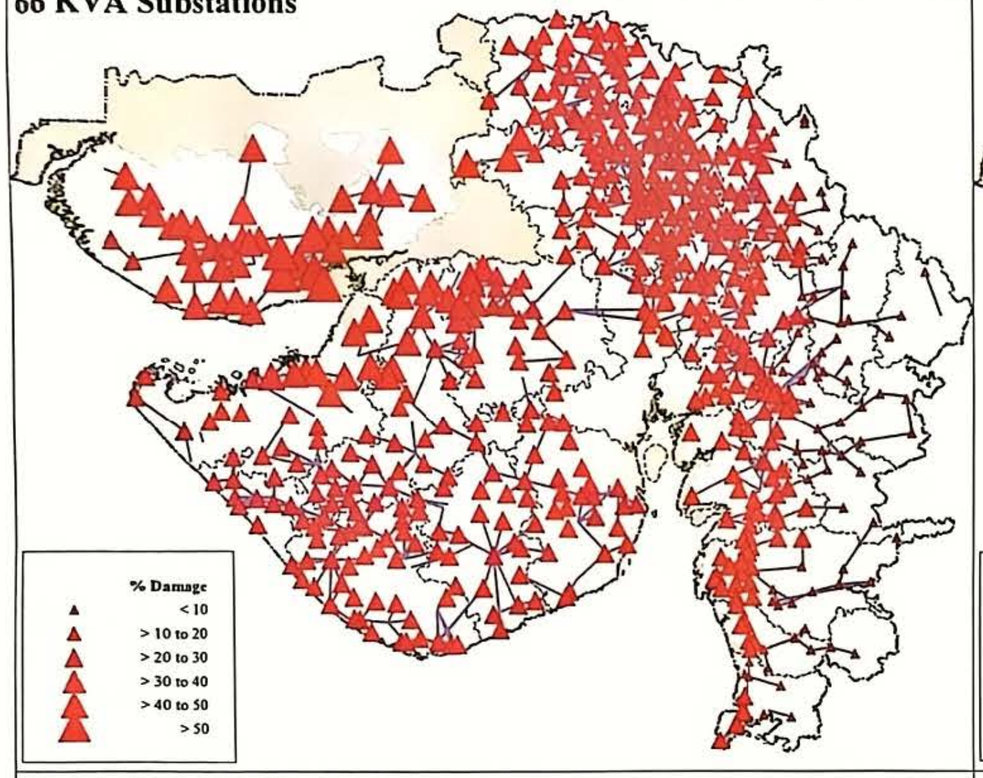
MAP No. : VIGM - 02 OF 05

Date : 18/6/2005

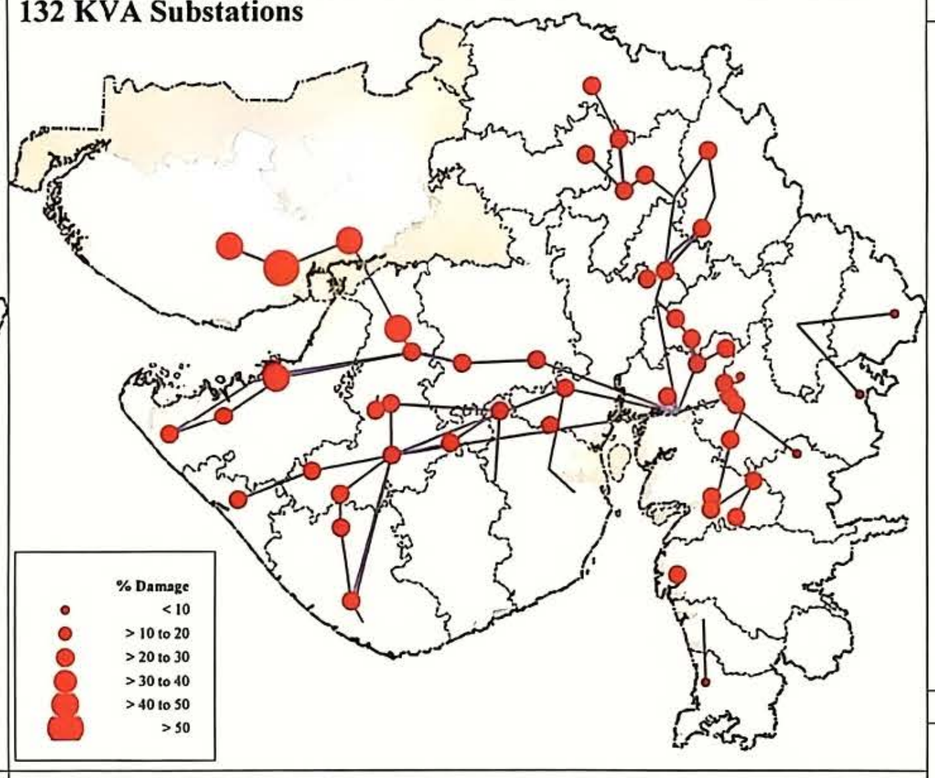
Gujarat Critical Infrastructure Vulnerability Zonation : Earthquake Damage to Substations
(100 year return period)

GSDMA

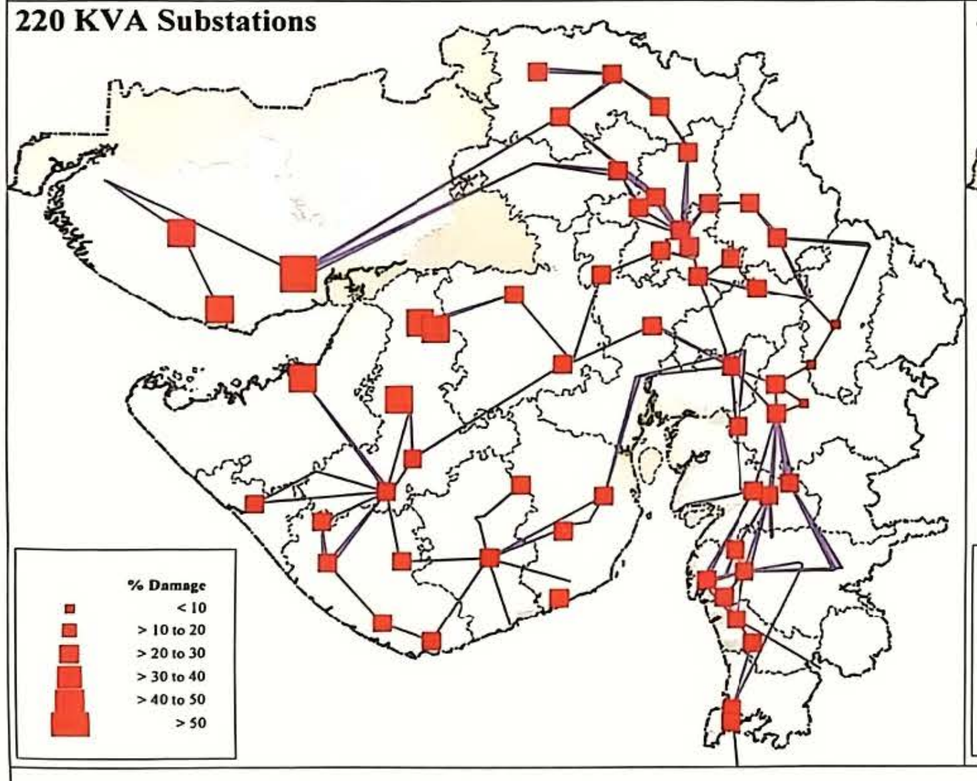
66 KVA Substations



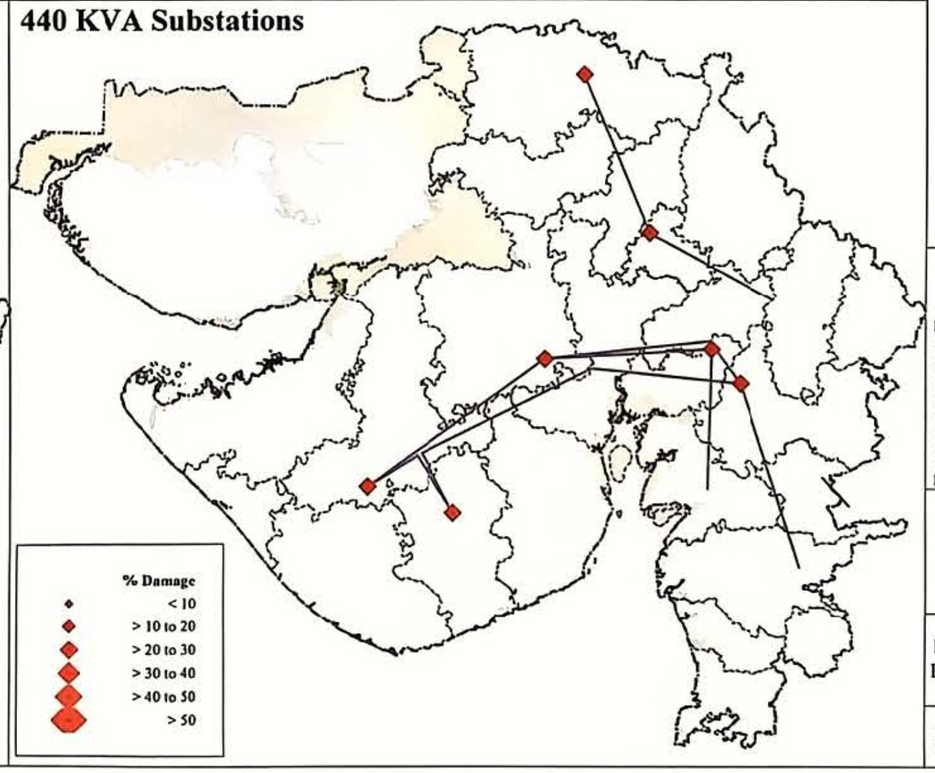
132 KVA Substations



220 KVA Substations



440 KVA Substations



Note: Total capital assets are exclusive of office buildings, staff housing, guest houses and other related assets.
This analysis is based on Gujarat Electricity Board (GEB) data for 2003.
Source: TARU Studies & Analysis, 2004; Generation, Transmission & Distribution data/inventory, 2003, GEB, GoG; Revenue data, 2001, GEB, GoG; Restoration timelines, Kachchh Earthquake, 2001, Kandla Cyclone, 1998, GEB, GoG; Damage data for Kachchh Earthquake, 2001, GEB, GoG; Capital Cost of Infrastructure, 2003, GEB, GoG; Memorandum to GoI, Kandla Cyclone, 1998, Kachchh Earthquake, 2001, Revenue Department, GoG; HAZUS-99; BISAG, GoG.

0 100 km

N

Projection : Lambert Azimuthal Equal Area
Datum : WGS 84

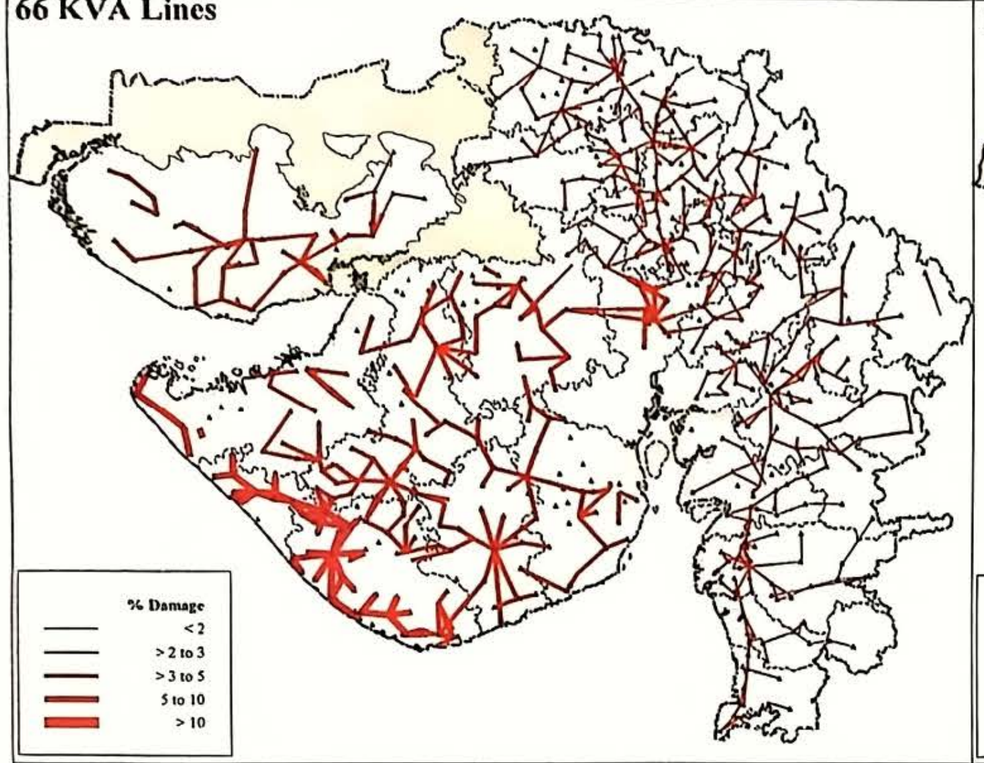
MAP No. : VIGM - 03 OF 05

Date : 18/6/2005

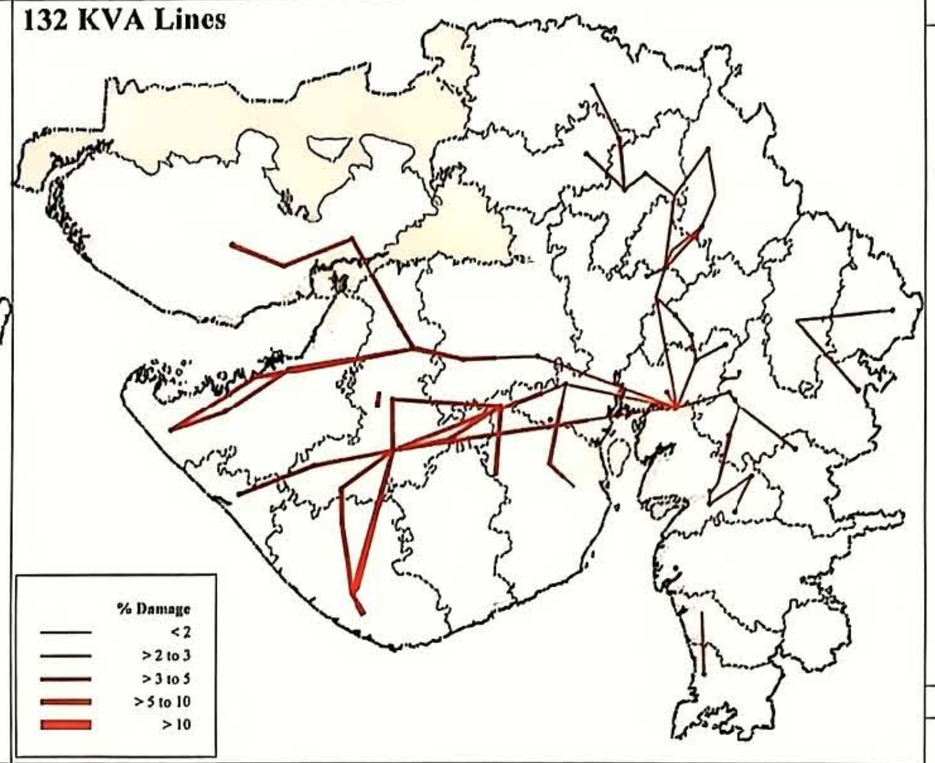
Gujarat Critical Infrastructure Vulnerability Zonation: Cyclone Damage to Transmission Networks
(50 year return period)

GSDMA

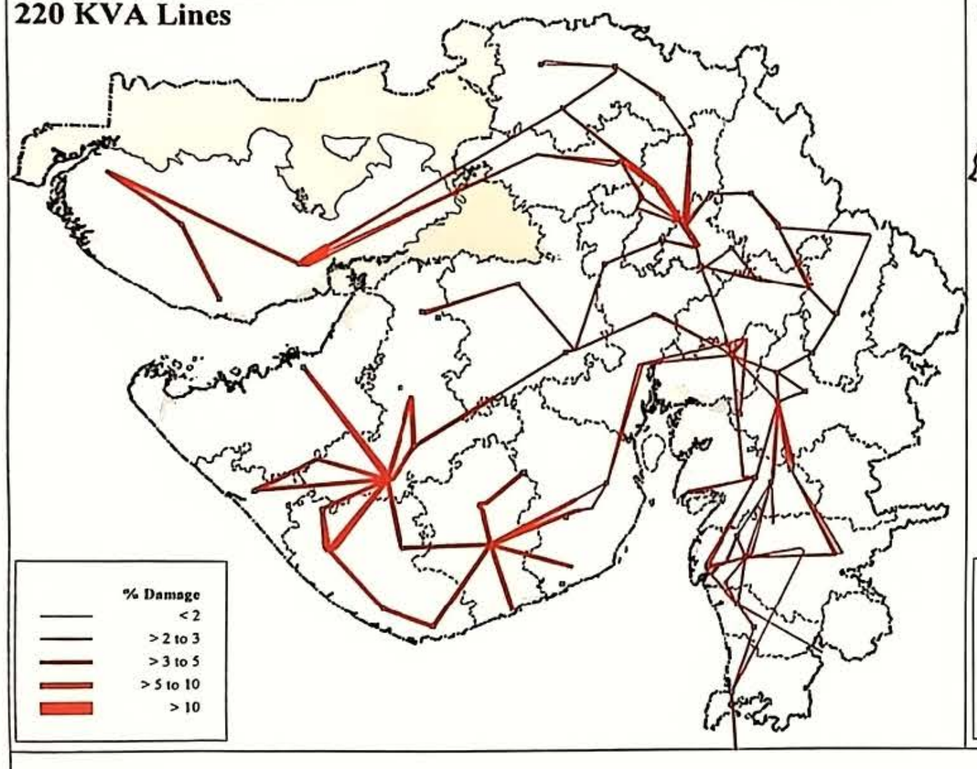
66 KVA Lines



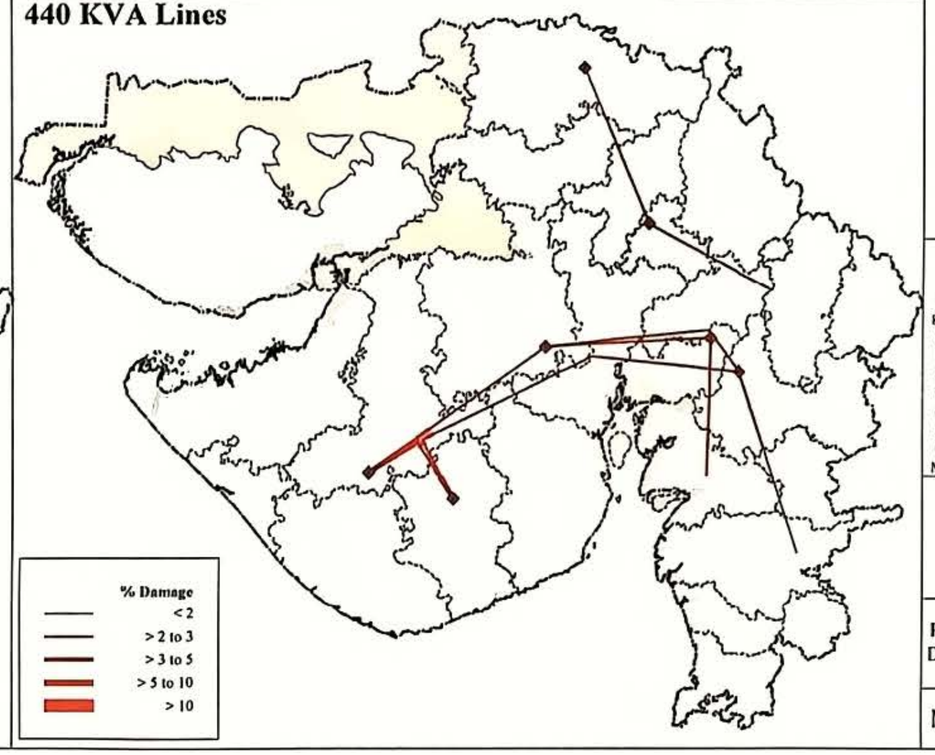
132 KVA Lines



220 KVA Lines



440 KVA Lines



Note: Total capital assets are exclusive of office buildings, staff housing, guest houses and other related assets.
Source: TARU Studies & Analysis, 2004, Generation, Transmission & Distribution data/inventory, 2003, GEB, GoG, Revenue data, 2001, GEB, GoG, Restoration timelines, Kachchh Earthquake, 2001, Kandla Cyclone, 1998, GEB, GoG, Damage data for Kachchh Earthquake, 2001,GEB, GoG, Capital Cost of Infrastructure, 2003, GEB, GoG, Memorandum to GoI, Kandla Cyclone, 1998, Kachchh Earthquake, 2001, Revenue Department, GoG, A Scale Relating Tropical Cyclone Wind Speed to Potential Damage for the Tropical Pacific Region A User's Manual, WERI, BISAG, GoG.

0 100 km

N

Projection : Lambert Azimuthal Equal Area
Datum : WGS 84

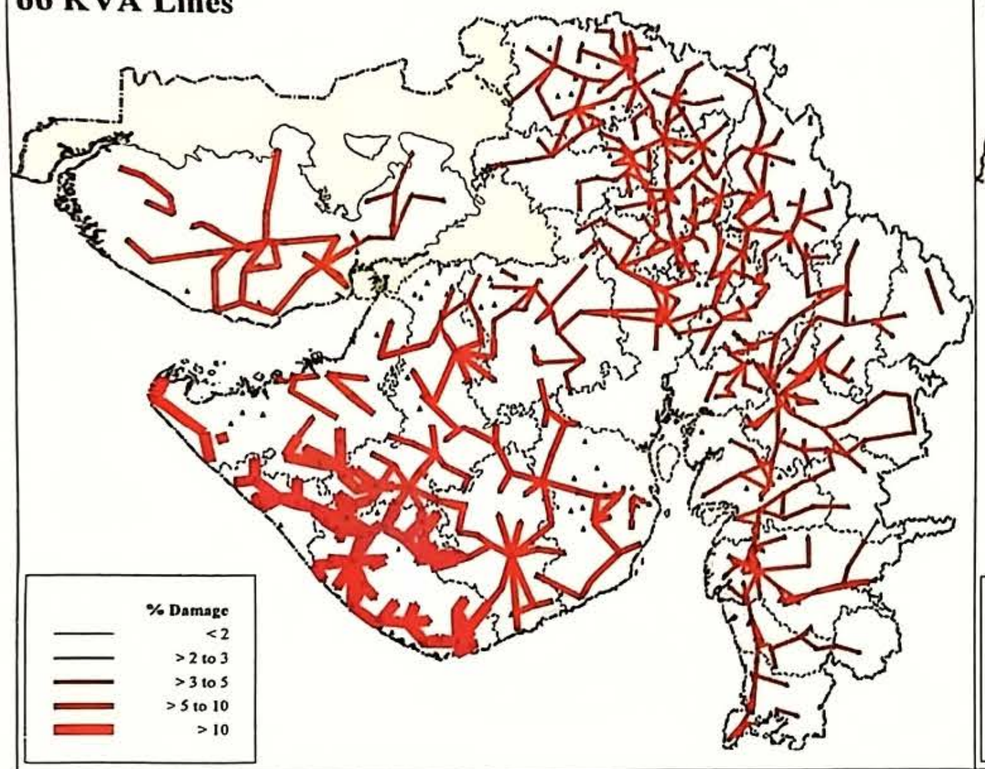
MAP No. : VIGM - 04 OF 05

Date : 18/6/2005

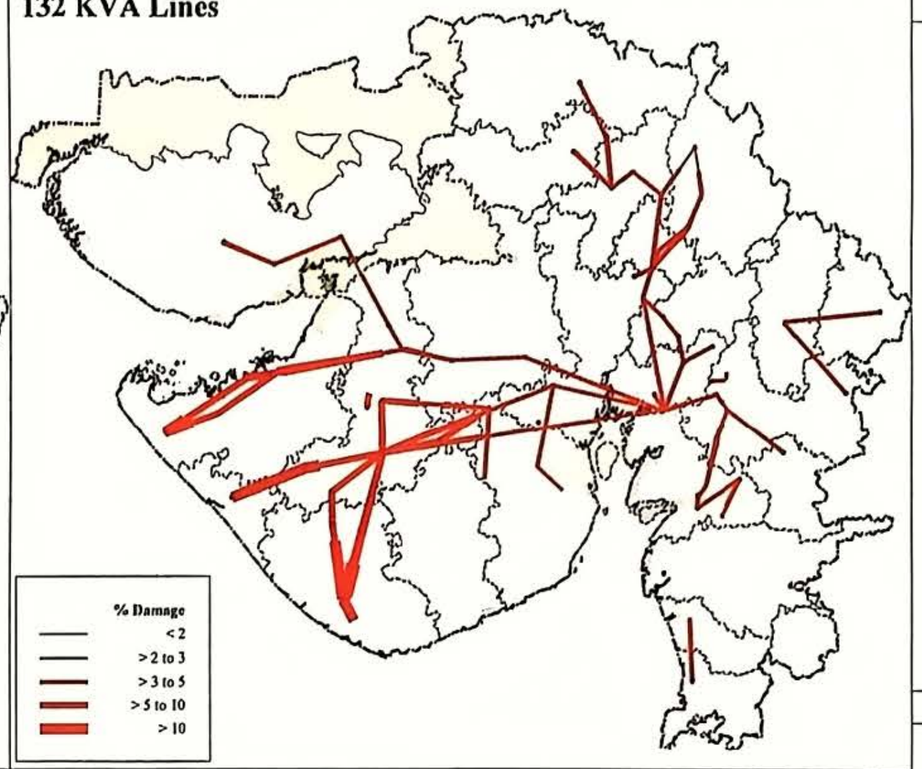
Gujarat Critical Infrastructure Vulnerability Zonation: Cyclone Damage to Critical Transmission Networks (100 year return period)

GSDMA

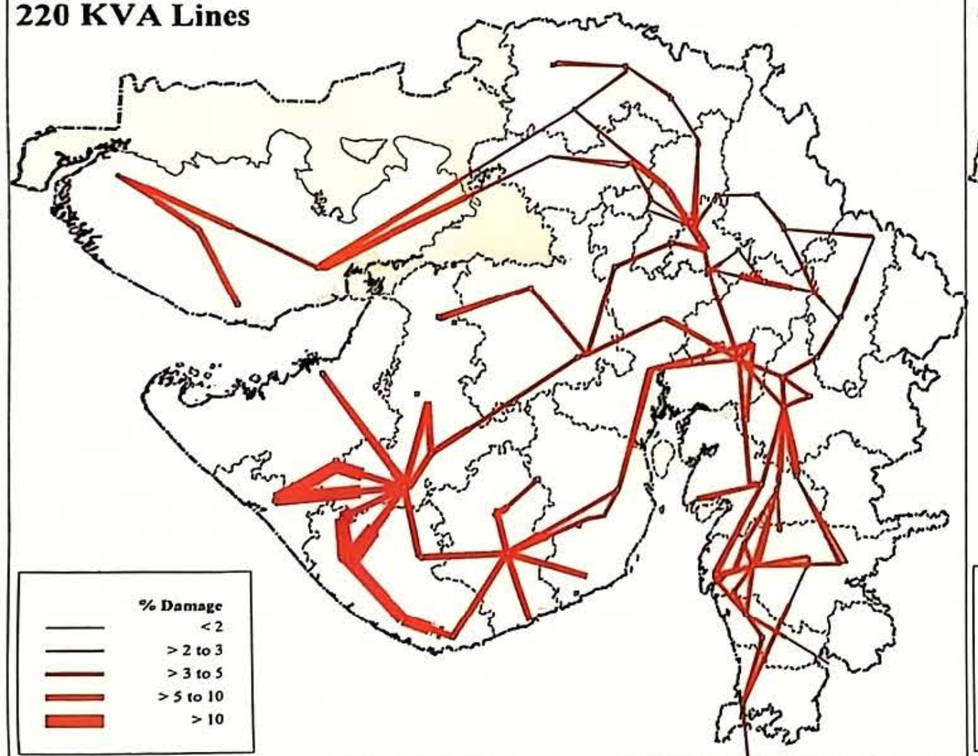
66 KVA Lines



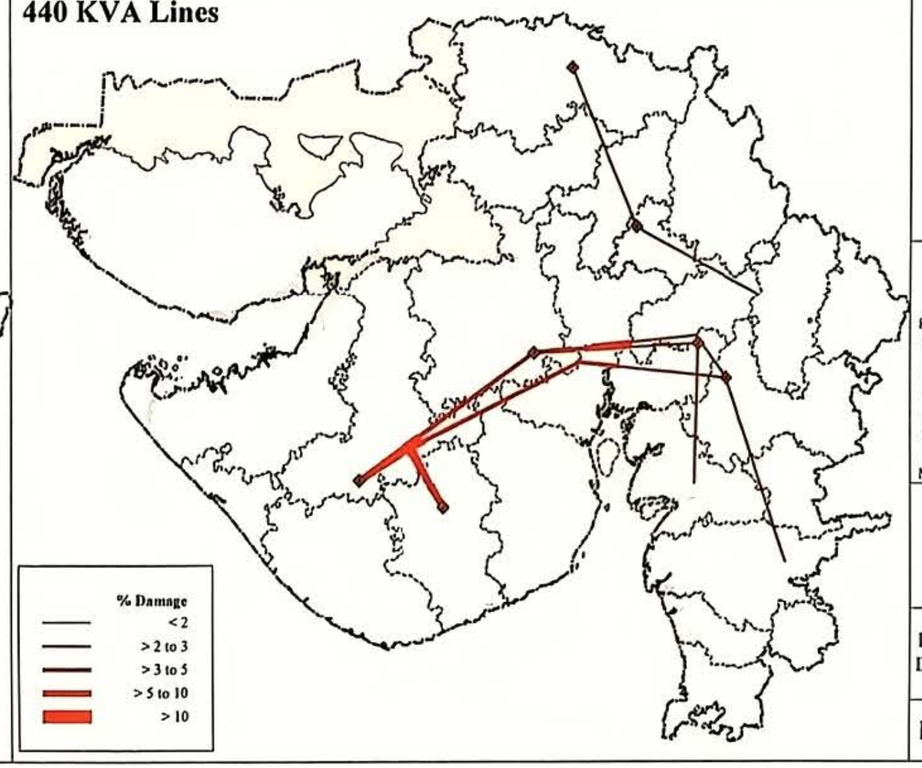
132 KVA Lines



220 KVA Lines



440 KVA Lines



Note: Total capital assets are exclusive of office buildings, staff housing, guest houses and other related assets.

Source: TARU Studies & Analysis, 2004, Generation, Transmission & Distribution data/inventory, 2003, GEB, GoG, Revenue data, 2001, GEB, GoG; Restoration timelines, Kachchh Earthquake, 2001, Kandla Cyclone, 1998, GEB, GoG, Damage data for Kachchh Earthquake, 2001,GEB, GoG, Capital Cost of Infrastructure, 2003, GEB, GoG, Memorandum to GoI, Kandla Cyclone, 1998, Kachchh Earthquake, 2001, Revenue Department, GoG, A Scale Relating Tropical Cyclone Wind Speed to Potential Damage for the Tropical Pacific Region. A User's Manual, WERI, BISAG, GoG.

0 100 km

N

Projection : Lambert Azimuthal Equal Area
Datum : WGS 84

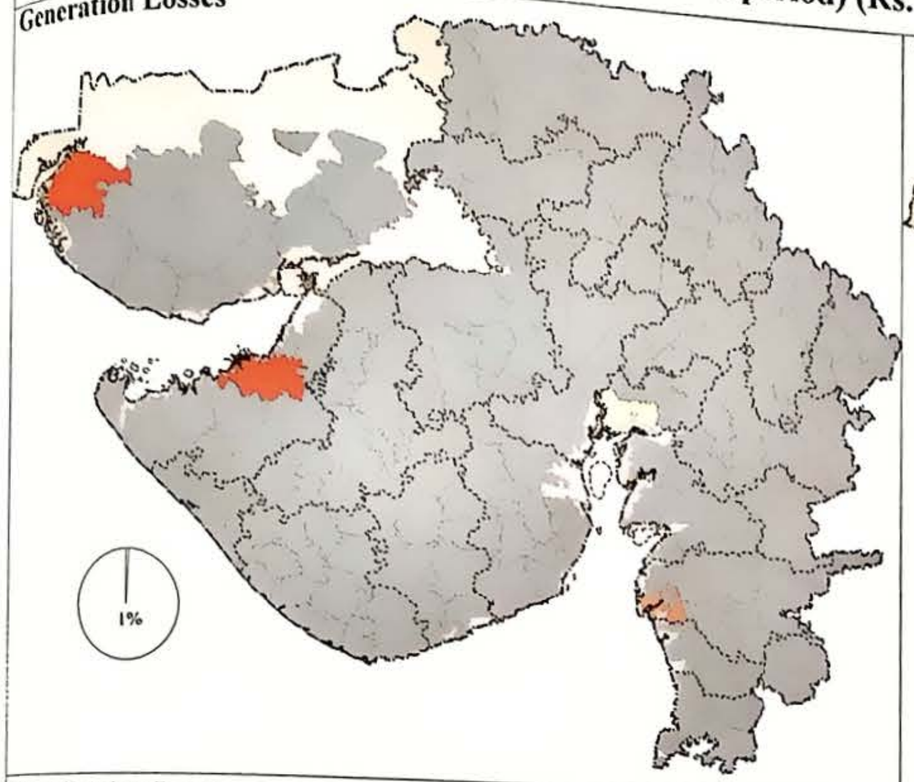
MAP No. : VIGM - 05 OF 05

Date : 18/6/2005

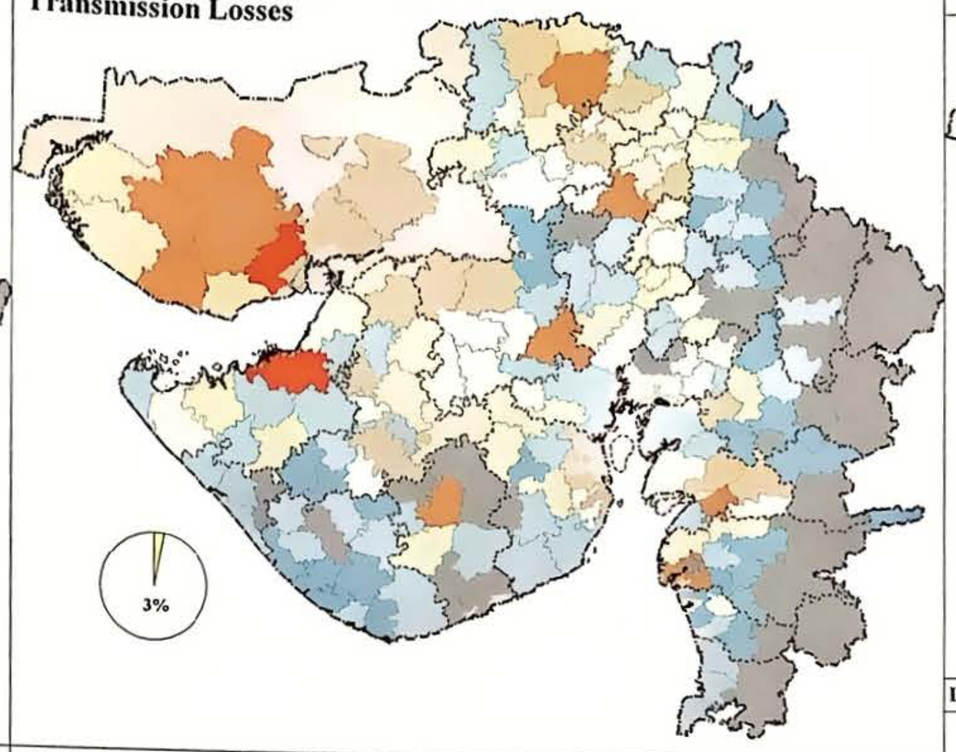
Gujarat Critical Infrastructure Risk Zonation : Earthquake Capital Loss to GEB
(50 year return period) (Rs. Million 2002-2003 prices)

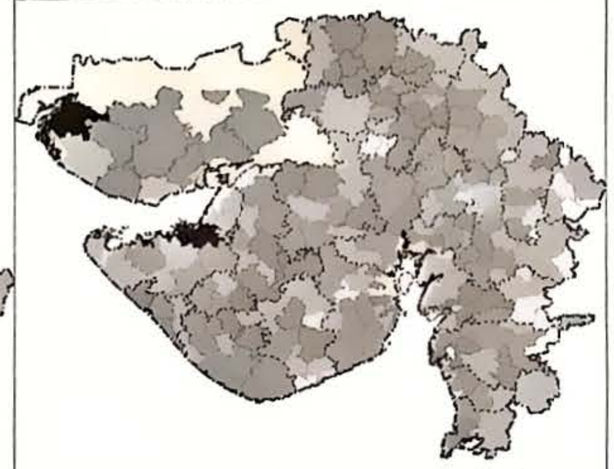
GSDMA

Generation Losses



Transmission Losses

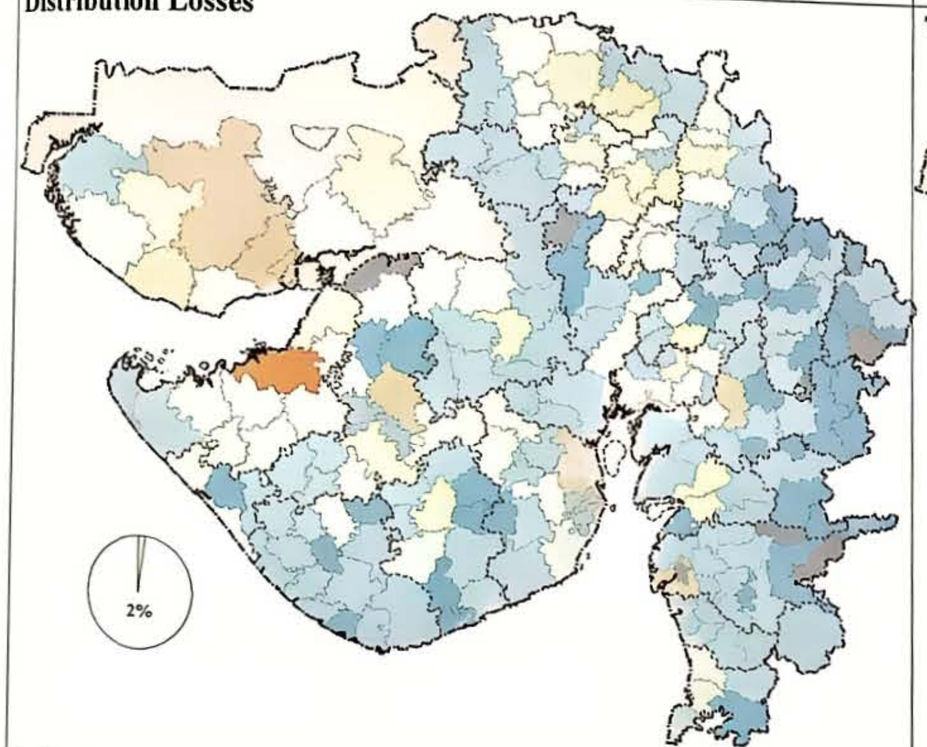




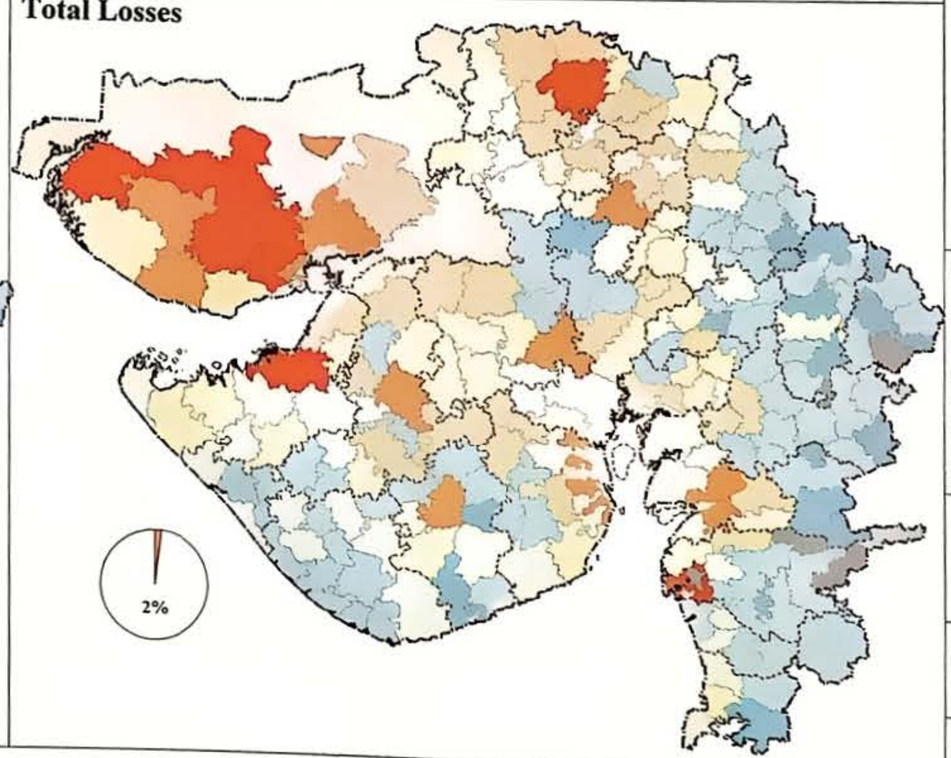
Total Capital Assets (Rs. Million)

- < 100
- > 100 to 200
- > 200 to 500
- >500 to 1000
- > 1000 to 5000
- > 5000

Distribution Losses



Total Losses



LEGEND

Capital Loss (Rs. Million)

- < 2
- > 2 to 5
- > 5 to 10
- > 10 to 20
- > 20 to 50
- > 50 to 100
- > 100
- No/insignificant loss

Main map pie charts show the proportion of loss to respective investments.

Note: Total capital assets are exclusive of office buildings, staff housing, guest houses and other related assets.

This analysis is based on Gujarat Electricity Board (GEB) data for 2003.

Source:TARU Studies & Analysis, 2004, Generation, Transmission & Distribution data/inventory, 2003, GEB GoG; Revenue data, 2001,GEB, GoG; Restoration timelines, Kachchh Earthquake, 2001, Kandla Cyclone, 1998, GEB, GoG; Damage data for Kachchh Earthquake, 2001, GEB, GoG; Capital Cost of Infrastructure, 2003, GEB, GoG; Memorandum to GoI, Kandla Cyclone, 1998, Kachchh Earthquake, 2001, Revenue Department, GoG; HAZUS-99; BISAG, GoG

0 100 km

N

Projection : Lambert Azimuthal Equal Area
Datum : WGS 84

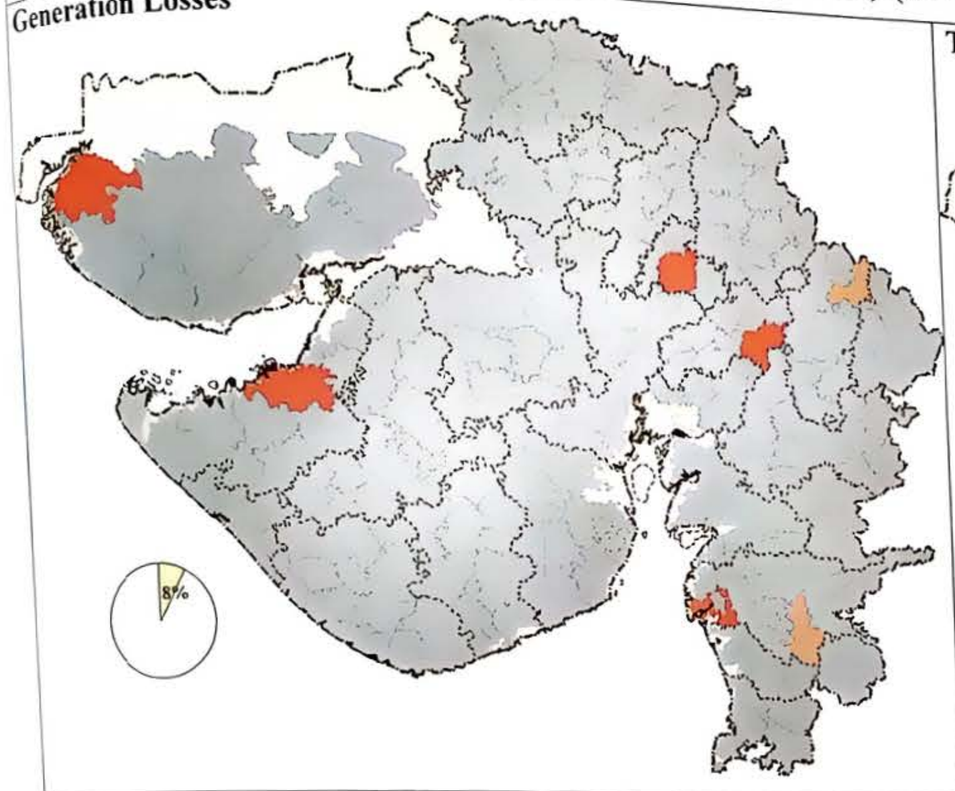
MAP No. : RIGM - 01 OF 05

Date : 18/6/2005

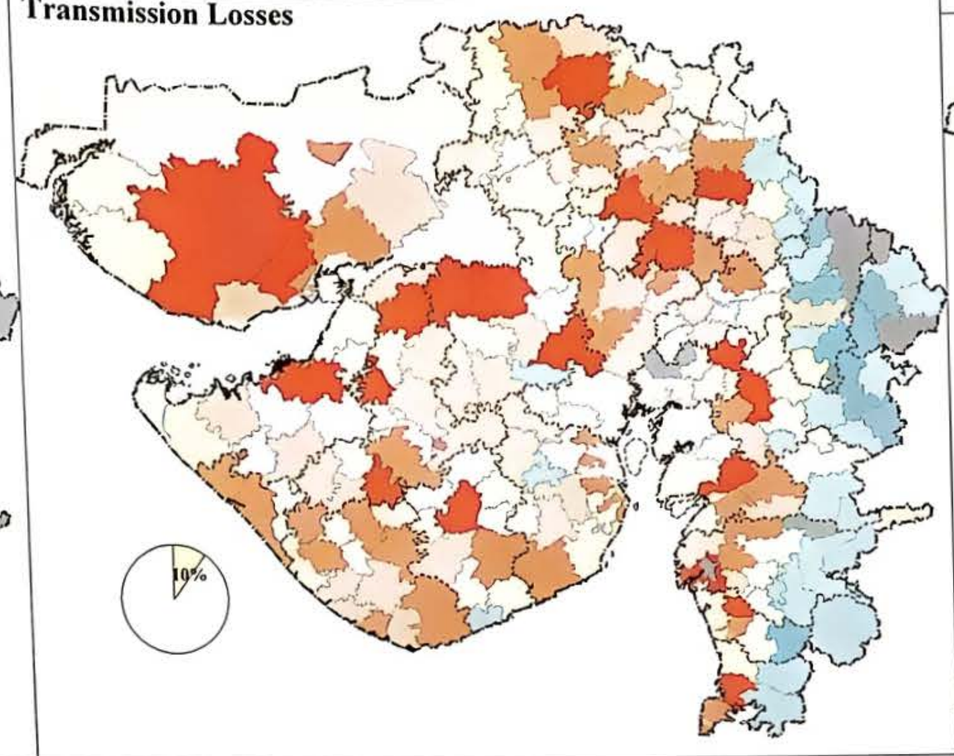
Gujarat Critical Infrastructure Risk Zonation : Earthquake Capital Loss to GEB
(100 year return period) (Rs. Million 2002-2003 prices)

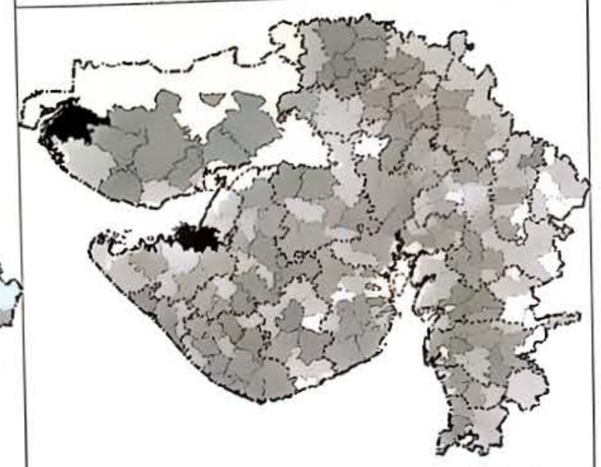
GSDMA

Generation Losses



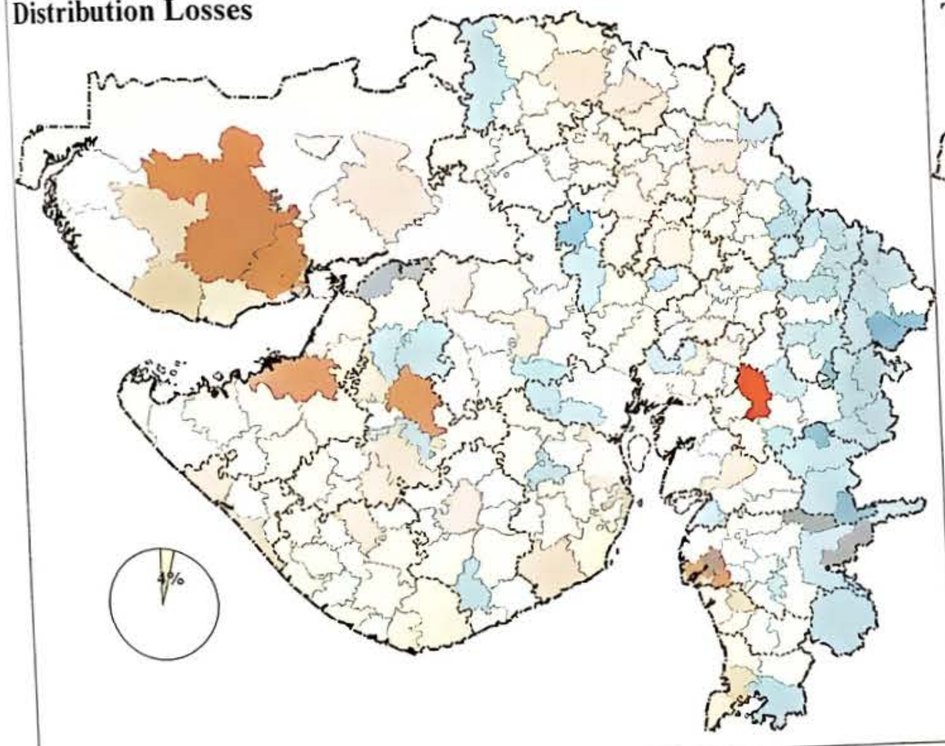
Transmission Losses



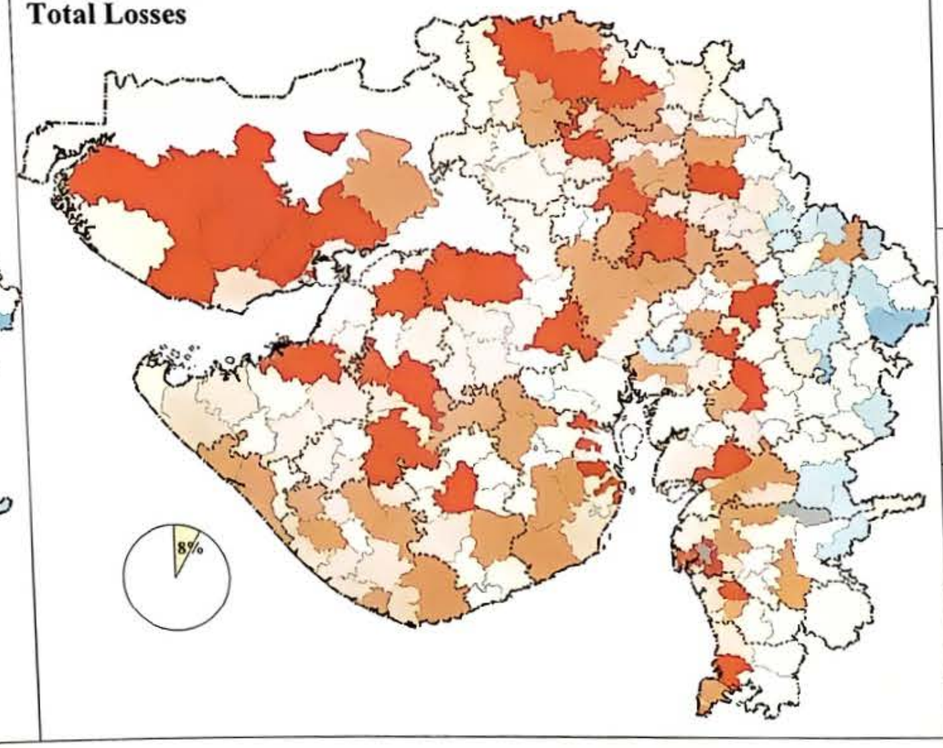


Total Capital Assets (Rs. Million)
- < 100
- > 100 to 200
- > 200 to 500
- >500 to 1000
- > 1000 to 5000
- > 5000

Distribution Losses



Total Losses



LEGEND

Capital Loss (Rs. Million)
- < 2
- > 2 to 5
- > 5 to 10
- > 10 to 20
- > 20 to 50
- > 50 to 100
- > 100
- No Loss / No Data

Main map pie charts show the proportion of loss to respective investments.

Note: Total capital assets are exclusive of office buildings, staff housing, guest houses and other related assets.

This analysis is based on Gujarat Electricity Board (GEB) data for 2003

Source:TARU Studies & Analysis, 2004; Generation, Transmission & Distribution data/inventory, 2003, GEB GoG; Revenue data, 2001,GEB GoG; Restoration timelines, Kachchh Earthquake, 2001, Kandla Cyclone, 1998, GEB, GoG; Damage data for Kachchh Earthquake, 2001, GEB, GoG; Capital Cost of Infrastructure, 2003, GEB, GoG; Memorandum to GoI, Kandla Cyclone, 1998, Kachchh Earthquake, 2001, Revenue Department, GoG; HAZUS-99; BISAG, GoG

0 100 km

N

Projection : Lambert Azimuthal Equal Area
Datum : WGS 84

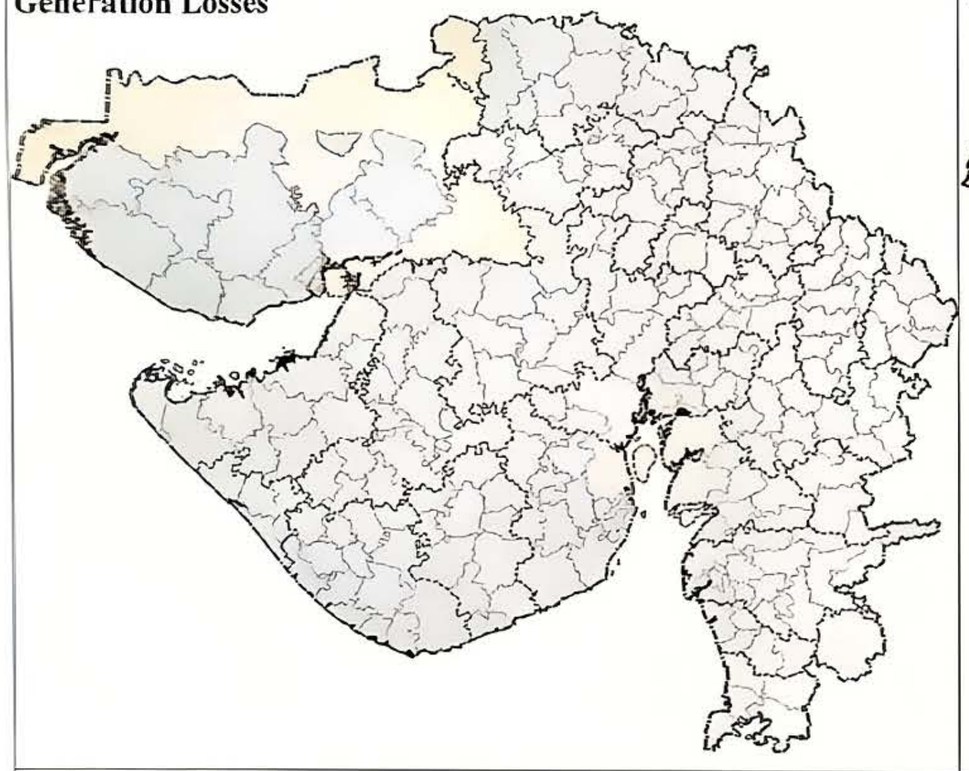
MAP No. : RIGM - 02 OF 05

Date : 27/6/2005

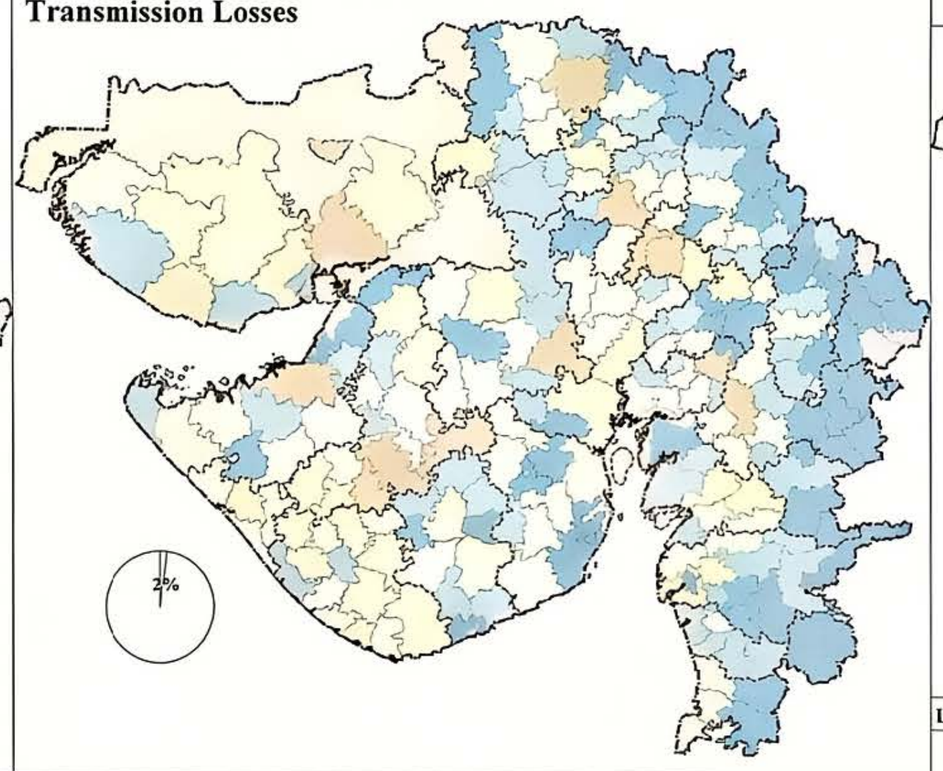
Gujarat Critical Infrastructure Risk Zonation : Cyclone Capital Loss to GEB
(50 year return period) (Rs. Million 2002-2003 prices)

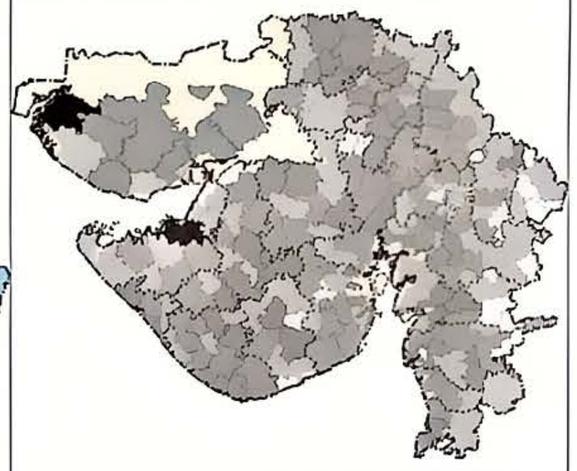
GSDMA

Generation Losses



Transmission Losses



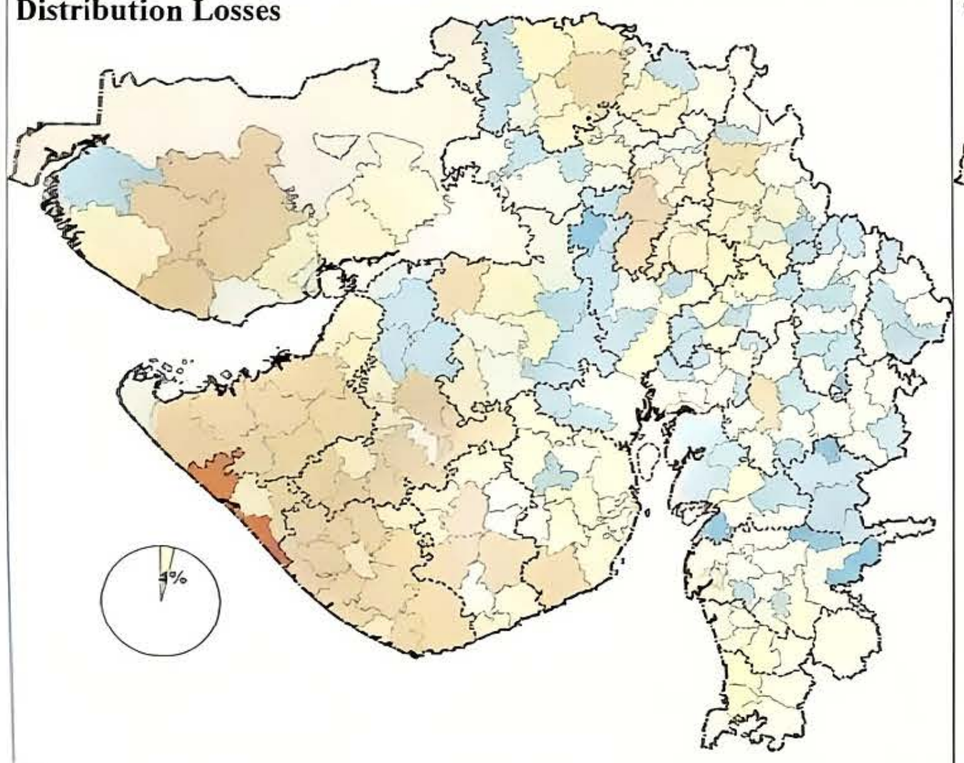


Total Capital Assets (Rs. Million)
- < 100
- > 100 to 200
- > 200 to 500
- > 500 to 1000
- > 1000 to 5000
- > 5000

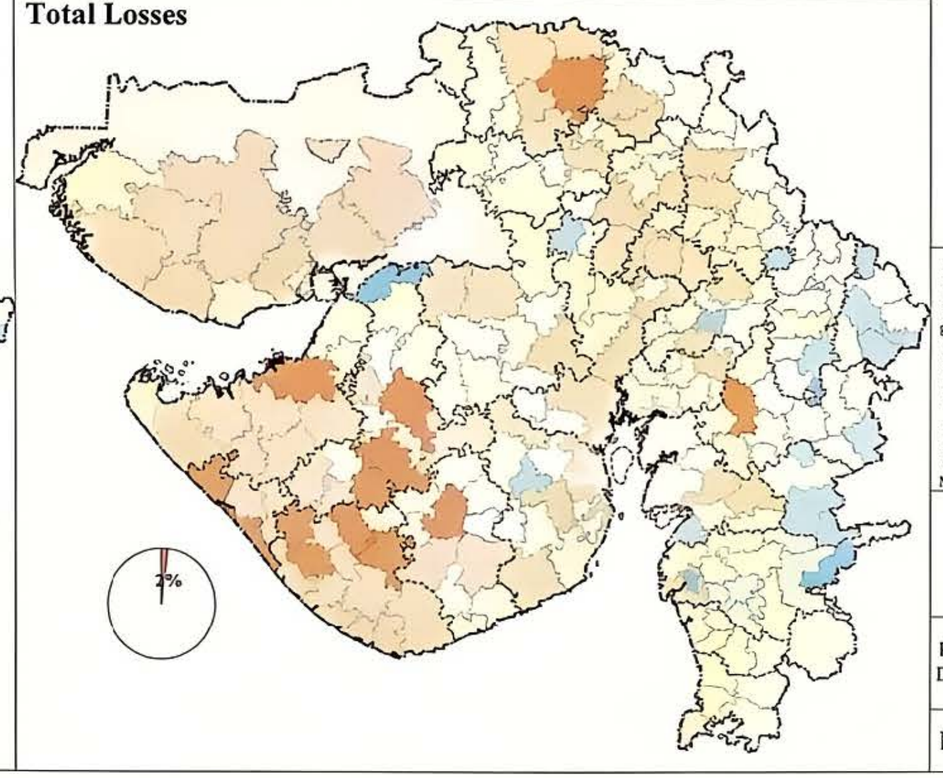
LEGEND

Capital Loss (Rs. Million)
- < 2
- > 2 to 5
- > 5 to 10
- > 10 to 20
- > 20 to 50
- > 50 to 100
- > 100
- No/insignificant loss

Distribution Losses



Total Losses



Main map pie charts show the proportion of loss to respective investments.
This analysis is based on Gujarat Electricity Board (GEB) data for 2003.
Note: Total capital assets are exclusive of office buildings, staff housing, guest houses and other related assets.
Source: TARU Studies & Analysis, 2004; Generation, Transmission & Distribution data/inventory, 2003, GEB, GoG; Revenue data, 2001, GEB, GoG; Restoration timelines, Kachchh Earthquake, 2001, Kandla Cyclone, 1998, GEB, GoG; Damage data for Kachchh Earthquake, 2001, GEB, GoG; Capital Cost of Infrastructure, 2003, GEB, GoG; Memorandum to GoI, Kandla Cyclone, 1998, Kachchh Earthquake, 2001, Revenue Department, GoG; A Scale Relating Tropical Cyclone Wind Speed to Potential Damage for the Tropical Pacific Region: A User's Manual, WERI; BISAG, GoG.

0 100 km

N

Projection : Lambert Azimuthal Equal Area
Datum : WGS 84

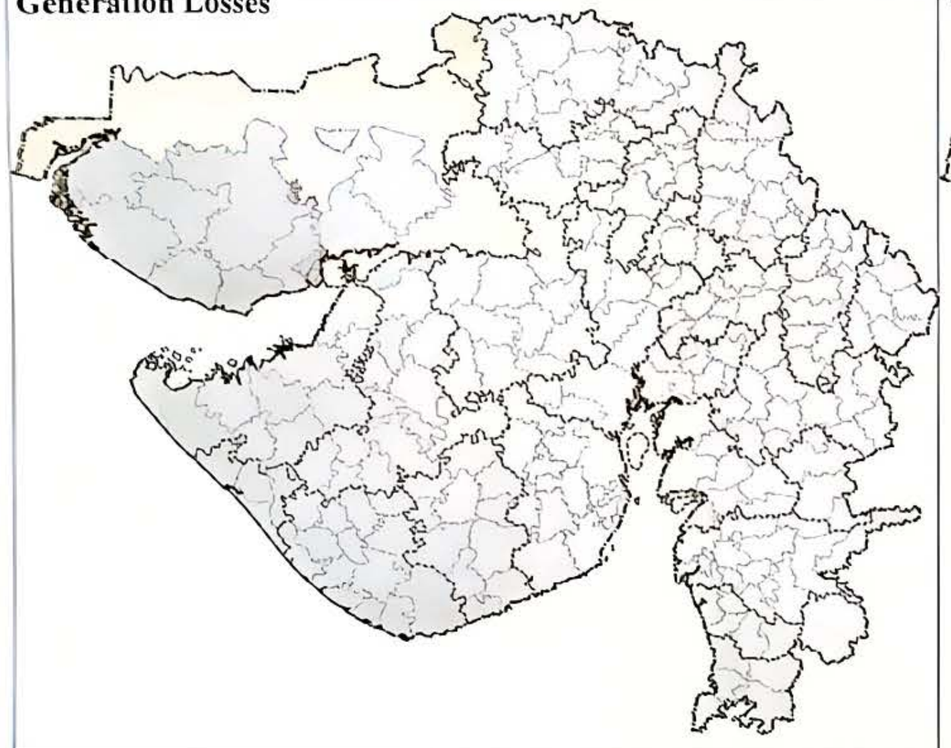
MAP No. : RIGM - 03 OF 05

Date : 18/6/2005

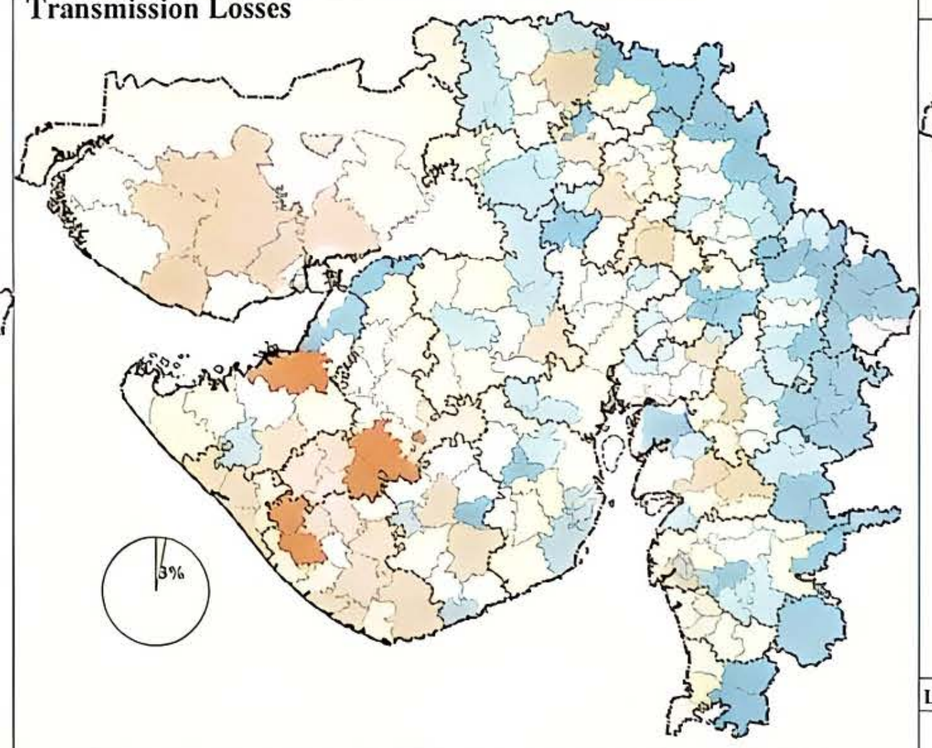
Gujarat Critical Infrastructure Risk Zonation : Cyclone Capital Loss to GEB
(100 year return period) (Rs. Million 2002-2003 prices)

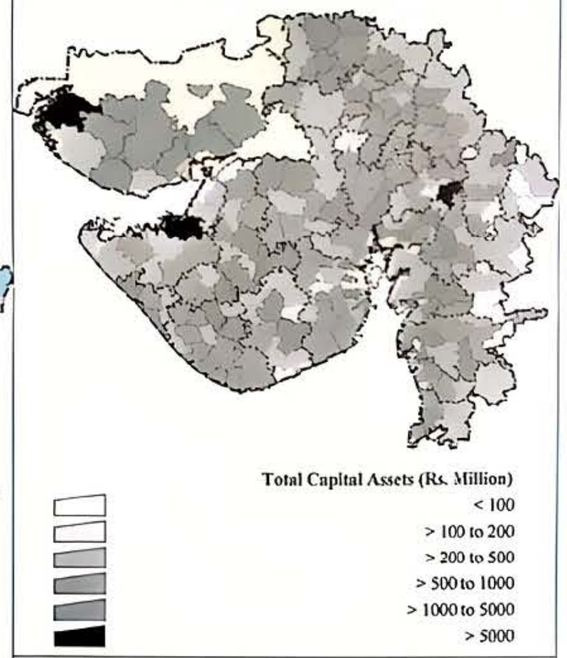
GSDMA

Generation Losses

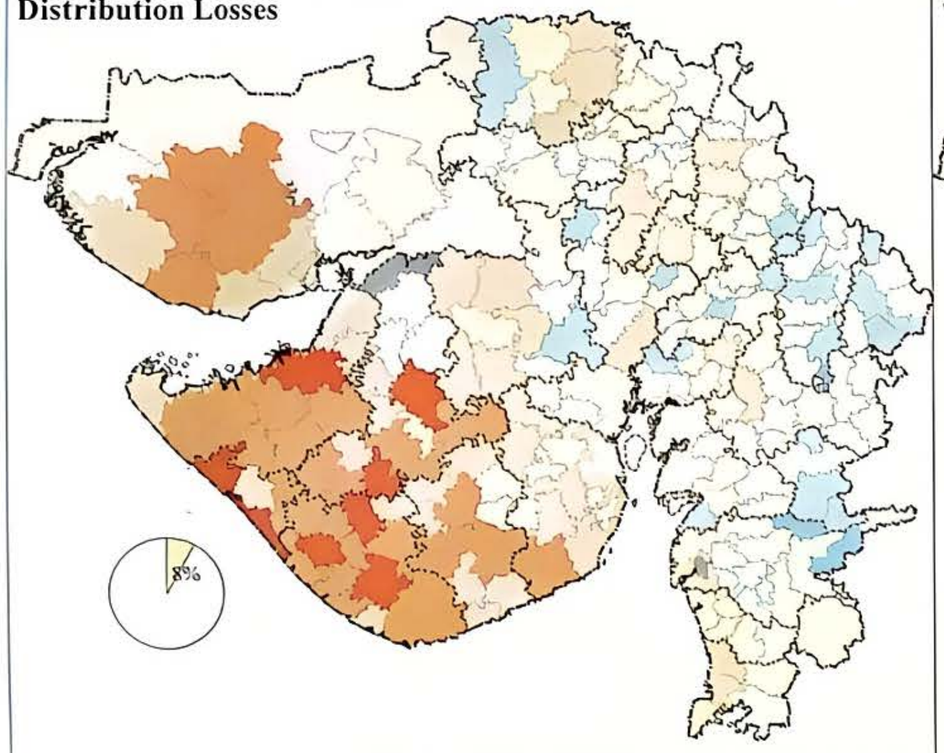


Transmission Losses

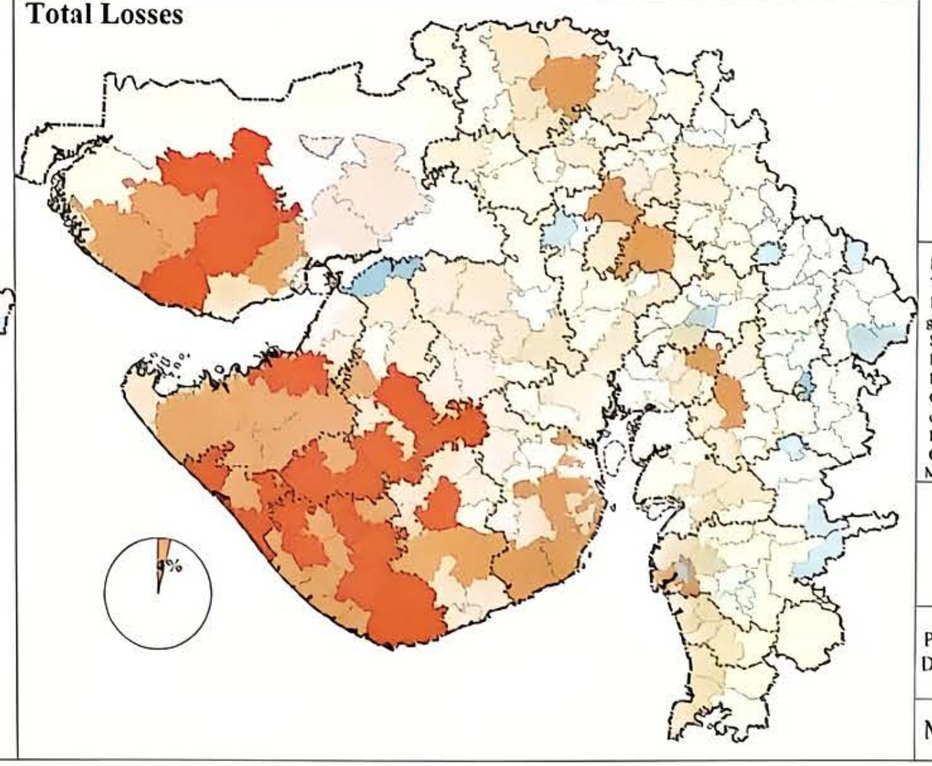




Distribution Losses



Total Losses



LEGEND

Capital Loss (Rs. Million)
< 2
> 2 to 5
> 5 to 10
> 10 to 20
> 20 to 50
> 50 to 100
> 100
No/insignificant loss

Main map pie charts show the proportion of loss to respective investments
This analysis is based on Gujarat Electricity Board (GEB) data for 2003.
Note: Total capital assets are exclusive of office buildings, staff housing, guest houses and other related assets
Source: TARU Studies & Analysis, 2001, Generation, Transmission & Distribution data/inventory, 2003, GEB, GoG; Revenue data, 2001, GEB, GoG; Restoration timelines, Kachchh Earthquake, 2001, Kandla Cyclone, 1998, GEB, GoG; Damage data for Kachchh Earthquake, 2001, GEB, GoG; Capital Cost of Infrastructure, 2003, GEB, GoG; Memorandum to GoI, Kandla Cyclone, 1998, Kachchh Earthquake, 2001, Revenue Dept GOG, A Scale Relating Tropical Cyclone Wind Speed to Potential Damage for the Tropical Pacific Region: A User's Manual, WERI, BISAG, GoG

0 100 km

N

Projection : Lambert Azimuthal Equal Area
Datum : WGS 84

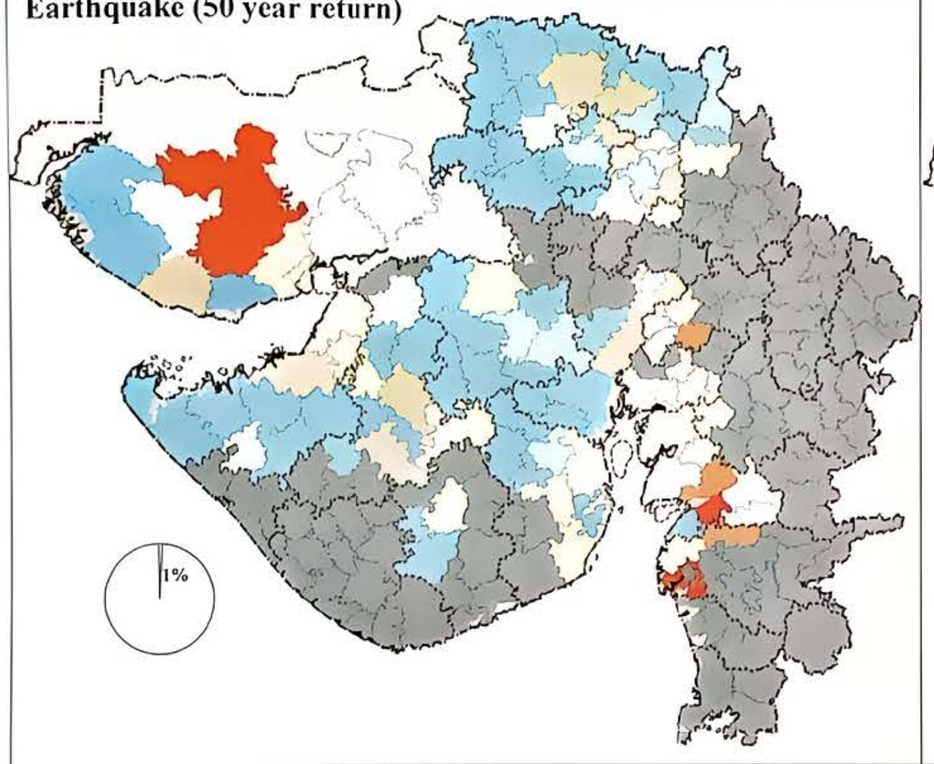
MAP No. : RIGM - 04 OF 05

Date : 18/6/2005

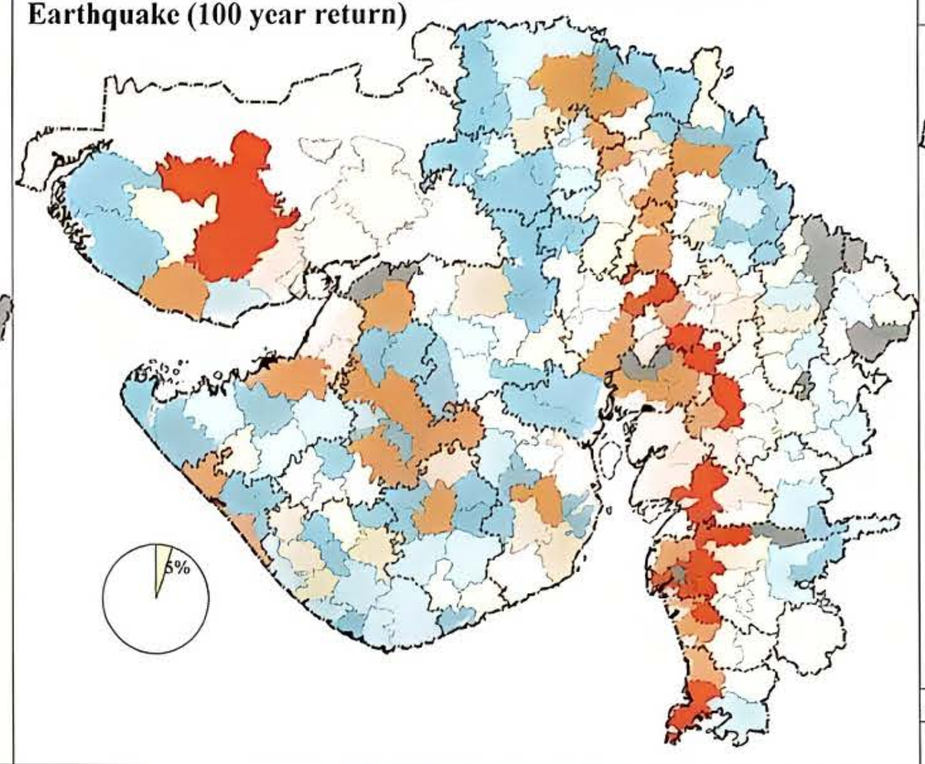
Gujarat Critical Infrastructure Risk Zonation : Revenue Loss to GEB due to Earthquake & Cyclone
(Rs. Million 2001 prices)

GSDMA

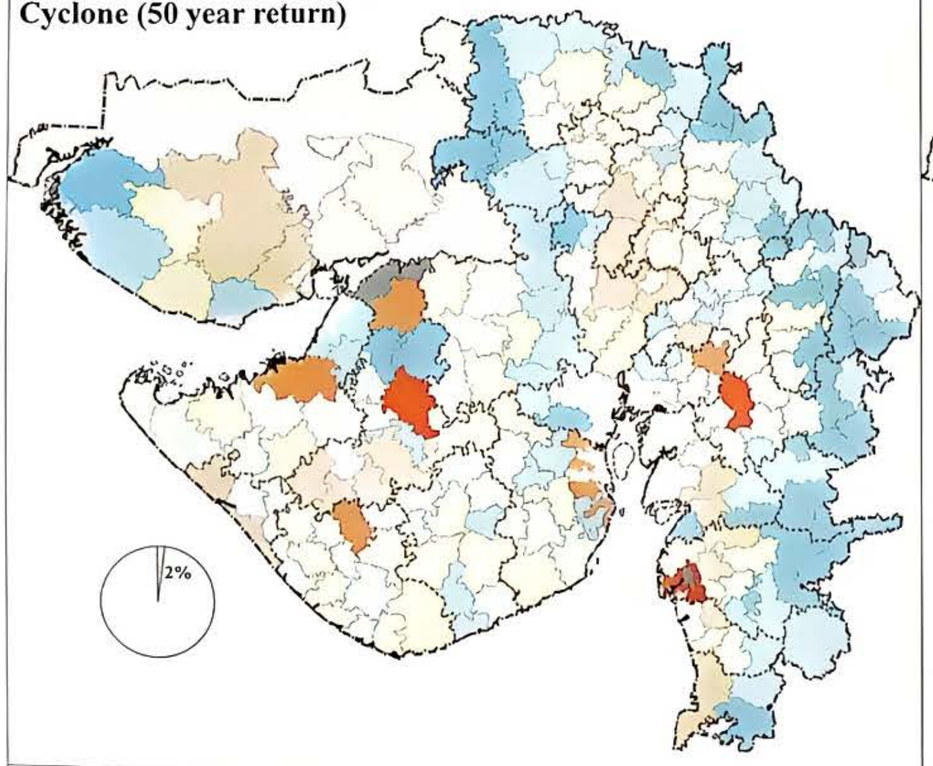
Earthquake (50 year return)



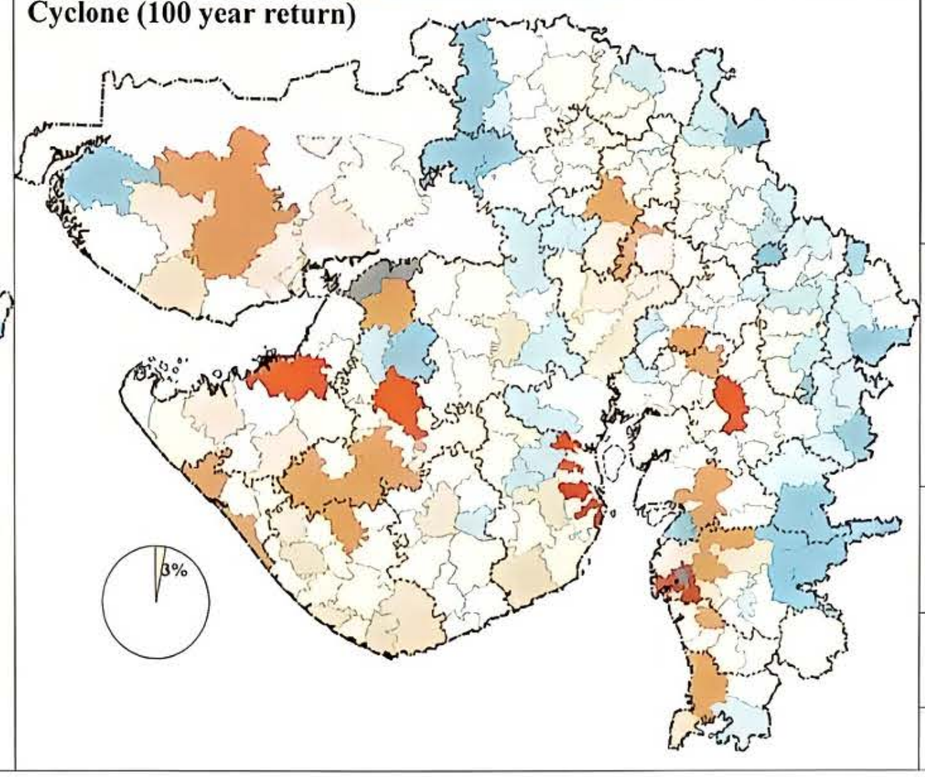
Earthquake (100 year return)

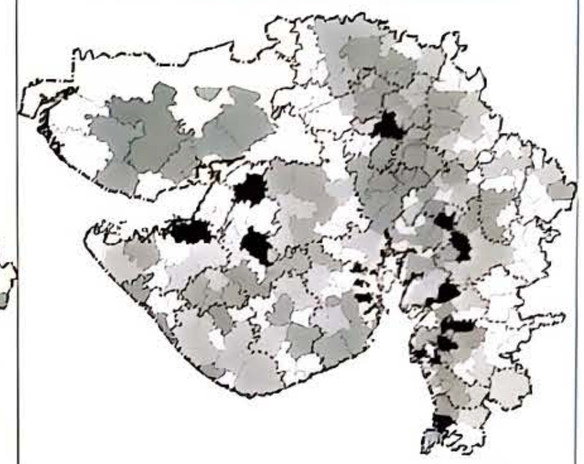


Cyclone (50 year return)



Cyclone (100 year return)





Total Annual Revenue (Rs. Million)
- < 50
- > 50 to 100
- > 100 to 200
- > 200 to 500
- > 500 to 1000
- > 1000

LEGEND

Revenue Loss (Rs. Million)
- < 1
- > 1 to 2
- > 2 to 5
- > 5 to 10
- > 10 to 20
- > 20 to 50
- > 50
- No/insignificant loss

Main map pie charts show the proportion of respective revenue loss to total annual revenue.

Note: Total capital assets are exclusive of office buildings, staff housing, guest houses and other related assets.

Source: TARU Studies & Analysis, 2004, Generation, Transmission & Distribution data/inventory, 2003, GEB, GoG; Revenue data, 2001, GEB, GoG; Restoration timelines, Kachchh Earthquake, 2001, Kandla Cyclone, 1998, GEB, GoG; Damage data for Kachchh Earthquake, 2001,GEB, GoG, Capital Cost of Infrastructure, 2003, GEB, GoG; Memorandum to GoI, Kandla Cyclone, 1998, Kachchh Earthquake, 2001, Revenue Department, GoG; A Scale Relating Tropical Cyclone Wind Speed to Potential Damage for the Tropical Pacific Region. A User's Manual, WERI, HAZUS-99, BISAG, GoG

0 100 km

N

Projection : Lambert Azimuthal Equal Area
Datum : WGS 84

MAP No. : RIGM - 05 OF 05

Date : 18/6/2005

GUJARAT CRITICAL INFRASTRUCTURE RISK ZONATION : EARTHQUAKE & CYCLONE CAPITAL LOSS TO GEB
(50 & 100 YEAR RETURN PERIOD) (Rs. MILLION 2002-2003 PRICES) Table No. VIGT - 01 of 02

GSDMA

Sr. No	District	Taluka	Cyclone (50 Year return)	Cyclone (100 Year return)	Earthquake (50 Year return)	Earthquake (100 Year return)	Total Avg. Annual Revenue	Total Capital Cost
1	Ahmadabad	Ahmadabad City	6.6	8.1	20 7	56.2	533	570
2	Ahmadabad	Barwala	5.9	12.5	16.0	16 0	42	209
3	Ahmadabad	Bavla	12.9	16.8	21.1	56.8	277	660
4	Ahmadabad	Daskroi	21.8	28.6	23.9	61.1	629	1,049
5	Ahmadabad	Detroj-Rampura	5.0	6 4	1.0	10.2	84	195
6	Ahmadabad	Dhandhuka	21.1	34.3	7.1	17.1	118	719
7	Ahmadabad	Dholka	25.7	37.2	15.7	38.4	451	1,018
8	Ahmadabad	Mandal	2 7	3.3	0 5	7.9	55	127
9	Ahmadabad	Ranpur	7.9	15.5	9.3	9.3	58	273
10	Ahmadabad	Sanand	14.1	17.0	3.6	50.6	557	736
11	Ahmadabad	Viramgam	10.6	15.4	2.6	54.8	279	556
12	Amreli	Amreli	51.1	111.7	65.7	174.7	344	1,421
13	Amreli	Babra	14.7	36.3	1.8	14.6	150	383
14	Amreli	Bagasara	12.0	28 5	6.7	16.7	77	254
15	Amreli	Dhari	35.9	83.2	16.3	41.3	186	751
16	Amreli	Jafrabad	12.5	29.5	1.2	8.8	57	194
17	Amreli	Khambha	13.1	29.8	1.2	14.7	50	275
18	Amreli	Kunkavav Vadia	16.4	39.0	1.8	14.7	89	336
19	Amreli	Lathi	11.3	24.4	1 6	18.2	104	340
20	Amreli	Lilia	7.1	18.2	1.1	10.5	43	163
21	Amreli	Rajula	17.8	47.5	2.0	19.5	88	392
22	Amreli	Savar Kundla	39.5	90.1	5.5	76.8	218	1,127
23	Anand	Anand	40.4	51.2	17.6	276.5	1,601	2,296
24	Anand	Anklav	8.9	11.9	6 7	16.7	155	398
25	Anand	Borsad	14.0	20.9	13.4	33.0	310	617
26	Anand	Khambhat	10.7	16.7	28.7	71.0	278	1,254
27	Anand	Petlad	14 9	21.8	16.0	38.2	344	647
28	Anand	Sojitra	5.5	7 7	2 0	4.3	85	205
29	Anand	Tarapur	6.2	8.9	1.9	4.2	78	230
30	Anand	Umreth	6.2	8.3	1.9	15.7	164	261
31	Banas Kantha	Amirgadh	5.4	6.5	4.2	10.1	77	220
32	Banas Kantha	Bhabhar	10.7	13.6	9.5	24.4	54	515
33	Banas Kantha	Danta	8.4	10.2	10.4	26.4	120	409
34	Banas Kantha	Dantiwada	10.4	12.4	10.0	24.9	111	479
35	Banas Kantha	Deesa	63 7	78.3	115.1	306.4	431	3,546
36	Banas Kantha	Deodar	24.5	30.4	28.6	74.3	155	1,243
37	Banas Kantha	Dhanera	20.9	24.8	24.4	62.3	173	1,076
38	Banas Kantha	Kankrej	21.9	27 7	24.8	64.2	157	1,191
39	Banas Kantha	Palanpur	23.8	29.7	43.9	114.4	425	1,432
40	Banas Kantha	Tharad	22.4	28.1	39.9	106.5	122	1,319
41	Banas Kantha	Vadgam	20.9	25 6	26.9	67.5	400	1,111
42	Banas Kantha	Vav	5.7	7 3	6 2	16.2	23	262
43	Bharuch	Amod	7.1	10.7	4.7	11 7	180	290
44	Bharuch	Anklesvar	14.0	22.5	85.5	85.5	908	1,040
45	Bharuch	Bharuch	26.3	39.7	52.2	136.7	1,137	1,408
46	Bharuch	Hansot	3.4	6.2	5.2	13.7	26	200
47	Bharuch	Jambusar	5.7	9.6	7.1	17.1	203	240
48	Bharuch	Jhagadia	22.8	32.0	32.9	89.6	145	1,272
49	Bharuch	Vagra	8.3	15.4	7.6	19.7	177	386
50	Bharuch	Valia	11.3	18.2	12.1	32.0	92	618
51	Bhavnagar	Bhavnagar	24 4	51.8	51.8	130.0	1,820	1,287
52	Bhavnagar	Botad	22.0	49.9	24.3	62.3	286	922
53	Bhavnagar	Gadhada	17.1	39.1	20.6	53.7	159	573
54	Bhavnagar	Gariadhar	9.6	23 8	1.9	18.7	103	318
55	Bhavnagar	Ghogha	8.0	20.2	7.5	18.9	95	303
56	Bhavnagar	Mahuva	28.9	83.1	6.2	74.0	271	966
57	Bhavnagar	Palitana	18.7	48 5	4 4	61.2	181	657
58	Bhavnagar	Sihor	23.2	55.5	20.1	50.3	350	921
59	Bhavnagar	Talaja	18.8	53.2	10.9	25.8	215	576
60	Bhavnagar	Umrala	4.8	13.2	3.0	7.1	52	147
61	Bhavnagar	Vallabhipur	6 9	16 7	5.4	13.4	58	232
62	Dohad	Devgadbaria	7.3	8.8	1.5	4.7	76	258
63	Dohad	Dhanpur	2.7	3.1	0.5	1.3	27	82
64	Dohad	Dohad	6.5	8.2	3.0	8.9	225	234
65	Dohad	Fatepura	3.2	3.8	0 6	1.5	31	92
66	Dohad	Garbada	2.0	2.4	0 5	1.4	28	58
67	Dohad	Jhalod	7.8	9.7	1.9	6.0	136	266
68	Dohad	Limkheda	4.3	5.5	0.8	2.7	58	156
69	Gandhinagar	Dehgam	27.8	34.0	5.0	68.7	326	1,231
70	Gandhinagar	Gandhinagar	39.7	52.3	11.3	803.3	555	14,314
71	Gandhinagar	Kalol	41.3	53.3	16.7	323.7	956	2,630
72	Gandhinagar	Mansa	17.5	21.6	18.1	46.0	342	889
73	Jamnagar	Bhanvad	22 6	60.3	6.5	14.9	98	327
74	Jamnagar	Dhrol	15.1	36.3	11.1	21.6	66	379
75	Jamnagar	Jamjodhpur	31.2	88.5	14.9	38.2	168	615
76	Jamnagar	Jamnagar	77.7	164.0	396.5	1,078.3	1,797	6,308
77	Jamnagar	Jodiya	15.9	33.6	19.9	37.6	72	385
78	Jamnagar	Kalavad	30.2	87.5	9.5	21.0	146	663
79	Jamnagar	Kalyanpur	31.4	85.9	10.3	26.0	104	446
80	Jamnagar	Khambhalia	37.6	83.4	17.5	44.6	218	664
81	Jamnagar	Lalpur	30 4	70.6	6.9	16.2	95	470
82	Jamnagar	Okhamandal	12.8	36.1	6.3	15 6	67	206
83	Junagadh	Bhesan	18.4	50.6	1.8	21.4	88	427
84	Junagadh	Junagadh	55.9	147.9	8.4	87.4	782	1,191
85	Junagadh	Keshod	58.2	160.4	5.2	72.1	199	986
86	Junagadh	Kodinar	45.7	114.7	3 4	39.2	161	708
87	Junagadh	Malia	40.4	97.1	2 7	32.6	140	579
88	Junagadh	Manavadar	55.4	149.3	4 9	68.7	147	889
89	Junagadh	Mangrol	35.4	90.9	2 8	28.3	134	468
90	Junagadh	Mendarda	22.0	60 9	1 7	18.2	86	350
91	Junagadh	Patan-Veraval	38.3	97.5	3 8	38.8	222	567
92	Junagadh	Sutrapada	32.2	81.1	4 1	84.3	81	567
93	Junagadh	Talala	48.3	132.1	3 2	38 5	153	704
94	Junagadh	Una	46.2	121.6	5 2	72.4	186	930
95	Junagadh	Vanthali	30 6	84.8	2 2	20 0	114	518
96	Junagadh	Visavadar	53.1	128 4	4 8	66.4	185	1,005
97	Kachchh	Abdasa	21.1	50.3	18.5	18.5	54	360
98	Kachchh	Anjar	30 7	62.4	221.3	381.6	478	1,282
99	Kachchh	Bhachau	31.6	46.2	57 9	105 6	391	1,261
100	Kachchh	Bhuj	47.8	103.2	119.7	216.3	640	1,799
101	Kachchh	Gandhidham	11.8	27.1	63.7	121 8	399	481
102	Kachchh	Lakhpat	10.2	18.1	420.8	1,490.4	26	8,460
103	Kachchh	Mandvi	43.2	122.3	89.1	160 9	210	1,152
104	Kachchh	Mundra	12.0	32 0	19.1	34 4	68	301
105	Kachchh	Nakhatrana	41.2	96.2	80.2	146.5	356	1,292
106	Kachchh	Rapar	27.0	38.3	34.2	64 6	348	1,105
107	Kheda	Balasinor	11.0	14.2	1 9	7 9	88	522
108	Kheda	Kapadvanj	23.1	29.9	5.3	70.1	227	1,087
109	Kheda	Kathlal	6.8	8 9	1.7	13.9	101	271
110	Kheda	Kheda	6.3	8.1	6.0	14.7	73	268
111	Kheda	Mahudha	3.6	4 8	1.3	11 8	91	160
112	Kheda	Matar	11.0	15.5	4.2	10.3	144	459
113	Kheda	Mehmedabad	14.9	19.8	15.5	38 8	288	623
114	Kheda	Nadiad	20 9	27 0	25.5	61.8	908	989

GUJARAT CRITICAL INFRASTRUCTURE RISK ZONATION : EARTHQUAKE & CYCLONE CAPITAL LOSS TO GEB
(50 & 100 YEAR RETURN PERIOD) (Rs. MILLION 2002-2003 PRICES) Table No. VIGT - 01 of 02

GSDMA

Sr. No	District	Taluka	Cyclone (50 Year return)	Cyclone (100 Year return)	Earthquake (50 Year return)	Earthquake (100 Year return)	Total Avg. Annual Revenue	Total Capital Cost
115	Kheda	Thasra	8.6	11.9	2.9	699.3	194	13,856
116	Kheda	Virpur	2.9	3.6	0.9	3.4	30	121
117	Mahesana	Becharaji	6.9	8.7	11.7	31.0	134	406
118	Mahesana	Kadi	25.8	34.9	6.4	66.2	719	1,203
119	Mahesana	Kheralu	11.6	14.2	21.2	55.7	164	609
120	Mahesana	Mahesana	46.4	57.5	69.0	182.3	1,090	2,455
121	Mahesana	Satlasana	6.4	7.8	8.6	21.8	101	317
122	Mahesana	Unjha	11.2	13.5	17.0	43.0	307	645
123	Mahesana	Vadnagar	9.5	11.7	9.3	23.6	108	446
124	Mahesana	Vijapur	25.2	30.5	35.3	91.2	453	1,258
125	Mahesana	Visnagar	19.8	24.3	29.2	75.0	386	1,088
126	Narmada	Dediapada	4.2	5.5	0.8	3.3	37	193
127	Narmada	Nandod	7.5	9.9	2.2	9.8	84	383
128	Narmada	Sagbara	3.5	4.1	0.7	3.0	27	145
129	Narmada	Tilakwada	3.6	4.7	1.3	7.8	49	185
130	Navsari	Bansda	9.3	13.5	2.1	5.9	155	408
131	Navsari	Chikhli	14.7	23.1	3.6	12.3	316	631
132	Navsari	Gandevi	12.4	20.5	5.4	67.9	376	649
133	Navsari	Jalalpore	11.2	21.7	3.6	32.4	341	502
134	Navsari	Navsari	15.3	22.4	8.8	137.0	897	954
135	Panch Mahals	Ghoghamba	4.4	5.3	0.8	2.9	61	163
136	Panch Mahals	Godhra	13.9	17.2	7.0	41.7	363	839
137	Panch Mahals	Halol	9.8	13.2	3.8	21.4	349	560
138	Panch Mahals	Jambughoda	1.5	1.8	0.3	0.8	23	47
139	Panch Mahals	Kadana	6.6	8.4	1.0	2.6	54	239
140	Panch Mahals	Kalol	7.3	9.9	2.2	8.2	209	354
141	Panch Mahals	Khanpur	5.2	6.9	1.0	3.4	78	217
142	Panch Mahals	Lunawada	7.8	9.3	2.8	9.9	196	339
143	Panch Mahals	Morwa (Hadaf)	7.2	8.5	1.5	3.9	77	224
144	Panch Mahals	Santrampur	7.0	8.7	1.7	64.0	116	3,223
145	Panch Mahals	Shehera	6.2	8.4	1.0	3.4	49	246
146	Patan	Chanasma	14.8	18.6	13.3	34.0	230	720
147	Patan	Harij	8.3	10.6	10.4	27.5	107	468
148	Patan	Patan	28.3	34.5	46.3	122.0	370	1,590
149	Patan	Radhanpur	9.2	12.1	5.0	12.4	19	376
150	Patan	Sami	10.1	12.8	7.9	20.4	94	390
151	Patan	Santalpur	17.1	21.5	16.2	30.5	10	706
152	Patan	Sidhpur	14.2	17.1	22.1	56.9	380	775
153	Patan	Vagdod	8.1	9.7	9.0	23.0	155	401
154	Porbandar	Kutiyana	41.1	109.2	2.2	16.2	80	498
155	Porbandar	Porbandar	73.4	199.3	7.8	83.1	535	1,172
156	Porbandar	Ranavav	34.6	95.3	3.8	67.4	73	625
157	Rajkot	Dhoraji	40.3	105.8	4.0	40.4	423	785
158	Rajkot	Gondal	57.7	142.7	41.7	108.1	533	1,661
159	Rajkot	Jamkandorna	19.5	51.1	6.0	15.1	106	443
160	Rajkot	Jasdan	43.9	100.1	21.7	54.9	346	1,383
161	Rajkot	Jetpur	82.0	205.0	12.7	226.3	447	2,057
162	Rajkot	Kotda Sangani	12.3	26.8	3.9	9.6	54	317
163	Rajkot	Lodhika	15.4	38.3	8.7	21.9	174	357
164	Rajkot	Maliya	1.2	1.9	11.9	21.0	-	117
165	Rajkot	Morvi	15.0	27.1	49.1	232.0	1,330	943
166	Rajkot	Paddhari	22.4	57.1	34.1	164.6	191	755
167	Rajkot	Rajkot	55.9	142.3	58.5	131.7	4,556	1,757
168	Rajkot	Tankara	7.0	13.8	2.9	13.9	39	208
169	Rajkot	Upleta	36.3	104.4	4.2	47.3	402	833
170	Rajkot	Wankaner	13.1	23.8	14.8	40.4	24	538
171	Sabar Kantha	Bayad	15.3	18.8	3.4	36.3	165	705
172	Sabar Kantha	Bhiloda	9.6	11.0	2.2	7.3	107	367
173	Sabar Kantha	Dhansura	12.2	15.3	2.9	48.8	92	616
174	Sabar Kantha	Himatnagar	26.5	31.0	9.0	125.8	425	1,337
175	Sabar Kantha	Idar	26.2	30.1	31.4	77.8	293	1,211
176	Sabar Kantha	Khedbrahma	7.1	8.4	7.0	16.3	60	273
177	Sabar Kantha	Malpur	6.2	8.1	1.1	4.1	52	287
178	Sabar Kantha	Meghraj	7.5	8.9	1.8	7.4	84	312
179	Sabar Kantha	Modasa	12.3	14.6	3.7	32.8	160	550
180	Sabar Kantha	Prantij	12.5	14.7	3.3	33.1	267	583
181	Sabar Kantha	Talod	15.6	18.9	3.5	48.9	162	741
182	Sabar Kantha	Vadali	5.6	6.5	18.9	18.9	62	282
183	Sabar Kantha	Vijaynagar	6.1	6.8	2.1	9.2	49	308
184	Surat	Bardoli	7.1	9.7	3.0	12.4	263	372
185	Surat	Chorasi	34.0	62.0	153.9	390.3	11,401	4,953
186	Surat	Kamrej	19.0	27.8	5.1	91.0	1,283	1,047
187	Surat	Mahuva	8.3	11.4	2.6	9.9	92	368
188	Surat	Mandvi	12.1	19.0	2.9	12.3	603	656
189	Surat	Mangrol	11.2	16.0	23.3	61.7	1,526	848
190	Surat	Nizar	6.9	7.2	2.4	14.8	58	445
191	Surat	Olpad	13.6	25.9	18.7	49.3	357	625
192	Surat	Palsana	5.6	8.4	2.4	28.5	670	355
193	Surat	Songadh	9.1	17.2	1.7	6.6	48	586
194	Surat	Surat City	1.6	2.3	-	-	-	64
195	Surat	Uchchhal	1.7	2.4	0.3	2.1	15	96
196	Surat	Umarpada	5.6	10.2	0.2	0.5	13	344
197	Surat	Valod	5.9	8.0	1.5	5.3	79	269
198	Surat	Vyara	12.0	14.5	3.3	96.6	148	4,749
199	Surendranagar	Chotila	16.9	36.6	13.2	34.0	112	619
200	Surendranagar	Chuda	7.5	14.5	7.6	7.6	66	269
201	Surendranagar	Dasada	10.1	13.5	2.3	25.6	80	428
202	Surendranagar	Dhrangadhra	27.7	42.5	48.4	129.7	228	1,454
203	Surendranagar	Halvad	29.5	49.9	29.9	147.1	268	1,340
204	Surendranagar	Lakhtar	6.1	9.2	4.2	10.4	104	228
205	Surendranagar	Limbdi	25.1	38.6	77.3	213.4	66	1,444
206	Surendranagar	Muli	9.6	21.6	9.6	24.4	141	415
207	Surendranagar	Sayla	17.1	34.8	11.7	30.5	235	605
208	Surendranagar	Wadhwan	18.4	35.2	18.7	44.9	362	742
209	The Dangs	The Dangs	9.3	11.5	2.0	7.6	130	339
210	Vadodara	Chhota Udaipur	6.8	8.1	1.8	7.6	82	275
211	Vadodara	Dabhoi	12.4	17.0	3.0	11.7	196	572
212	Vadodara	Jetpur Pavi	6.1	7.4	1.6	4.7	58	212
213	Vadodara	Karjan	14.8	20.2	3.3	45.4	170	724
214	Vadodara	Kavant	4.8	5.9	1.0	3.4	39	171
215	Vadodara	Nasvadi	7.5	9.2	1.8	7.5	74	291
216	Vadodara	Padra	17.1	25.3	27.8	72.7	266	890
217	Vadodara	Sankheda	9.3	11.5	2.9	9.3	184	351
218	Vadodara	Savli	16.4	22.2	3.3	16.5	316	784
219	Vadodara	Sinor	8.4	11.5	1.7	7.3	137	411
220	Vadodara	Vadodara	63.6	80.5	40.3	482.4	6,018	3,795
221	Vadodara	Vaghodia	8.4	10.9	3.1	18.6	160	465
222	Valsad	Dharampur	9.4	13.3	2.0	6.8	145	316
223	Valsad	Kaprada	6.7	9.4	1.2	5.6	47	252
224	Valsad	Pardi	20.0	34.0	9.5	129.5	1,368	1,317
225	Valsad	Umbergaon	14.8	24.0	5.8	88.1	716	847
226	Valsad	Valsad	17.1	29.0	7.2	30.5	853	856

GUJARAT CRITICAL INFRASTRUCTURE RISK ZONATION : EARTHQUAKE & CYCLONE REVENUE LOSS TO GEB
(50 & 100 YEAR RETURN PERIOD) (Rs. MILLION 2001-2002 PRICES) Table No. VIGT - 02 of 02

GSDMA

Sr. No	District	Taluka	Cyclone (50 Year return)	Cyclone (100 Year return)	Earthquake (50 Year return)	Earthquake (100 Year return)	Total Avg. Annual Revenue	Total Capital Cost
1	Ahmadabad	Ahmadabad City	9.4	12.5	1.5	4.4	533	570
2	Ahmadabad	Barwala	0.9	1.3	0.4	0.4	42	209
3	Ahmadabad	Bavla	5.3	6.9	0.8	2.3	277	660
4	Ahmadabad	Daskroi	11.1	14.7	17.5	52.4	629	1,049
5	Ahmadabad	Detroj-Rampura	1.3	1.9	-	0.7	84	195
6	Ahmadabad	Dhandhuka	2.3	3.4	0.3	1.0	118	719
7	Ahmadabad	Dholka	8.6	11.8	12.5	37.6	451	1,018
8	Ahmadabad	Mandal	1.0	1.2	-	0.5	55	127
9	Ahmadabad	Ranpur	1.2	1.8	0.5	0.5	58	273
10	Ahmadabad	Sanand	10.7	13.1	-	4.6	557	736
11	Ahmadabad	Viramgam	4.9	6.9	-	2.3	279	556
12	Amreli	Amreli	9.5	14.1	9.6	28.7	344	1,421
13	Amreli	Babra	3.7	5.8	-	12.5	150	383
14	Amreli	Bagasara	2.3	3.6	0.2	0.6	77	254
15	Amreli	Dhari	5.4	8.6	0.5	1.5	186	751
16	Amreli	Jafrabad	1.7	2.7	-	0.5	57	194
17	Amreli	Khambha	1.5	2.3	-	4.1	50	275
18	Amreli	Kunkavav Vadia	2.5	3.9	-	0.7	89	336
19	Amreli	Lathi	2.6	3.8	-	0.9	104	340
20	Amreli	Lilia	1.1	1.7	-	0.4	43	163
21	Amreli	Rajula	2.3	3.8	-	7.3	88	392
22	Amreli	Savar Kundla	5.7	8.9	-	1.8	218	1,127
23	Anand	Anand	25.6	37.5	-	133.4	1,601	2,296
24	Anand	Anklav	2.5	3.6	4.3	12.9	155	398
25	Anand	Borsad	5.0	7.7	8.6	25.8	310	617
26	Anand	Khambhat	4.9	7.3	7.7	23.1	278	1,254
27	Anand	Petlad	5.5	8.5	9.6	28.7	344	647
28	Anand	Sojitra	1.5	2.1	-	-	85	205
29	Anand	Tarapur	1.4	1.9	-	-	78	230
30	Anand	Umreth	2.6	3.8	-	13.6	164	261
31	Banas Kantha	Amirgadh	0.8	1.5	0.2	0.6	77	220
32	Banas Kantha	Bhabhar	0.8	1.2	0.2	0.5	54	515
33	Banas Kantha	Danta	1.2	2.3	0.3	1.0	120	409
34	Banas Kantha	Dantiwada	1.2	2.1	0.3	0.9	111	479
35	Banas Kantha	Deesa	5.3	8.9	12.0	35.9	431	3,546
36	Banas Kantha	Deodar	2.2	3.4	0.4	1.3	155	1,243
37	Banas Kantha	Dhanera	1.8	3.3	0.5	1.4	173	1,076
38	Banas Kantha	Kankrej	2.2	3.5	4.3	13.0	157	1,191
39	Banas Kantha	Palanpur	5.3	8.8	11.8	35.4	425	1,432
40	Banas Kantha	Tharad	1.3	2.3	0.3	1.0	122	1,319
41	Banas Kantha	Vadgam	5.0	8.2	1.1	3.3	400	1,111
42	Banas Kantha	Vav	0.3	0.5	0.1	0.2	23	262
43	Bharuch	Amod	2.9	4.5	5.0	15.0	180	290
44	Bharuch	Anklesvar	11.3	22.6	75.7	75.7	908	1,040
45	Bharuch	Bharuch	16.2	28.2	31.6	94.7	1,137	1,408
46	Bharuch	Hansot	0.4	0.7	0.7	2.1	26	200
47	Bharuch	Jambusar	3.6	5.3	5.6	16.9	203	240
48	Bharuch	Jhagadia	1.8	3.2	4.0	12.1	145	1,272
49	Bharuch	Vagra	2.8	4.9	4.9	14.8	177	386
50	Bharuch	Valia	1.0	2.0	2.6	7.7	92	618
51	Bhavnagar	Bhavnagar	34.8	56.1	5.1	15.2	1,820	1,287
52	Bhavnagar	Botad	5.9	9.3	0.8	2.4	286	922
53	Bhavnagar	Gadhada	3.7	5.5	0.4	1.3	159	573
54	Bhavnagar	Gariadhar	2.4	3.8	-	0.9	103	318
55	Bhavnagar	Ghogha	1.9	3.1	0.3	0.8	95	303
56	Bhavnagar	Mahuva	6.4	10.4	-	2.3	271	966
57	Bhavnagar	Palitana	4.2	6.6	-	15.1	181	657
58	Bhavnagar	Sihor	7.2	11.4	9.7	29.2	350	921
59	Bhavnagar	Talaja	4.4	7.4	6.0	18.0	215	576
60	Bhavnagar	Umrala	1.1	1.8	0.1	0.4	52	147
61	Bhavnagar	Vallabhipur	1.2	1.9	1.6	4.8	58	232
62	Dohad	Devgadbaria	0.9	1.7	-	2.1	76	258
63	Dohad	Dhanpur	0.3	0.6	-	-	27	82
64	Dohad	Dohad	2.3	4.9	-	6.2	225	234
65	Dohad	Fatepura	0.4	0.6	-	-	31	92
66	Dohad	Garbada	0.3	0.6	-	-	28	58
67	Dohad	Jhalod	1.7	3.0	-	3.8	136	266
68	Dohad	Limkheda	0.7	1.3	-	1.6	58	156
69	Gandhinagar	Dehgam	5.2	7.2	-	2.7	326	1,231
70	Gandhinagar	Gandhinagar	8.9	13.0	-	46.2	555	14,314
71	Gandhinagar	Kalol	15.3	22.4	-	8.0	956	2,630
72	Gandhinagar	Mansa	5.5	7.5	9.5	28.5	342	889
73	Jamnagar	Bhanvad	3.0	5.5	2.7	8.2	98	327
74	Jamnagar	Dhrol	1.6	2.5	5.5	11.0	66	379
75	Jamnagar	Jamjodhpur	5.2	10.1	0.5	1.4	168	615
76	Jamnagar	Jamnagar	49.8	73.5	15.0	30.0	1,797	6,308
77	Jamnagar	Jodiya	1.8	2.5	6.0	12.0	72	385
78	Jamnagar	Kalavad	3.8	6.7	0.4	1.2	146	663
79	Jamnagar	Kalyanpur	3.4	6.7	0.3	0.9	104	446
80	Jamnagar	Khambhalia	6.7	10.8	0.6	1.8	218	664
81	Jamnagar	Lalpur	2.8	4.4	0.3	0.8	95	470
82	Jamnagar	Okhamandal	2.3	5.0	0.2	0.6	67	206
83	Junagadh	Bhesan	2.6	4.6	-	0.7	88	427
84	Junagadh	Junagadh	24.1	44.1	-	6.5	782	1,191
85	Junagadh	Keshod	6.8	13.8	-	16.6	199	986
86	Junagadh	Kodinar	5.5	10.4	-	1.3	161	708
87	Junagadh	Malia	5.1	9.7	-	11.7	140	579
88	Junagadh	Manavadar	5.1	10.2	-	12.2	147	889
89	Junagadh	Mangrol	4.9	9.9	-	1.1	134	468
90	Junagadh	Mendarda	2.8	5.5	-	0.7	86	350
91	Junagadh	Patan-Veraval	8.1	16.5	-	1.9	222	567
92	Junagadh	Sutrapada	3.0	5.6	-	0.7	81	567
93	Junagadh	Talala	5.0	9.9	-	1.3	153	704
94	Junagadh	Una	5.7	10.5	-	1.5	186	930
95	Junagadh	Vanthali	3.7	7.4	-	1.0	114	518
96	Junagadh	Visavadar	5.7	9.8	-	15.4	185	1,005
97	Kachchh	Abdasa	1.5	2.3	0.4	0.4	54	360
98	Kachchh	Anjar	11.2	16.5	8.0	17.3	478	1,282
99	Kachchh	Bhachau	8.1	10.8	3.3	6.5	391	1,261
100	Kachchh	Bhuj	15.0	22.0	53.3	106.7	640	1,799
101	Kachchh	Gandhidham	9.4	13.7	6.7	14.4	399	481
102	Kachchh	Lakhpat	0.6	0.9	0.2	0.4	26	8,460
103	Kachchh	Mandvi	5.8	10.4	17.5	35.0	210	1,152
104	Kachchh	Mundra	1.8	2.9	0.6	1.1	68	301
105	Kachchh	Nakhatrana	8.8	13.7	3.0	5.9	356	1,292
106	Kachchh	Rapar	6.1	8.7	2.9	5.8	348	1,105
107	Kheda	Balasinor	1.3	1.9	-	2.5	88	522
108	Kheda	Kapadvanj	3.6	5.3	-	19.0	227	1,087
109	Kheda	Kathlal	1.6	2.4	-	8.4	101	271
110	Kheda	Kheda	1.3	1.7	2.0	6.1	73	268
111	Kheda	Mahudha	1.5	2.1	-	7.6	91	160
112	Kheda	Matar	2.5	3.6	4.0	12.0	144	459
113	Kheda	Mehmedabad	4.6	6.8	8.0	24.0	288	623
114	Kheda	Nadiad	14.5	21.3	25.2	75.6	908	989

GUJARAT CRITICAL INFRASTRUCTURE RISK ZONATION : EARTHQUAKE & CYCLONE REVENUE LOSS TO GEB
(50 & 100 YEAR RETURN PERIOD) (Rs. MILLION 2001-2002 PRICES) Table No. VIGT - 02 of 02

GSDMA

Sr. No	District	Taluka	Cyclone (50 Year return)	Cyclone (100 Year return)	Earthquake (50 Year return)	Earthquake (100 Year return)	Total Avg. Annual Revenue	Total Capital Cost
115	Kheda	Thasra	3.1	4 5	-	16 2	194	13,856
116	Kheda	Virpur	0 4	0.7	-	0.8	30	121
117	Mahesana	Becharaji	2.1	3 0	0.4	1.1	134	406
118	Mahesana	Kadi	12.7	16.8	-	6 0	719	1,203
119	Mahesana	Kheralu	2.0	3.4	4 6	13 7	164	609
120	Mahesana	Mahesana	17.4	24.0	3.0	9 1	1,090	2,455
121	Mahesana	Satlasana	1.3	2.1	0 3	0.8	101	317
122	Mahesana	Unjha	4.4	6.3	8.5	25.6	307	645
123	Mahesana	Vadnagar	1.5	2 2	3.0	9.0	108	446
124	Mahesana	Vijapur	6.5	9.3	12.6	37.8	453	1,258
125	Mahesana	Visnagar	5.5	8.0	1.1	3.2	386	1,088
126	Narmada	Dediapada	0.4	0.7	-	1.0	37	193
127	Narmada	Nandod	1.0	1.7	-	2.3	84	383
128	Narmada	Sagbara	0.2	0.5	-	0.8	27	145
129	Narmada	Tilakwada	0.6	1.1	-	1.4	49	185
130	Navsari	Bansda	1.6	3.4	-	4.3	155	408
131	Navsari	Chikhli	3.9	7.9	-	8 8	316	631
132	Navsari	Gandevi	5.4	9.9	-	31.4	376	649
133	Navsari	Jalalpore	4.9	9.5	-	28 4	341	502
134	Navsari	Navsari	12.8	22.3	-	74.8	897	954
135	Panch Mahals	Ghoghamba	0.9	1.3	-	1.7	61	163
136	Panch Mahals	Godhra	5.2	8.0	-	10.1	363	839
137	Panch Mahals	Halol	5.0	8.2	-	9.7	349	560
138	Panch Mahals	Jambughoda	0.3	0.5	-	-	23	47
139	Panch Mahals	Kadana	0.7	1.2	-	-	54	239
140	Panch Mahals	Kalol	3.0	4.9	-	5.8	209	354
141	Panch Mahals	Khanpur	1.0	1.7	-	2.2	78	217
142	Panch Mahals	Lunawada	2.8	4.3	-	5.4	196	339
143	Panch Mahals	Morwa (Hadaf)	1.0	1.7	-	-	77	224
144	Panch Mahals	Santrampur	1.4	2.5	-	-	116	3,223
145	Panch Mahals	Shehera	0.7	1.1	-	1.4	49	246
146	Patan	Chanasma	3.3	4.7	0.6	1.9	230	720
147	Patan	Harij	1.5	2 3	0 3	0.9	107	468
148	Patan	Patan	5.3	7.6	1.0	3.1	370	1,590
149	Patan	Radhanpur	0.3	0.4	0.5	1.6	19	376
150	Patan	Sami	1.5	2.1	0.3	0.8	94	390
151	Patan	Santalpur	0.2	0.2	0.1	0.2	10	706
152	Patan	Sidhpur	5.4	7.8	10.6	31.7	380	775
153	Patan	Vagdod	2.2	3.2	0.4	1.3	155	401
154	Porbandar	Kutiyana	2.7	5.5	-	0.7	80	498
155	Porbandar	Porbandar	18.4	37.1	-	44.6	535	1,172
156	Porbandar	Ranavav	2.5	5.1	-	0 6	73	625
157	Rajkot	Dhoraji	13.0	23.8	-	3.5	423	785
158	Rajkot	Gondal	14.0	23.2	14.8	44.4	533	1,661
159	Rajkot	Jamkandorna	2.9	5.2	0.3	0 9	106	443
160	Rajkot	Jasdan	8.1	12.6	9.6	28.8	346	1,383
161	Rajkot	Jetpur	13.1	22.1	-	3 7	447	2,057
162	Rajkot	Kotda Sangani	1.4	2.2	0.2	0 5	54	317
163	Rajkot	Lodhika	4.6	7.1	0.5	1.5	174	357
164	Rajkot	Maliya	-	-	-	-	-	117
165	Rajkot	Morvi	29.3	41.0	3.7	22.2	1,330	943
166	Rajkot	Paddhari	4.7	7.4	5.3	31.8	191	755
167	Rajkot	Rajkot	113.2	175.7	12.7	38.0	4,556	1,757
168	Rajkot	Tankara	1.0	1.4	0.1	0.7	39	208
169	Rajkot	Upleta	12.4	24.3	-	3.4	402	833
170	Rajkot	Wankaner	0 6	0 8	0.1	0.2	24	538
171	Sabar Kantha	Bayad	2.4	3.6	-	1.4	165	705
172	Sabar Kantha	Bhiloda	1.1	2.0	-	0.3	107	367
173	Sabar Kantha	Dhansura	1.3	2 0	-	0 8	92	616
174	Sabar Kantha	Himatnagar	6.1	8 8	-	3.5	425	1,337
175	Sabar Kantha	Idar	3.6	5 6	8.1	24.4	293	1,211
176	Sabar Kantha	Khedbrahma	0 6	1.2	1.7	5.0	60	273
177	Sabar Kantha	Malpur	0.7	1.2	-	0.1	52	287
178	Sabar Kantha	Meghraj	1.0	1.7	-	0.2	84	312
179	Sabar Kantha	Modasa	2.0	3 3	-	1.3	160	550
180	Sabar Kantha	Prantij	3.8	5.5	-	2.2	267	583
181	Sabar Kantha	Talod	2.3	3.6	-	13.5	162	741
182	Sabar Kantha	Vadali	0.6	1.2	0.5	0.5	62	282
183	Sabar Kantha	Vijaynagar	0.5	0.9	-	0 1	49	308
184	Surat	Bardoli	3.3	6 2	-	7.3	263	372
185	Surat	Chorasi	182.4	316.0	316.7	950 1	11,401	4,953
186	Surat	Kamrej	18.3	31.9	-	107 0	1,283	1,047
187	Surat	Mahuva	1.1	2.1	-	2.5	92	368
188	Surat	Mandvi	6.3	14.1	-	16.8	603	656
189	Surat	Mangrol	18.9	35.8	42.4	127 1	1,526	848
190	Surat	Nizar	0.5	0.9	-	1.6	58	445
191	Surat	Olpad	5.7	10.4	9 9	29 7	357	625
192	Surat	Palsana	9.6	16.6	-	55.8	670	355
193	Surat	Songadh	0.4	1.0	-	1.3	48	586
194	Surat	Surat City	-	-	-	-	-	64
195	Surat	Uchchhal	0.1	0.3	-	0 4	15	96
196	Surat	Umarpada	0.1	0.3	-	-	13	344
197	Surat	Valod	0.8	1.7	-	2.2	79	269
198	Surat	Vyara	1.5	3.0	-	4.1	148	4,749
199	Surendranagar	Chotila	2.6	3.8	0.3	0.9	112	619
200	Surendranagar	Chuda	1.3	2.0	0 6	0.6	66	269
201	Surendranagar	Dasada	1.4	1.9	-	0.7	80	428
202	Surendranagar	Dhrangadhra	4.4	6.0	6.3	19.0	228	1,454
203	Surendranagar	Halvad	5.5	7 4	0.7	4.5	268	1,340
204	Surendranagar	Lakhtar	2.0	2.7	0.3	0.9	104	228
205	Surendranagar	Limbdi	1.3	1.8	1.8	5.5	66	1,444
206	Surendranagar	Muli	2.9	4.4	0 4	1 2	141	415
207	Surendranagar	Sayla	5.2	7.7	0.7	2.0	235	605
208	Surendranagar	Wadhwan	6.9	10.6	1.0	3.0	362	742
209	The Dangs	The Dangs	1.1	2.5	-	3.6	130	339
210	Vadodara	Chhota Udaipur	1.0	1.7	-	2.3	82	275
211	Vadodara	Dabhoi	2.8	4 6	-	5 4	196	572
212	Vadodara	Jetpur Pavi	0.8	1.3	-	1.6	58	212
213	Vadodara	Karjan	2 4	4 0	-	14 1	170	724
214	Vadodara	Kavant	0.5	0.8	-	1 1	39	171
215	Vadodara	Nasvadi	0.9	1.5	-	2.0	74	291
216	Vadodara	Padra	4.2	6 6	7 4	22.1	266	890
217	Vadodara	Sankheda	2.6	4 0	-	5.1	184	351
218	Vadodara	Savli	5.1	7.4	-	8 8	316	784
219	Vadodara	Sinor	2.0	3 2	-	3 8	137	411
220	Vadodara	Vadodara	96.3	141.1	-	501 5	6,018	3,795
221	Vadodara	Vaghodia	2.6	3.7	-	4 4	160	465
222	Valsad	Dharampur	1.8	3 4	-	4.0	145	316
223	Valsad	Kaprada	0 7	1 1	-	1 3	47	252
224	Valsad	Pardi	19.5	35 9	-	114.0	1,368	1,317
225	Valsad	Umbergaon	11 5	18 8		59 7	716	847
226	Valsad	Valsad	12 2	22 4	-	23.7	853	856

PORT & AIRPORT VULNERABILITY AND RISK

PORTS

The state of Gujarat has 40 minor and intermediate ports geographically dispersed across south Gujarat (13 ports), Saurashtra (23) and Kachchh (4) regions. Kandla, the major port is located in Kachchh and is under the administrative control of the Central Government. In order to accelerate the development of ports and putting their working on a commercial footing, a nodal maritime authority, the Gujarat Maritime Board (GMB) was constituted in 1982. The GMB administers the 11 intermediate and 29 minor ports of Gujarat.

DATA SOURCES AND METHODOLOGY

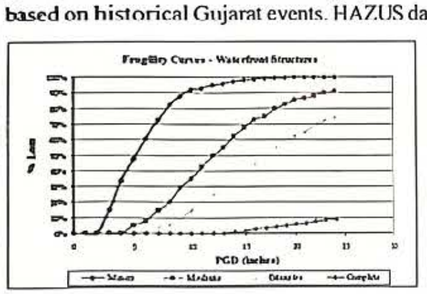
The key data sources used in this assessment include:

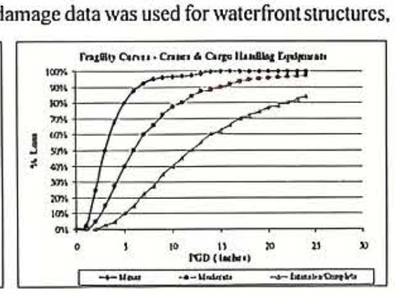
- Administrative reports of the Gujarat Maritime Board for 2000, 2001 and 2002
- Studies conducted by TARU from 1991-2004 on earthquakes, cyclones and floods
- Port-wise lists of infrastructure provided by Gujarat Maritime Board

A port system consists of four components: waterfront structures, cranes/cargo handling equipment, fuel facilities, and warehouses.

Damage functions or fragility curves due to ground motion for all four port system components are lognormal distributed functions that estimate the probability of exceeding different levels of damage for a given level of earthquake ground motion. Each fragility curve is characterized by a median value of ground motion (or failure) and an associated dispersion factor (lognormal standard deviation). Ground motion is quantified in terms of peak ground acceleration (PGA) and ground failure is quantified in terms of permanent ground displacement (PGD).

For office and other buildings that are constructed mostly with RCC roofs on brick walls, as well as for warehouses that largely have CGI/ACC roofs, vulnerability functions are based on historical Gujarat events. HAZUS damage data was used for waterfront structures,

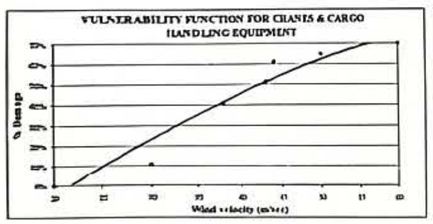


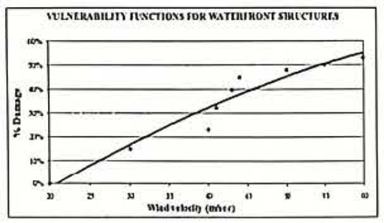


cranes and cargo equipment. A total of five damage states are defined for port system components. These are none, slight/minor, moderate, extensive and complete damage.

DAMAGE FUNCTIONS FOR PEAK WIND SPEEDS

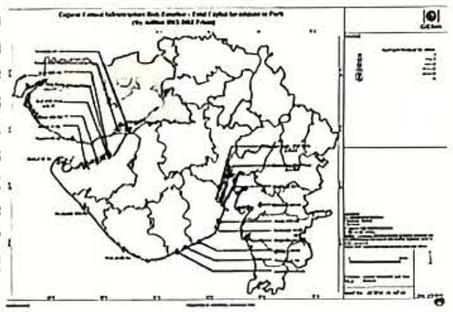
Vulnerability functions for cranes and cargo handling equipment and water front structures are derived from the reported damage following the Kandla Cyclone (1998). For



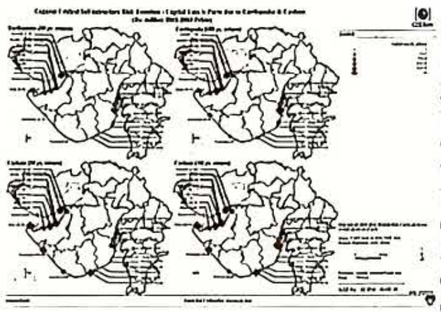


warehouses, which usually have GI sheet roofs and for office buildings which usually have RCC roofs, past Gujarat building vulnerability functions for buildings were utilized.

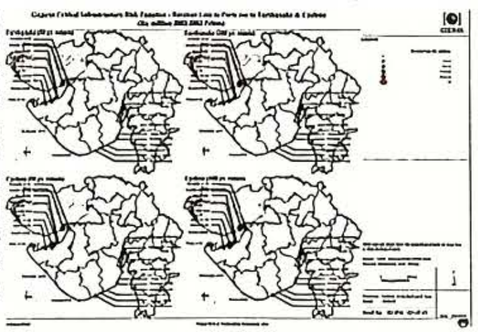
The total invested capital in Gujarat's ports is presented in adjoining figure. There is a large variation in capital investments owing to specialty, cargo throughput and function attributed to various ports. Kandla port has the highest capital investment (33 percent of the total investment) followed by Porbandar (17 percent) and Bhavnagar new port (17 percent).



The estimated capital losses to ports due to earthquake and cyclone are presented in the figure below. Kandla port is exposed to the highest risk owing to high investment and being in high hazard risk zone. The net capital losses for 50-year return earthquakes are estimated at 6 percent and for 100-year return period, pegged at 15 percent loss due to cyclones are more or less similar, apart from changes in the inventories that suffer damage. Earthquake related damage is concentrated in and around the Kachchh district, while cyclone related damage is more prominent in the coastal Saurashtra region.



The estimated revenue risk to ports due to earthquake and cyclone are presented in the figure below. Revenue losses are reported only in commercial ports handling cargo. Fishing ports and jetties in Gujarat do not have any formal revenue records. The highest revenue risk of Rs. 235 million is to Kandla port for 100-year return period earthquake and cyclone. These losses are largely due to interruption in port functioning. Sikka port has an estimated risk of Rs. 12 million and Rs. 68 million for 100-year return period earthquake and cyclone events respectively. However the net risk is less than 1 percent of the net annual revenue generated.



AIRPORTS

Gujarat has a fairly extensive network of airports and airfields scattered throughout the state catering to tourist and industrial centres. A list of the functional airports of Gujarat, and the size of aircraft that they are capable of landing, is given in the adjoining table. Airports were earlier controlled by two corporations % the International Airport Authority of India (IAAI) and the National Airport Authority (NAA). To ensure better administration and management of airports, NAA and IAAI merged to form the Airport Authority of India (AAI) in April 1995.

TABLE (1): FUNCTIONAL AIRPORTS IN GUJARAT

Name of Airport	Ownership	Max. Size of Airport
Ahmedabad	AAI	All - 300
Vadodara	AAI	All - 320
Rajkot	AAI	B - 737
Bhavnagar	AAI	B - 737
Bhuj	AAI / IAF	B - 737
Jamnagar	AAI / IAF	B - 737
Kandla	AAI	F - 27
Keshod	AAI	F - 27
Porbandar	AAI	F - 27
Deesa	AAI	DO - 228
Surat	AAI	DO - 228

Source: GIDB, 2004,GoG

DATA SOURCES AND METHODOLOGY

DATA SOURCES

The primary data sources for this assessment were:

- Aviation Master Plan for Gujarat state, prepared by EMA Unihorn Pvt Ltd. for GIDB
- Studies conducted by TARU from 1991-2004 on earthquakes in India

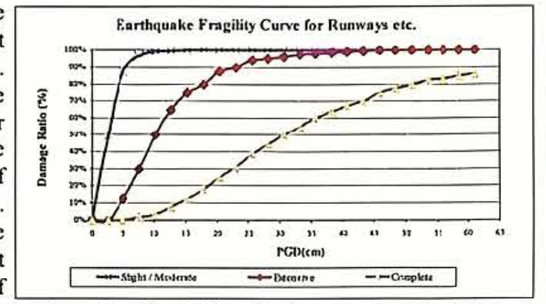
Airport infrastructure is classified into two major categories (HAZUS, 2002):

- Runways, taxiways and aprons
- Terminal buildings and other structures

Vulnerability functions based on historical events have been used for terminal buildings and other structures which are mostly with RCC roofs on brick walls. Fragility curves developed by HAZUS have been used for runways, taxiways and aprons.

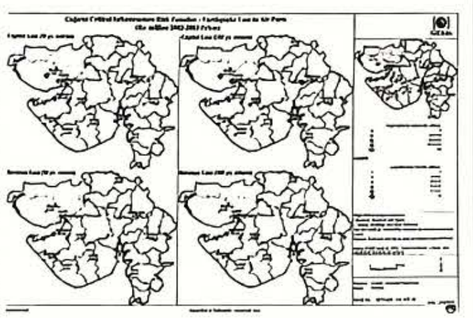
The damage levels describing the intensity of damage to each airport system component are defined as slight, moderate, extensive or complete. They are related to the damage ratios (ratio of repair to replacement cost) used to evaluate direct economic losses.

Component restoration curves are estimated for each damage state to evaluate indirect loss functions. Restoration curves describe the fraction of the fragility that is expected to be operational as a function of time following an earthquake event. For airports, restoration is largely dependent upon the extent of damage to the airport terminal buildings, runways, taxiways and aprons.



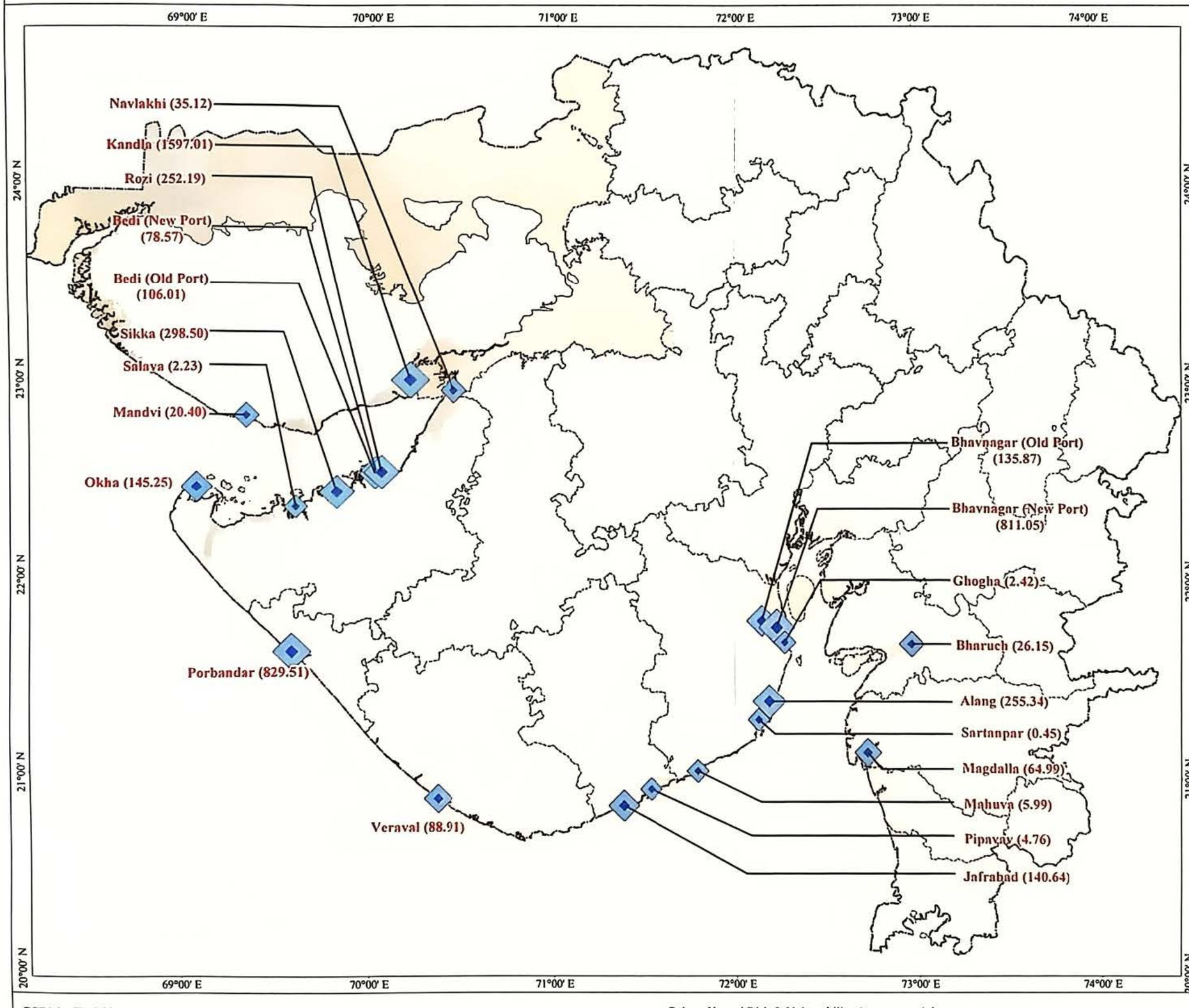
Fragility curves were developed for each component class of the airport system. These curves describe the probability of reaching or exceeding each damage state given the specific levels of earthquake ground motion. Damage functions are lognormal functions that estimate the probability of exceeding different damage levels for a given level of earthquake ground motion. They are characterized by a median value of ground motion (or failure) and an associated dispersion factor (lognormal standard deviation). Ground motion is quantified in terms of Peak Ground Acceleration (PGA). Ground failure is quantified in terms of Permanent Ground Displacement (PGD). For runways, damage functions are defined in terms of PGD.

Capital and revenue risk to airports due to earthquakes is presented in adjoining figure. Ahmedabad airport is at maximum risk with estimated losses of Rs. 35 million and Rs.134 million respectively for a 50-and 100-year return period. The vulnerability of Ahmedabad airport is, however, lower than Bhuj. Being the only international airport in Gujarat, the higher capital risk for Ahmedabad can be attributed to higher capital investment.. Airports in Kachchh have high vulnerability with estimated capital losses of Rs. 111 million and Rs. 70 million in Bhuj and Kandla airport respectively, for a 100-year return period earthquake. Direct revenue losses are insignificant as majority of the revenue is collected by operating airlines, airports only leasing out space and utility to the airlines.



Gujarat Critical Infrastructure Risk Zonation : Total Capital Investment in Ports
(Rs. Million 2002-2003 prices)

GSDMA



LEGEND

Total Capital Investment (Rs. Million)

- < 10
- > 10 to 50
- > 50 to 100
- > 100 to 200
- > 200 to 500
- > 500

Assumptions:
Port infrastructure is classified as 1. Waterfront Structures; 2. Warehouses, 3 Cranes & Cargo Handling Equipments, 4 Office & other buildings. Building / Warehouses vulnerability functions are based on historical events. Waterfront structures and Cranes & Cargo handling equipments loss analysis is based on HAZUS-99.

Source: TARU Analysis, 2004, Kandla Port Trust, GMB, GoG, BISAG, GoG

0 — 100 km

N

Projection : Lambert Azimuthal Equal Area
Datum : WGS 84

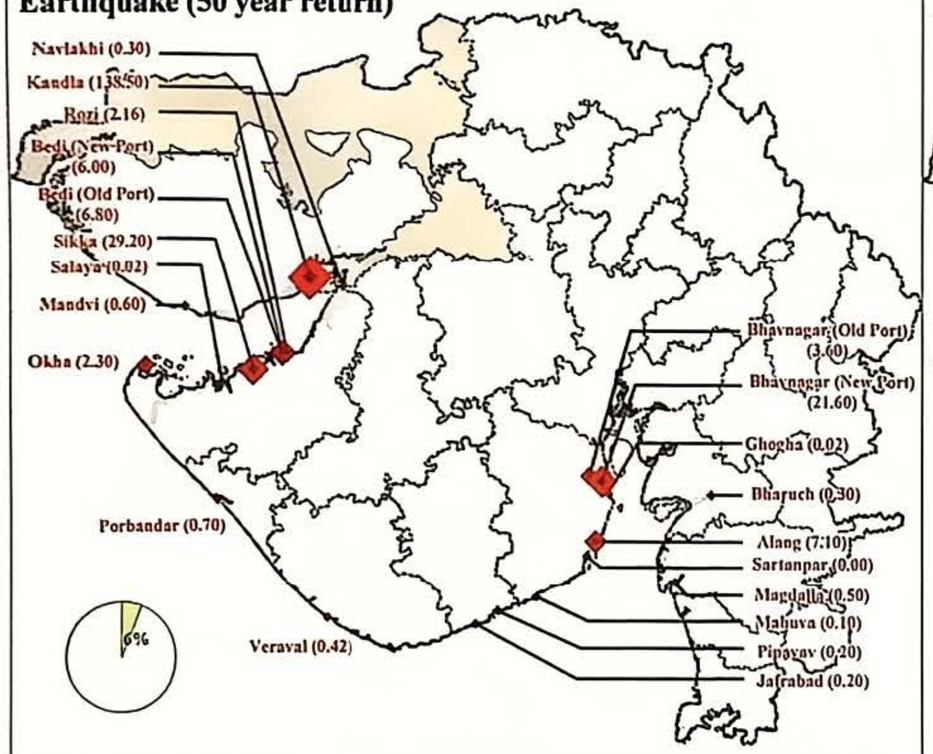
MAP No. : RIPM - 01 OF 03

Date : 29/6/2005

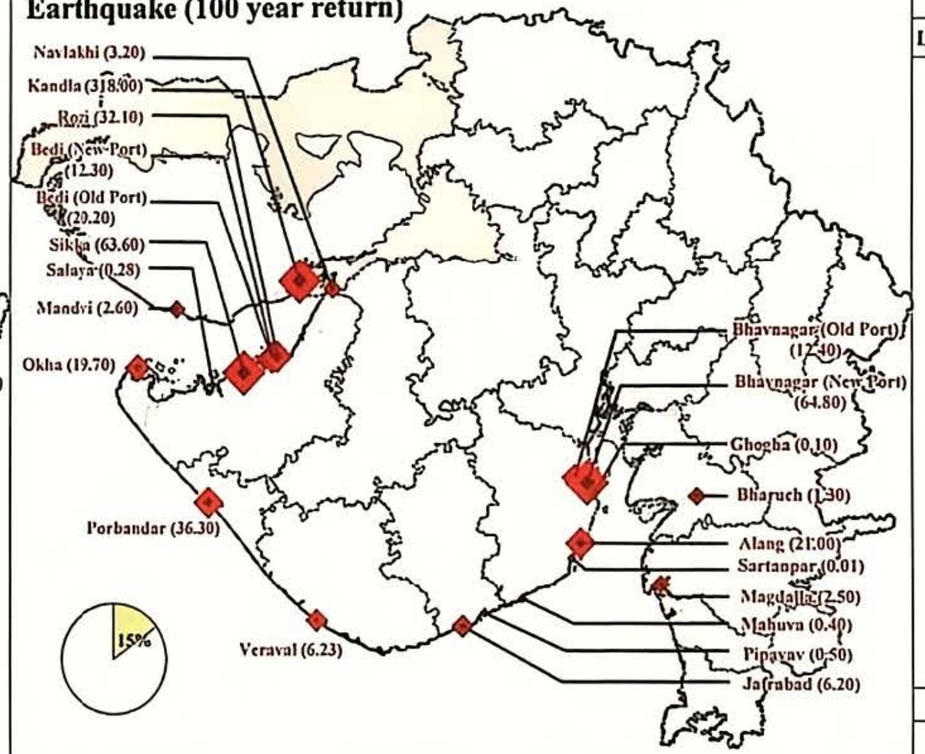
Gujarat Critical Infrastructure Risk Zonation : Capital Loss to Ports due to Earthquake & Cyclone
(Rs. Million 2002-2003 prices)

GSDMA

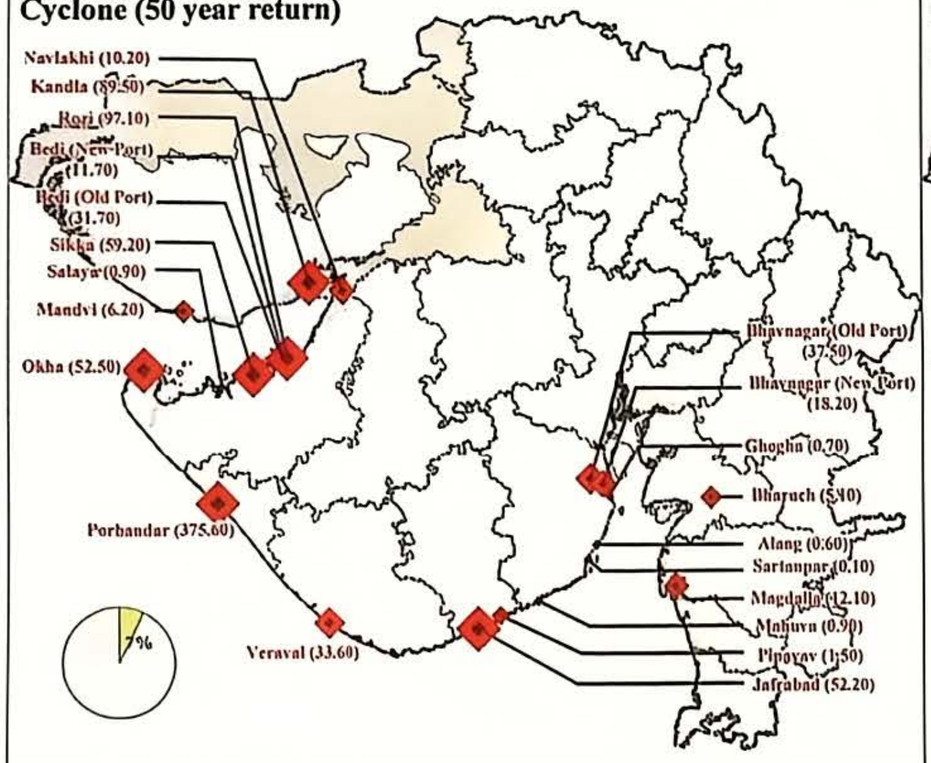
Earthquake (50 year return)



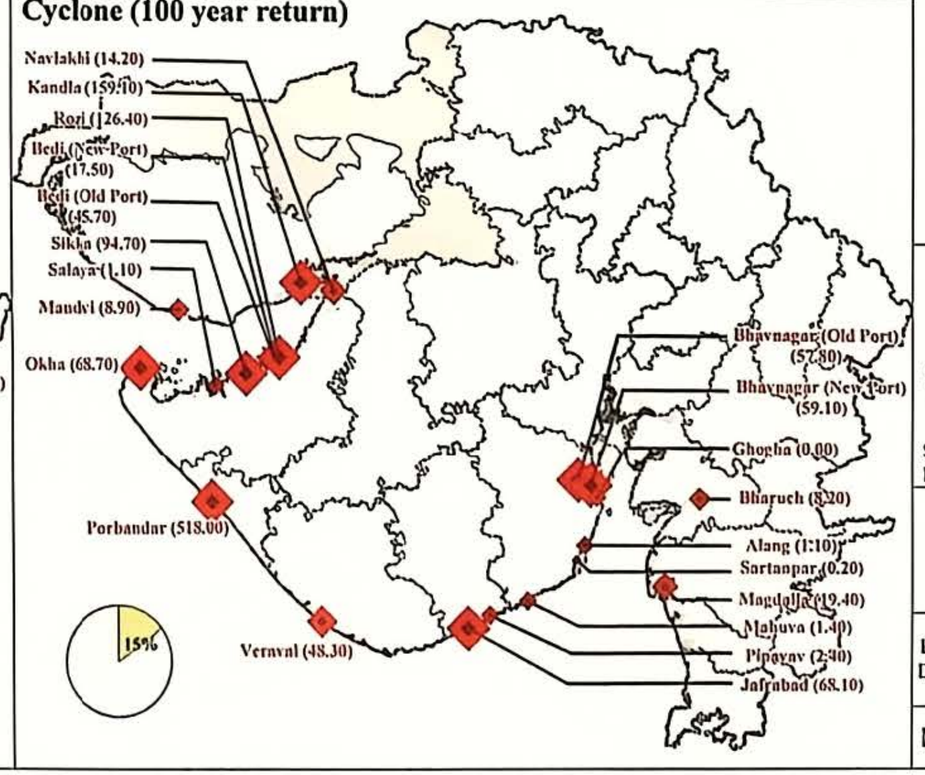
Earthquake (100 year return)



Cyclone (50 year return)



Cyclone (100 year return)



LEGEND

Capital Loss (Rs. Million)
- < 1
- > 1 to 5
- > 5 to 10
- > 10 to 20
- > 20 to 50
- > 50

Main map pie charts show the proportion of Port capital loss to total capital cost of Ports.

Source: TARU Analysis 2004; GMB, GoG; Revenue Department, GoG; BISAG, GoG.

0 100 km

N

Projection : Lambert Azimuthal Equal Area
Datum : WGS 84

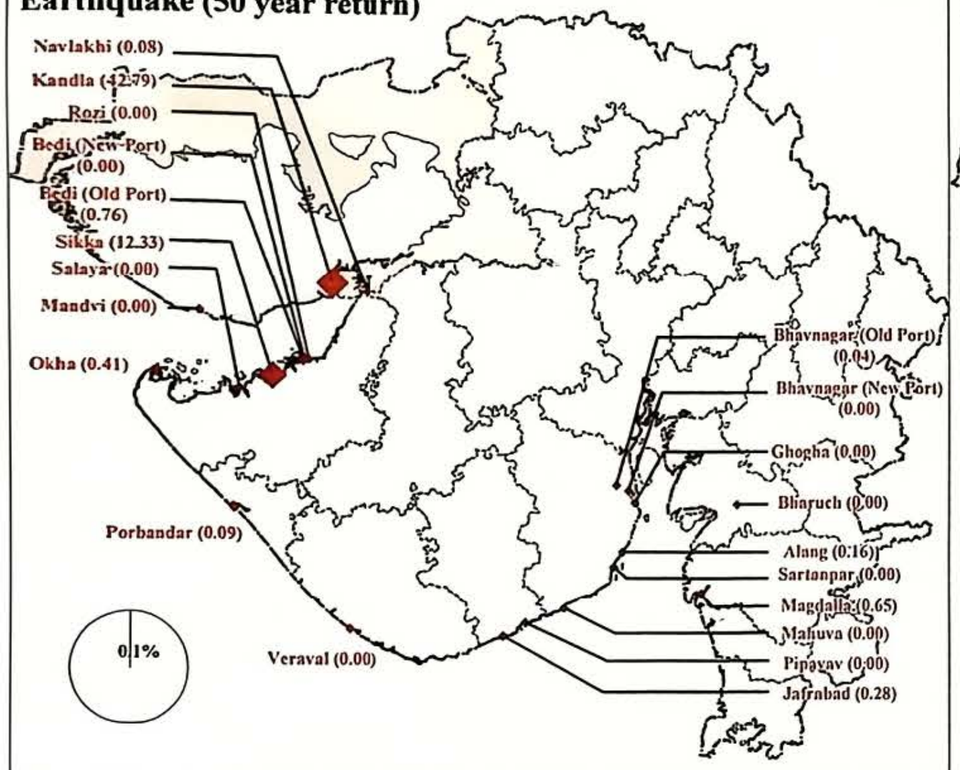
MAP No. : RIPM - 02 OF 03

Date : 29/6/2005

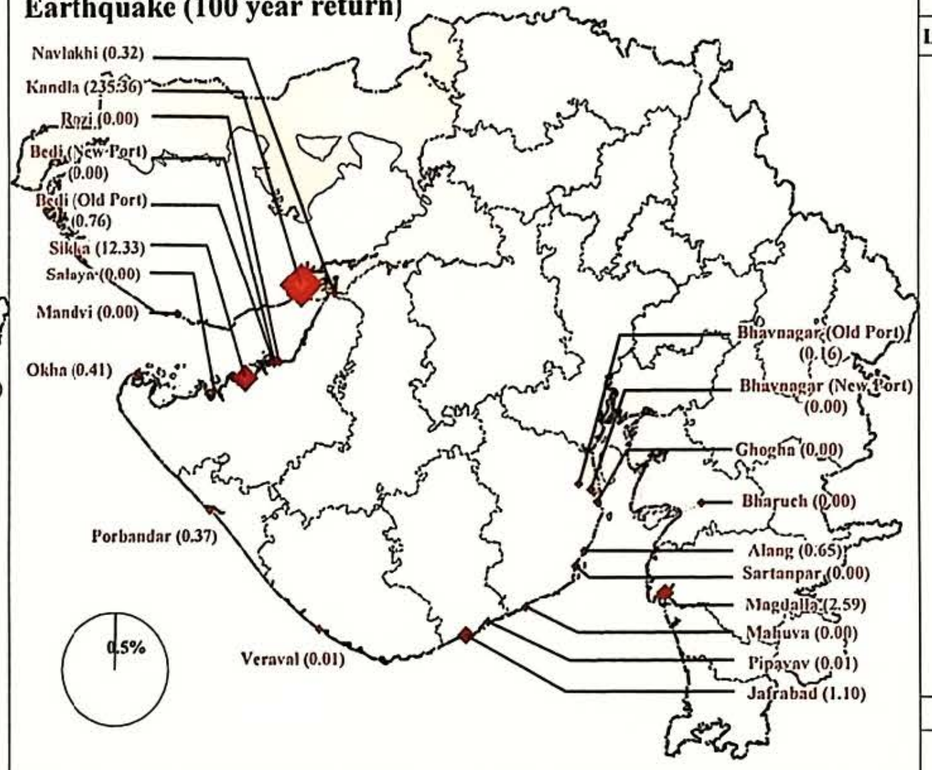
Gujarat Critical Infrastructure Risk Zonation : Revenue Loss to Ports due to Earthquake & Cyclone
(Rs. Million 2002-2003 prices)

GSDMA

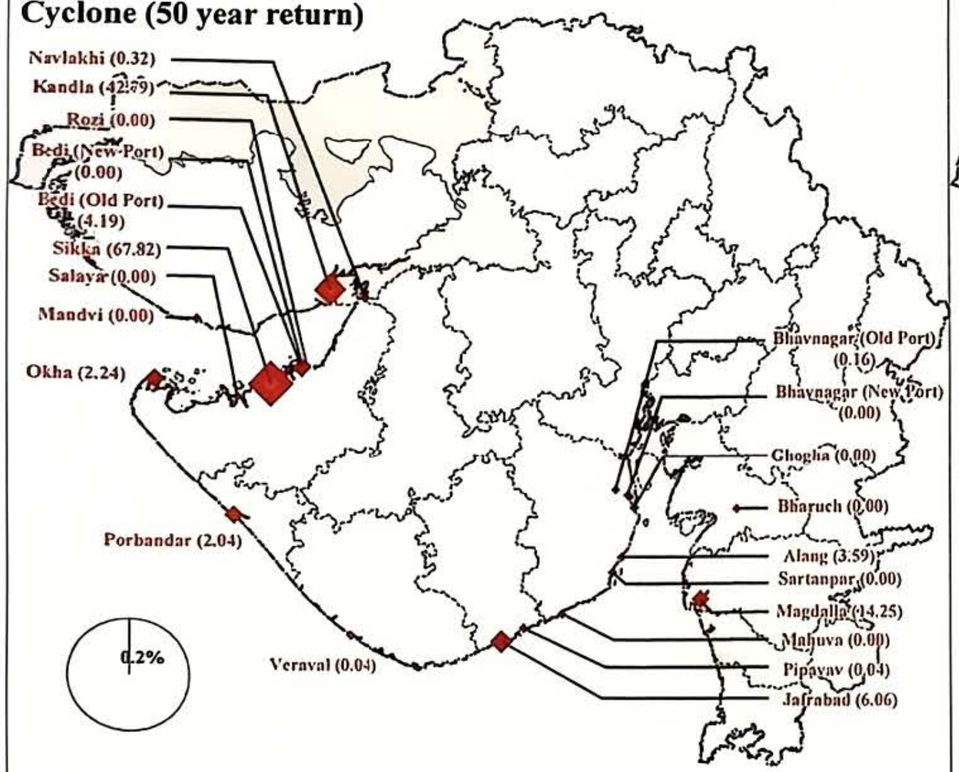
Earthquake (50 year return)



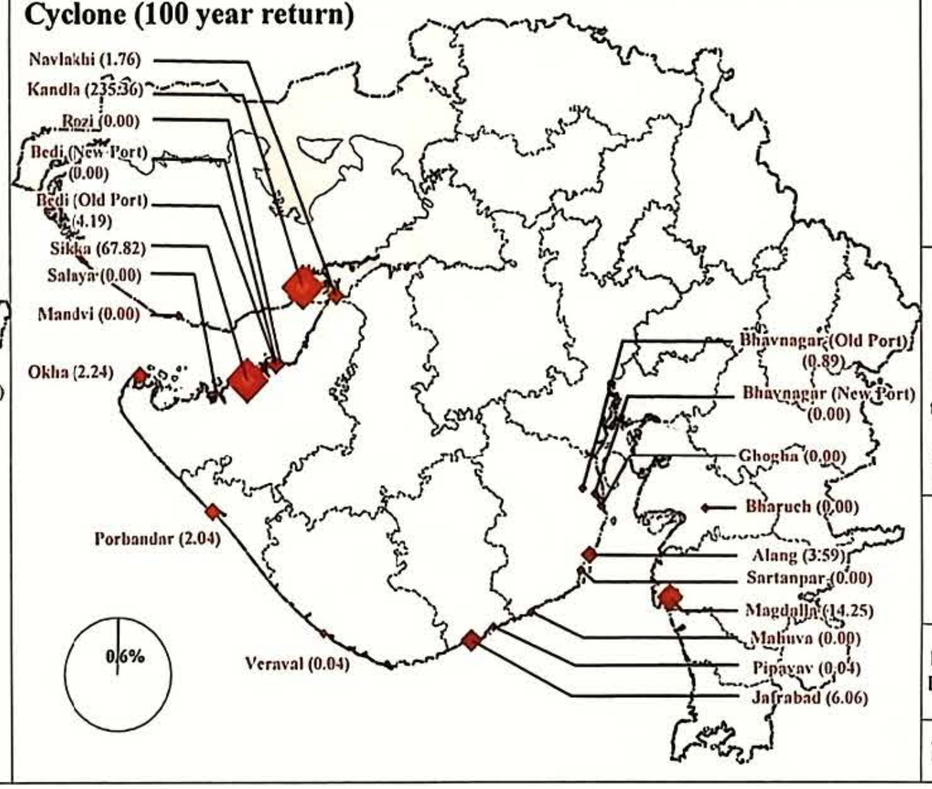
Earthquake (100 year return)



Cyclone (50 year return)



Cyclone (100 year return)



LEGEND

Revenue Loss (Rs. Million)
< 1
> 1 to 5
> 5 to 10
> 10 to 20
> 20 to 50
> 50

Main map pie charts show the proportion of Port revenue loss to total revenue of Ports.

Source: TARU Analysis, 2004; GMB, GoG; Revenue Department, GoG; BISAG, GoG.

0 100 km

N

Projection : Lambert Azimuthal Equal Area
Datum : WGS 84

MAP No. : RIPM - 03 OF 03

Date : 29/6/2005

GUJARAT CRITICAL INFRASTRUCTURE RISK ZONATION : EARTHQUAKE & CYCLONE DAMAGE TO PORTS
(50 & 100 YEAR RETURN PERIOD) (Rs. MILLION 2002-2003 PRICES) Table No. RIPT - 01 of 01

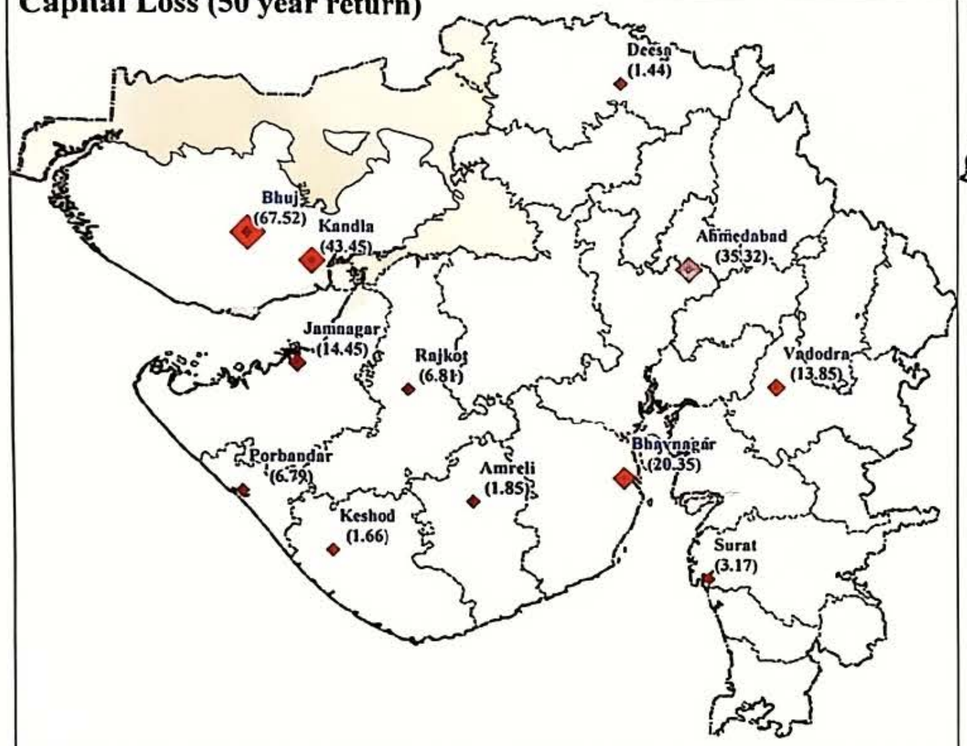
GSDMA

Sr. No	Taluka	Port	Capital Investment	Capital Loss				Revenue Loss			
				Intensity Zone (50 year return)	Intensity Zone (100 year return)	Wind Velocity (50 year return)	Wind Velocity (100 year return)	Intensity Zone (50 year return)	Intensity Zone (100 year return)	Wind Velocity (50 year return)	Wind Velocity (100 year return)
1	Bharuch	Bharuch	26	0.3	1.3	5.1	8.2	-	-	-	-
2	Bhavnagar	Gogha	2	0.0	0.1	0.7	1.0	-	-	-	-
3	Chorasi	Magdalla	65	0.5	2.5	12.1	19.4	0.6	2.6	2.6	14.3
4	Gandhidham	Kandla Port	1,597	362.0	742.0	423.3	614.0	42.8	235.4	42.8	235.4
5	Jafrabad	Jafarabad	141	0.2	6.2	52.2	68.1	0.3	1.1	6.1	6.1
6	Jamnagar	Bedi	106	6.6	20.2	31.7	45.7	0.8	0.8	4.2	4.2
7	Jamnagar	New Port (Bedi)	79	6.0	12.3	11.7	17.5	-	-	-	-
8	Jamnagar	Rozi	252	2.0	32.1	97.1	126.4	-	-	-	-
9	Jamnagar	Sikka	799	33.0	127.3	252.6	346.6	12.3	12.3	67.8	67.8
10	Khambhalia	Salaya	2	0.0	0.3	0.9	1.1	-	-	-	-
11	Mahuva(B)	Mahuva	6	0.1	0.4	0.9	1.4	-	-	-	-
12	Maliya(R)	Navlakhi	35	0.3	3.2	10.2	14.2	0.1	0.3	0.3	1.8
13	Mandvi(K)	Mandvi(K)	20	0.6	2.6	6.2	8.9	-	-	-	-
14	Okhamandal	Okha	145	2.3	19.7	52.5	68.7	0.4	0.4	2.2	2.2
15	Patan Veraval	Veraval	89	0.4	6.2	33.6	48.3	0.0	0.0	0.0	0.0
16	Porbandar	Porbandar	830	0.7	36.3	375.6	518.0	0.1	0.4	2.0	2.0
17	Rajula	Victor (Pipavav)	5	0.2	0.5	1.5	2.4	0.0	0.0	0.0	0.0
18	Talaja	Alang	255	7.1	21.0	0.6	1.1	0.2	0.7	0.7	3.6
19	Talaja	New Port (Bhv.)	811	21.6	64.8	18.2	29.1	-	-	-	-
20	Talaja	Old Port (Bhv.)	136	3.6	12.4	37.5	57.8	0.0	0.2	0.2	0.9
21	Talaja	Sartanpar	0	0.0	0.0	0.1	0.2	-	-	-	-

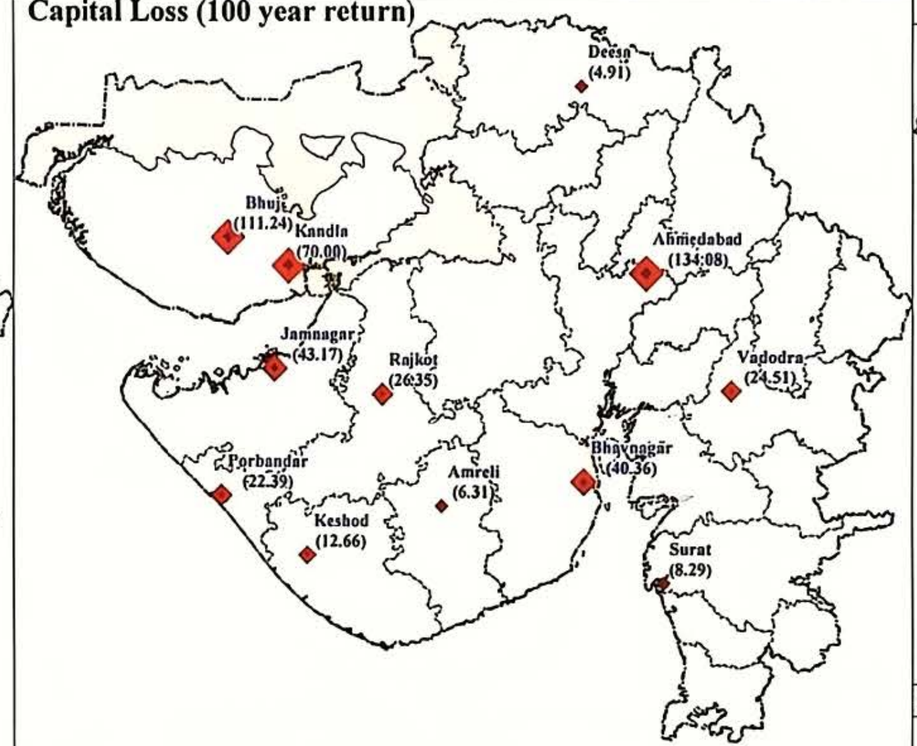
Gujarat Critical Infrastructure Risk Zonation : Earthquake Loss to Air Ports
(Rs. Million 2002-2003 prices)

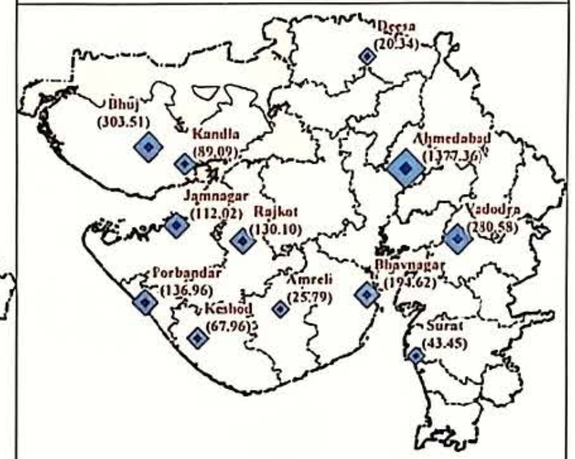
GSDMA

Capital Loss (50 year return)



Capital Loss (100 year return)

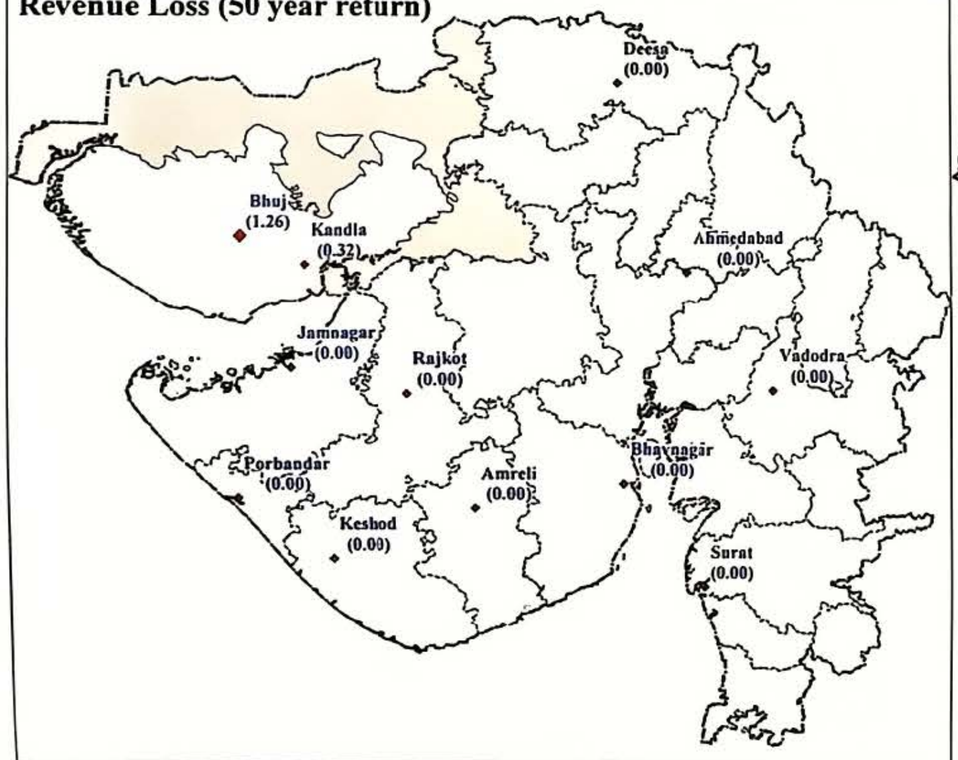




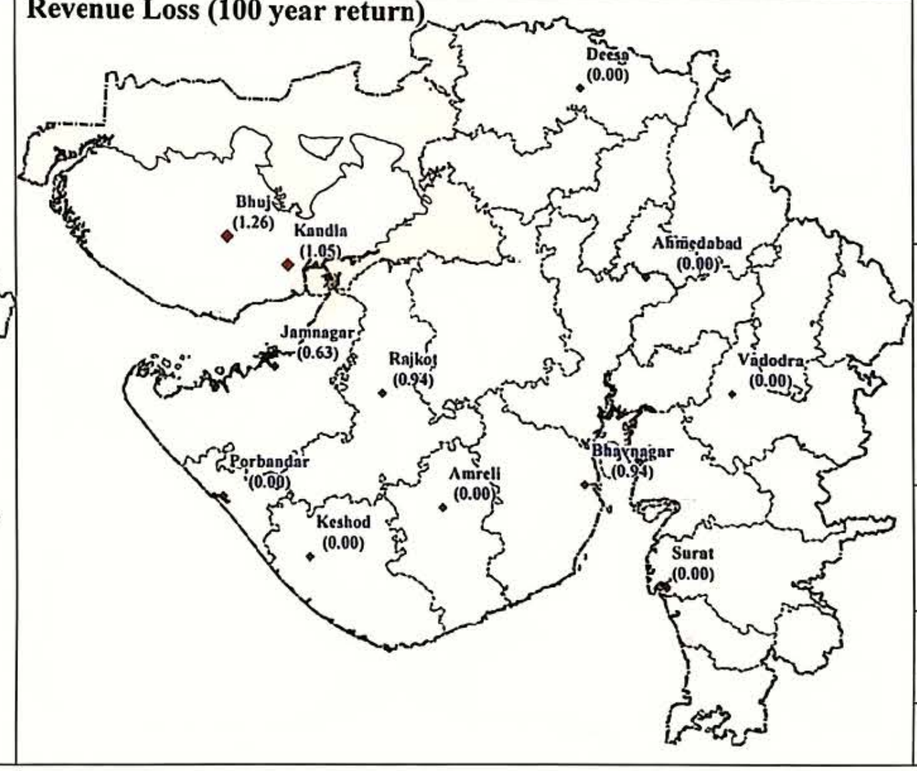
Total Capital Investment (Rs. Million)

- < 50
- > 50 to 100
- > 100 to 200
- > 200 to 500
- > 500

Revenue Loss (50 year return)



Revenue Loss (100 year return)



Capital/Revenue Loss (Rs. Million)

- < 1
- > 1 to 10
- > 10 to 20
- > 20 to 30
- > 30 to 50
- > 50

LEGEND

Assumptions:

Airport infrastructure classified as: 1. Runways, Taxiways and Apron; 2. Terminal Buildings and other Structures;
Terminal buildings vulnerability functions are based on historical events;
Runways, Taxiways and Apron, analysis is based on HAZUS-99.

Source: TARU Analysis, 2004; Airport Authority of India, GoI, GIDB, GoG; HAZUS-99, BISAG, GoG.

0 100 km

N

Projection : Lambert Azimuthal Equal Area
Datum : WGS 84

MAP No. : RIAM - 01 OF 01

Date : 17/8/2005

GUJARAT CRITICAL INFRASTRUCTURE RISK ZONATION : EARTHQUAKE DAMAGE TO AIRPORTS
(50 YEAR & 100 YEAR RETURN PERIOD) (Rs. MILLION 2002-2003 PRICES) Table No. RIAT - 01 of 01

GSDMA

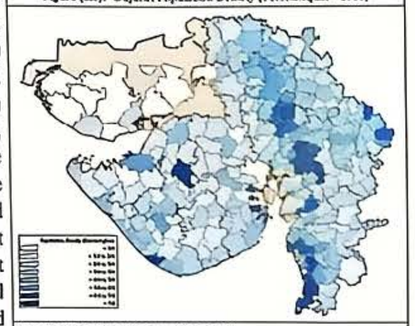
Sr. No	Air Port	Capital Investment	Earthquake (50 year return)		Earthquake (100 year return)		Vulnerability (% Capital Loss)	
			Capital Loss	Revenue Loss	Capital Loss	Revenue Loss	50 Year Return	100 Year return
1	Kandla	89	43.5	0.3	70.0	1.1	49%	79%
2	Jamnagar	112	14.5	-	43.2	0.6	13%	39%
3	Bhuj	304	67.5	1.3	111.2	1.3	22%	37%
4	Amreli	26	1.8	-	6.3	-	7%	24%
5	Deesa	20	1.4	-	4.9	-	7%	24%
6	Bhavnagar	195	20.3	-	40.4	0.9	10%	21%
7	Rajkot	130	6.8	-	26.4	0.9	5%	20%
8	Surat	43	3.2	-	8.3	-	7%	19%
9	Kothod	68	1.7	-	12.7	-	2%	19%
10	Porbandar	137	6.8	-	22.4	-	5%	16%
11	Ahmedabad	1,377	35.3	-	134.1	-	3%	10%
12	Vadodra	261	13.9	-	24.5	-	5%	9%

LOSS OF LIFE

POPULATION DISTRIBUTION

The state of Gujarat is exposed to multiple natural hazards especially drought, earthquake, cyclone, storm surge and flood (World Bank, 2001). It covers a total area of 19.6 million hectares, accounting for 6 percent of India's geographical area and over 50 million people (i.e. 5 percent of India's population) of which 37 percent live in urban areas. Large urban concentrations are located in the cities of Ahmedabad, Vadodara, Surat, Rajkot, Bhavnagar and Jamnagar. The plains of south and central Gujarat and the western coastal belt of Porbandar and Junagadh districts contain the highest population densities in the state. The lowest densities are in Kachchh and in the tribal belts of The Dangs, Narmada and Valsad districts.

Figure (2.1): Gujarat Population Density (Person/sqkm – 2001)

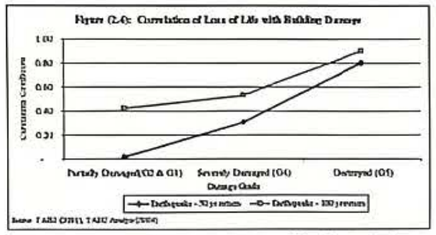


Source: TARU Analysis, 2004; Census of India, 2001

BUILDING DAMAGE AND LOSS OF LIFE

Loss of life and injury has a close relation to the type of building one is working or living in, especially in the case of an earthquake (Murakami, 2004; TARU/BMTPC, 2001). The primary challenge to physical vulnerability assessment in Gujarat is the overwhelming proportion of non-engineered or partially engineered structures. Even buildings erected in conventional materials (e.g. RCC) effectively behave as partially engineered structures as observed in the damage to multi-storied buildings in Ahmedabad (TARU, 2001; GSDMA/CEPT, 2001).

Figure (2.4): Correlation of Loss of Life with Building Damage



The correlation between the casualties and grade of building damage in the Kachchh earthquake of 2001, as shown in the adjoining figure, suggests that there is a close relationship between the two largely because of existing house-types in different regions in Gujarat.

POTENTIAL LOSS OF LIFE ESTIMATION METHOD

Most commonly used and method for calculating risk to human life in a region is by calculating Individual Risk (IR) and the Societal Risk (SR) (Jonkman, 2003).

INDIVIDUAL RISK MEASURE

- Individual Risk (IR) is defined as the probability that an average unprotected person, permanently present at a certain location, is killed due to a hazard event or an accident resulting from a hazardous activity.

$$IR = Pf.\ Pd|f$$

(Where Pf is the probability of failure and Pd|f is the probability of dying of an individual in the case of failure or onset of a hazard event.)

SOCIETAL RISK MEASURE

- Societal Risk is defined as "the relationship between frequency and the number of people suffering from a specified level of harm in a given population from the realization of specified hazards". The aggregated weighted risk (AWR) as described and calculated by multiplying the number of houses inside a certain area with their IR level (Jonkman 2003):

$$AWR = \iint_A IR(x,y)h(x,y)dxdy$$

Where IR(x,y) is the individual risk on location (x,y); h(x,y) number of houses on location (x,y) and A is area for which the AWR is determined.

Based on the above observed data, the individual risk function coupled with the probabilities of 50-year and 100-year return period of earthquake, flood, cyclone and storm surge in different parts of Gujarat has been estimated as per the Societal Risk estimation method (Jonkman, 2003).

VALUATION OF LOSS OF LIFE

Five approaches are commonly used to value loss of life:

(i) macro-economic valuation framework

(ii) comparative approach

(iii) the utility based approach i.e. the Life Quality Index (LQI)

(iv) the contingent valuation framework

(v) the DALYs framework

ESTIMATION METHOD FOR MEAN VALUE OF LIFE

Particular	Amount (Rs.)
Gujarat per Capita GSDP at Current Prices (2000-01)	23,018
Gujarat Life Expectancy at Birth (2001)	61 years
Assumption for proportion of Life used for economic activities (20-60 years of age)	66%
Life Quality Index (LQI)	316,970

Source: TARU Analysis, 2004, GoG, State Domestic Product Gujarat State 2000-2001, Census of India 2001

Based on suitability and data availability, the LQI method was chosen to assess the value of loss of life in Gujarat.

This function of life quality index (LQI) is based on the income per capita (g) and on the life expectancy (e) and expressed as:

$$LQI = gwe(1-w)$$

(Where 'w' is the part of human life used for economic activities.)

This should be improved as and when better data becomes.

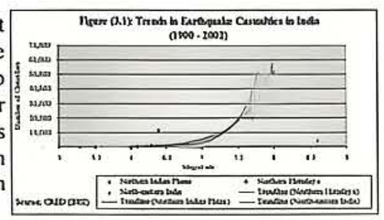
ESTIMATION OF LOSS OF LIFE

Estimates of loss of life due to earthquake, cyclone, and storm surge and floods have been undertaken. Estimation of loss of life due to drought has not been undertaken due to limited number of reported casualties in recent events.

EARTHQUAKE

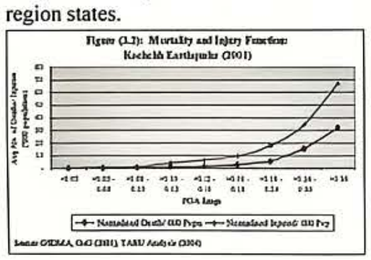
Past earthquake casualty trends in different regions of India (including Gujarat) were normalized to the 2001 Census population to estimate mortality and injury estimates for earthquakes of magnitude 5 to 8.5. The trends are quite distinct for the northern Himalayan belt, the India plains and the north-eastern region states.

Figure (3.1): Trends in Earthquake Casualties in India (1900 - 2002)



Source: CRED (2002)

Figure (3.2): Mortality and Injury Function: Kachchh Earthquake (2001)



Source: GSDMA, GoG (2001), TARU Analysis (2004)

In order to estimate risk of loss of life, a regression analysis between historical casualties and Peak Ground Acceleration (PGA) for the Kachchh earthquake of 2001 was undertaken after normalizing for population densities. This suggests correlation coefficients of 0.82 for casualties and 0.89 for injuries.

CYCLONE

The loss of life reported in the International Disaster Database (CRED, 2002) for past cyclones in Gujarat is presented in the adjoining table. It presents the magnitude of loss of life due to cyclone and storm-surge over the past 100 years. The ratio of death-injury ratios in cyclone and storm surge is estimated to be 0.20 (All India) and 0.18 (Gujarat) according to CRED (2002) database.

TABLE (3.2): PAST CYCLONES IN GUJARAT AND CASUALTIES REPORTED

Year	Location	No. of Casualties
1927	Gujarat, Ahmedabad, Baroda	36
1936	Gujarat, Maharastra	87
1941	Gujarat	470
1982	Gujarat, Maharashtra	500
1983	Saurashtra coast (N-W. Gujarat)	551
1990	Gujarat	120
1998	Kachchh, Porbandar, Jamnagar, Junagadh, Amreli, Bhavnagar, Banaskantha, Surat, Dharoch, Rajkot, Valsad, Navsari districts	2,871
1999	Gujarat coast	275

Source: CRED, 2002

TABLE (3.3): ESTIMATES FROM LOSS OF LIFE FROM ORISSA CYCLONE 05B-99

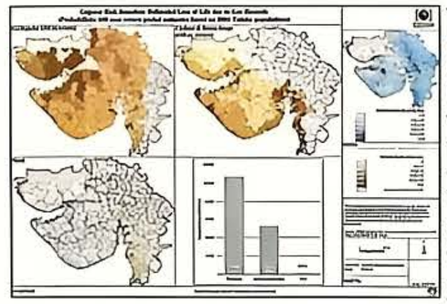
Hazard		Death/ 000 Population	Population Density (per sqkm)
High Wind Speed	<50 m/s	0.05	452
	>50 m/s	0.47	535
Storm Surge + Wind (Inundation level)	3-4m	200	197
	1.5-3m	15	197
	<1.5m	4	197
	All	33	197
Flooding	Flash Flood	1.05	390
	Inundation >3 m	0.67	401
	Inundation 1.5-3 m	0.50	452

Source: TARU (2000), TARU Analysis, 2004

In the absence of data on loss of life at various wind velocities and height of storm surge inundations, primary data from the Orissa super cyclone (05B- 1999) (TARU 2000) was used to calibrate the casualty and injuries functions for the state.

FLOODS

The individual risk estimates for loss of life due to floods has been based on the Gujarat floods of 2004. Given that inundation levels were not as high as that reported in Orissa cyclone (1999) where it was accompanied with moderate wind velocity and surge, the recent flood casualties in Gujarat (2004) have been limited to 211 people. This suggests that around 0.20 people died per '000 population affected in the flooded areas.

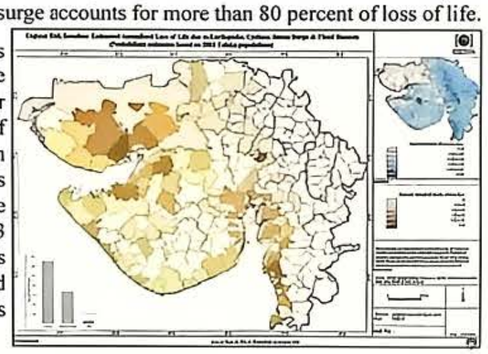


The 100-year return period earthquake map shows potential loss of life across most of Gujarat except the eastern tribal belt. Cyclonic storms pose a serious threat to much of southern Saurashtra, whereas storm surge poses a threat to coastal south Gujarat and the Gulf of Khambat region. In the case of 100-year return period cyclone, most of Saurashtra and Kachchh will experience potential loss of life apart from coastal south Gujarat and Gulf of Khambat region.

CONCLUSIONS

Earthquakes stand out as the most important hazard with respect to loss of life with over 11,000 potential casualties in 50-year return period and over 1,00,000 potential casualties in 100-year return period. This is followed by cyclone and storm surge with potential casualties of around 6,000 in 50-year return period and over 50,000 in case of 100 year return period, within which storm surge accounts for more than 80 percent of loss of life.

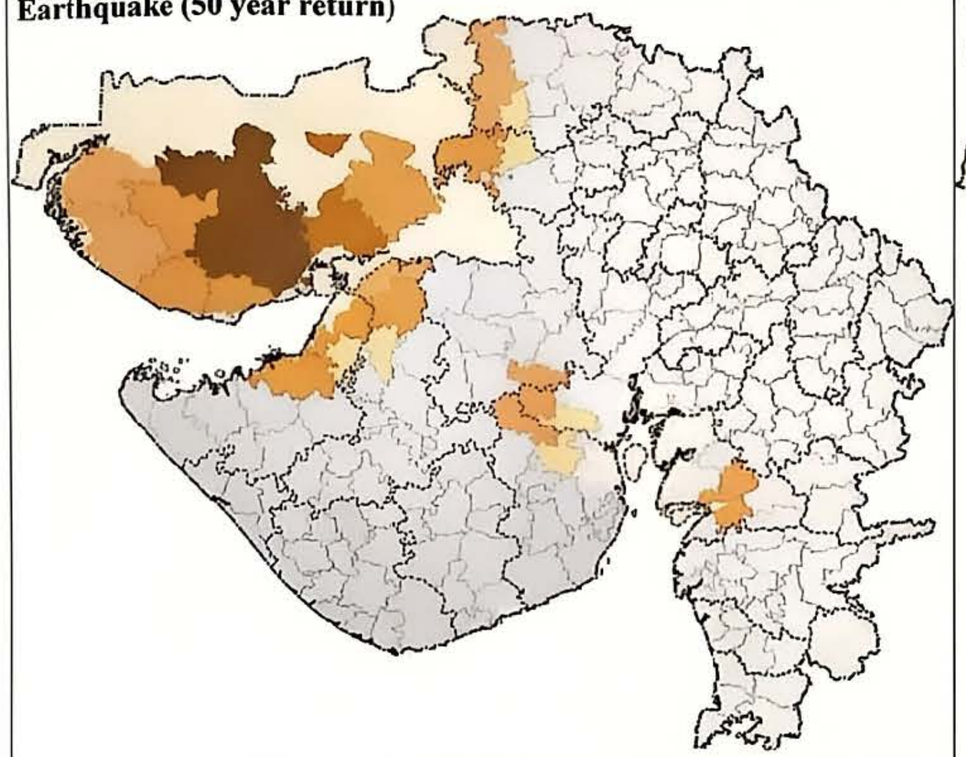
The annualized loss of life suggests that around 2,000 persons can be statistically estimated to lose their life each year on account of earthquake, cyclone, and storm surge and flood. Earthquakes account for about 65 percent of the loss of life, cyclone and surge 33 percent and flood 2 percent of loss of life. Drought has been assumed to cause negligible human deaths based on recent trends.



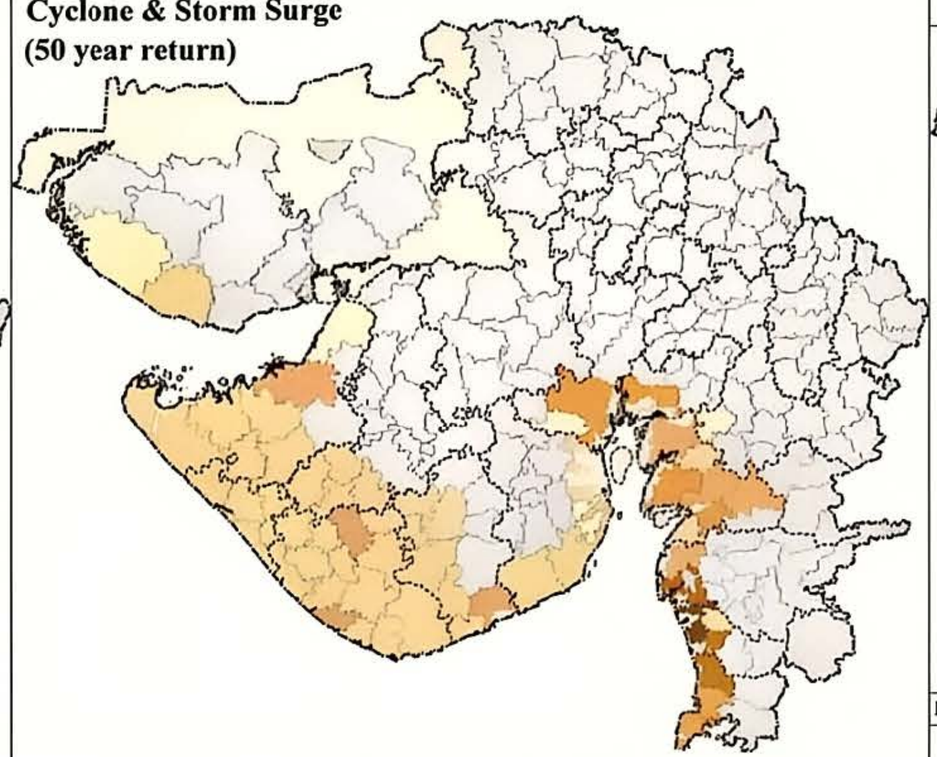
Gujarat Risk Zonation: Estimated Loss of Life due to Key Hazards
(Probabilistic 50 year return period estimates based on 2001 Taluka populations)

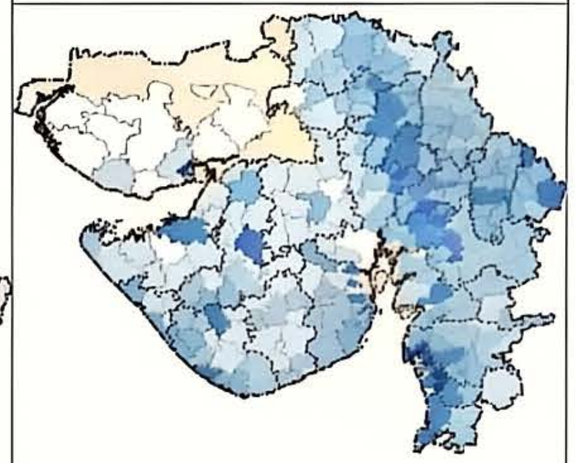
GSDMA

Earthquake (50 year return)



Cyclone & Storm Surge (50 year return)

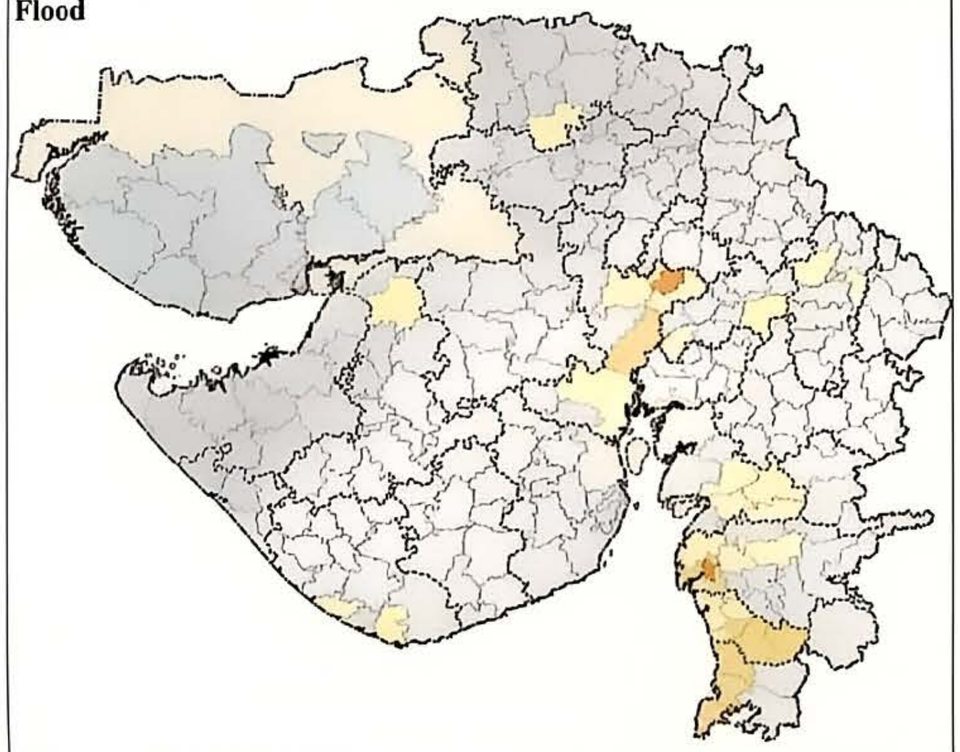


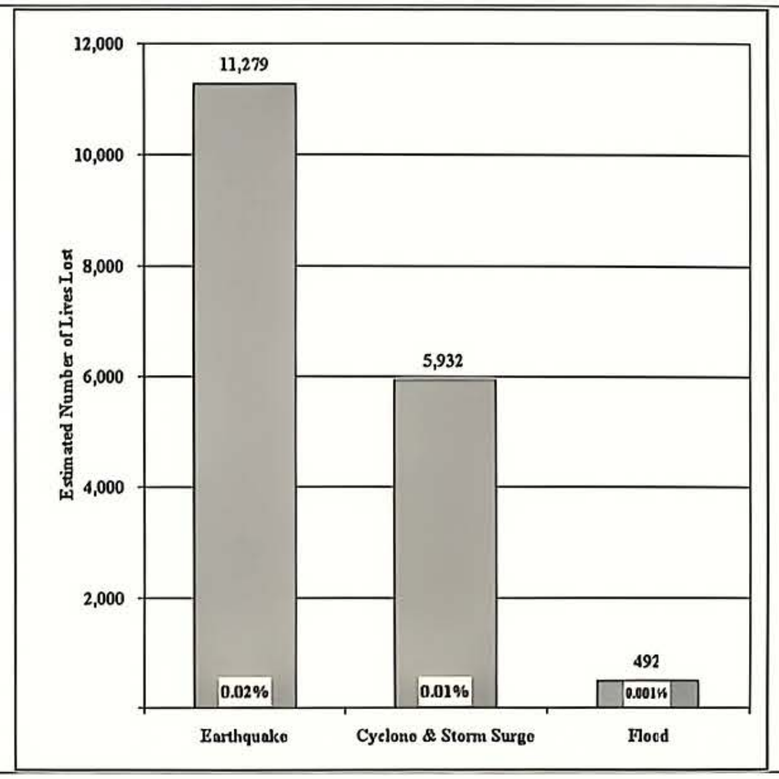


Population Density (Person/Sq. Km.)
- < 100
- > 100 to 200
- > 200 to 300
- > 300 to 500
- > 500 to 1000
- > 1000

LEGEND

Flood





Estimated Number of Lives Lost
- < 10
- > 10 to 50
- > 50 to 100
- > 100 to 500
- > 500 to 1000
- > 1000
- Limited potential for loss of life

These estimates are only indicative and based on specific hazard risk exceedance probabilities over a defined return period. They do not purport to correspond to a particular historical, future event or other hazards. Please see the detailed Technical paper for methods used to estimate the potential loss of life based on hazard intensity and historical data.

Sources: TARU Analysis, 2004; Jonkman et al., 2003; Nathwani et al., 1997; CRED, 2002; BMTPC, 2000; BISAG, GoG

0 100 km

N

Projection : Lambert Azimuthal Equal Area
Datum : WGS 84

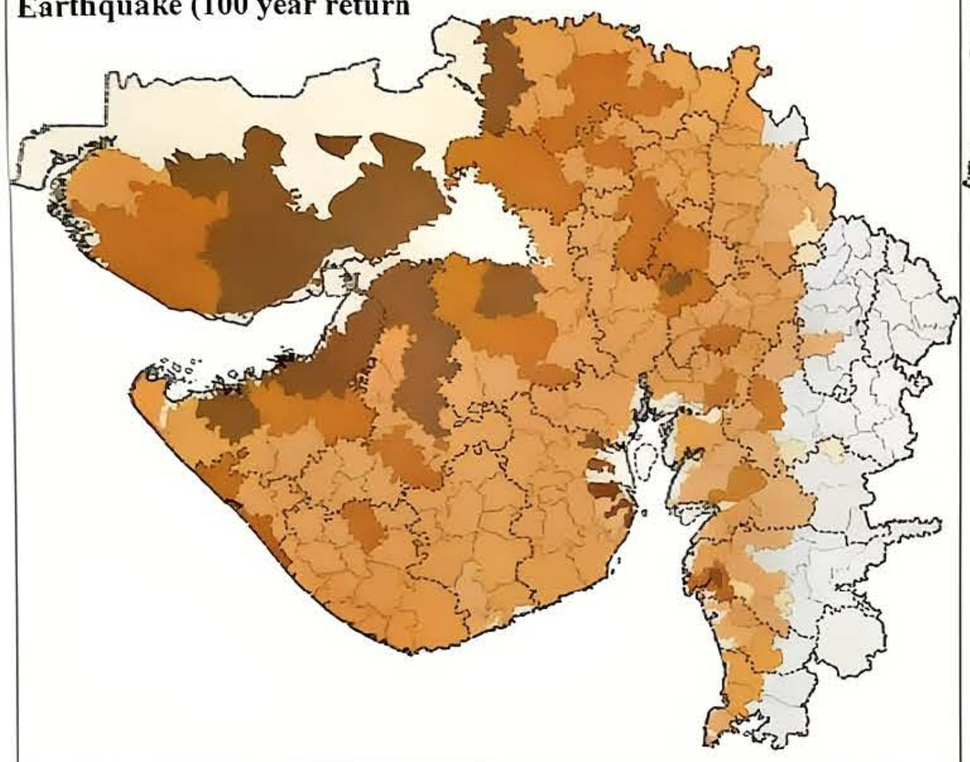
MAP No. : CLLM - 01 OF 06

Date : 18/6/2005

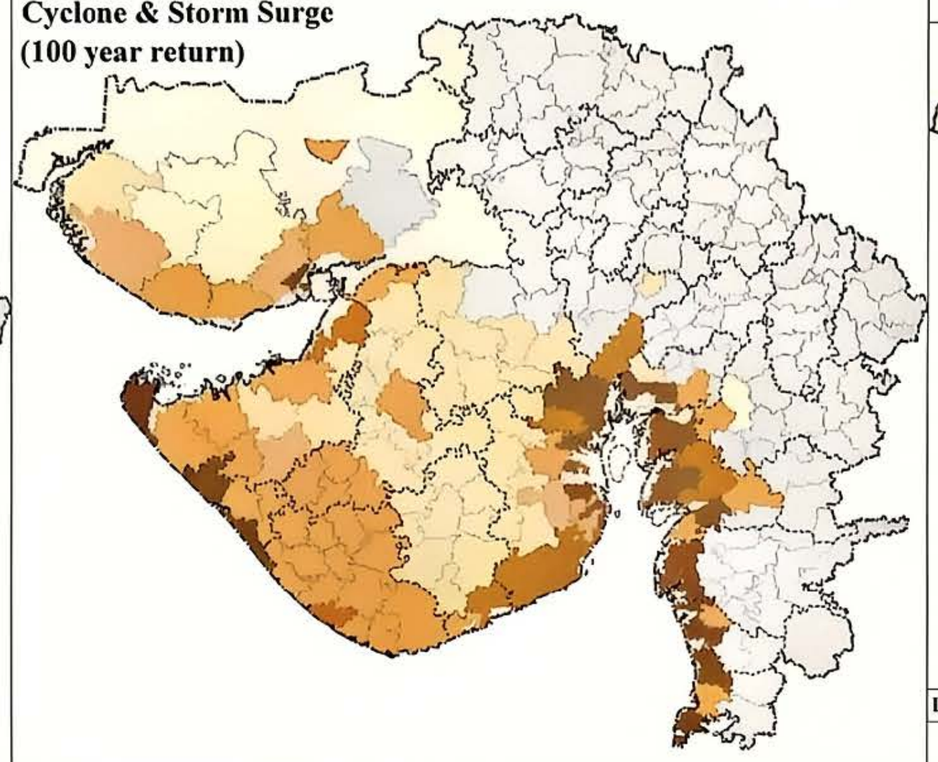
Gujarat Risk Zonation: Estimated Loss of Life due to Key Hazards
(Probabilistic 100 year return period estimates based on 2001 Taluka populations)

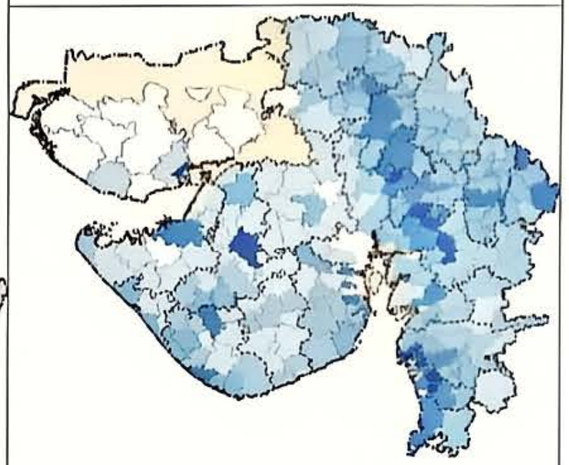
GSDMA

Earthquake (100 year return



Cyclone & Storm Surge (100 year return)



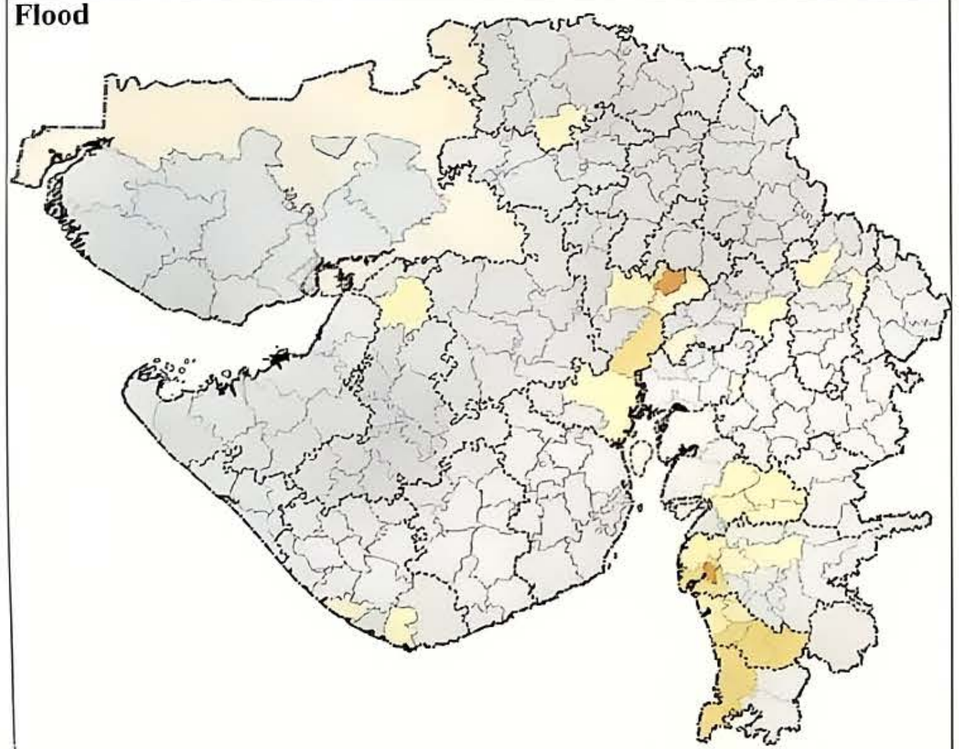


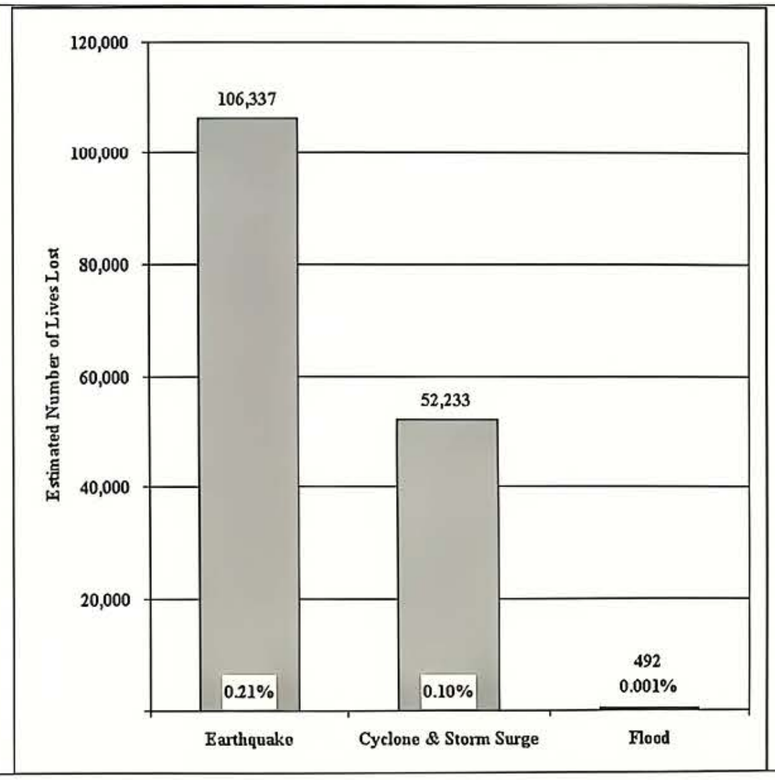
Population Density (Person/Sq. Km.)

- < 100
- > 100 to 200
- > 200 to 300
- > 300 to 500
- > 500 to 1000
- > 1000

LEGEND

Flood





Estimated Number of Lives Lost

- < 10
- > 10 to 50
- > 50 to 100
- > 100 to 500
- > 500 to 1000
- > 1000
- Limited potential for loss of life

These estimates are only indicative and based on specific hazard risk exceedance probabilities over a defined return period. They do not purport to correspond to a particular historical, future event or other hazards. Please see the detailed Technical paper for methods used to estimate the potential loss of life based on hazard intensity and historical data.

Sources: TARU Analysis, 2004, Jonkman et al , 2003; Nathwani et al., 1997, CRED, 2002; BMTPC, 2000; BISAG, GoG

0 100 km

N

Projection : Lambert Azimuthal Equal Area
Datum : WGS 84

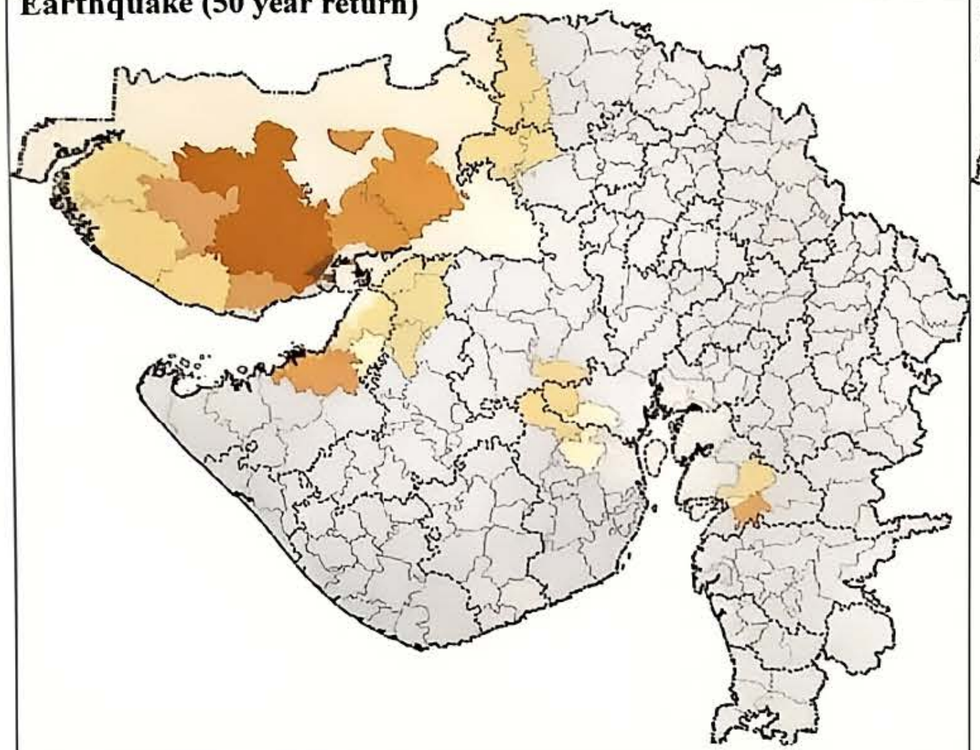
MAP No. : CLLM - 02 OF 06

Date : 18/6/2005

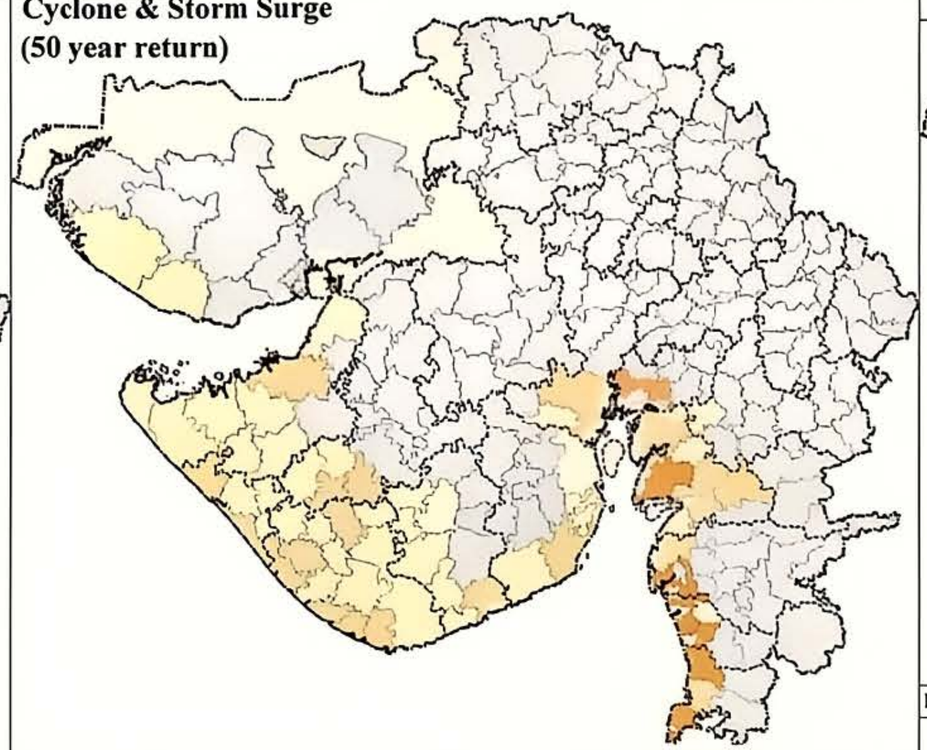
Gujarat Risk Zonation: Estimated Value of Loss of Life due to Key Hazards
(Probabilistic 50 year return period estimates based on 2001 Taluka populations and per capita SDP estimates)

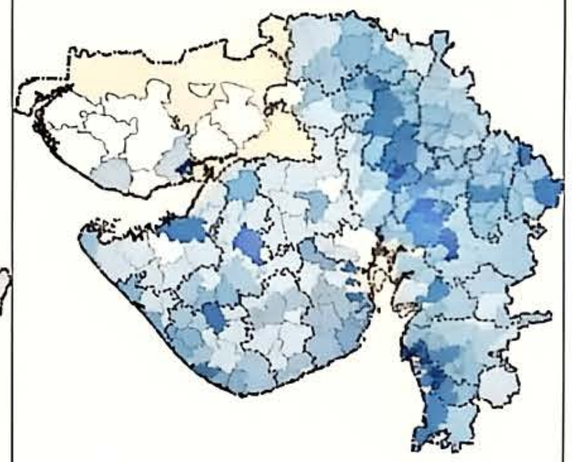
GSDMA

Earthquake (50 year return)



Cyclone & Storm Surge (50 year return)



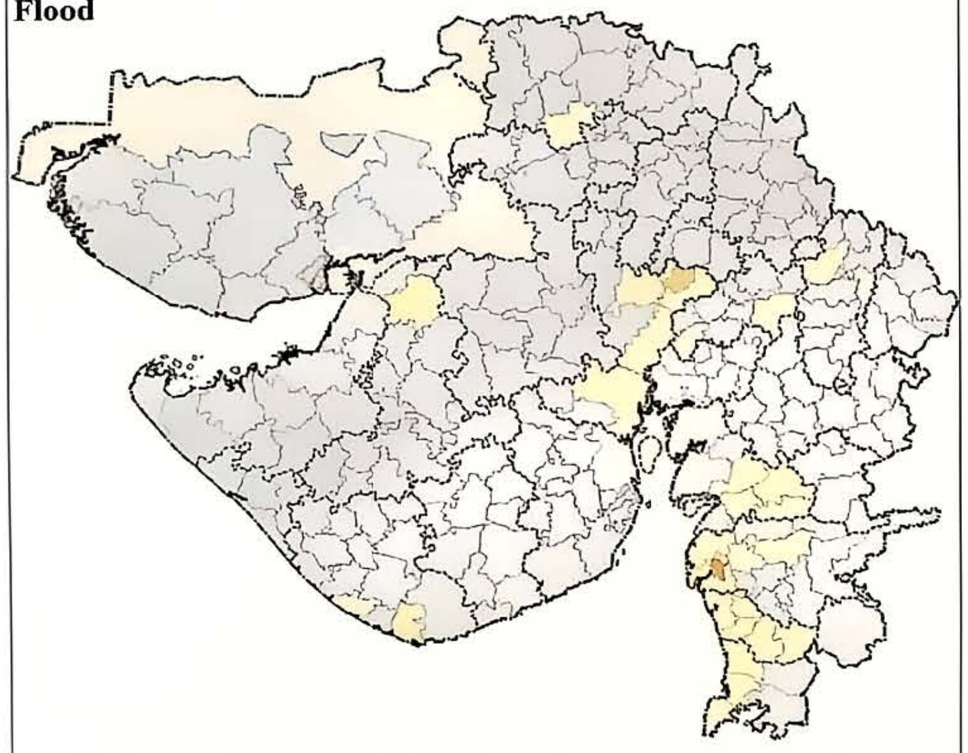


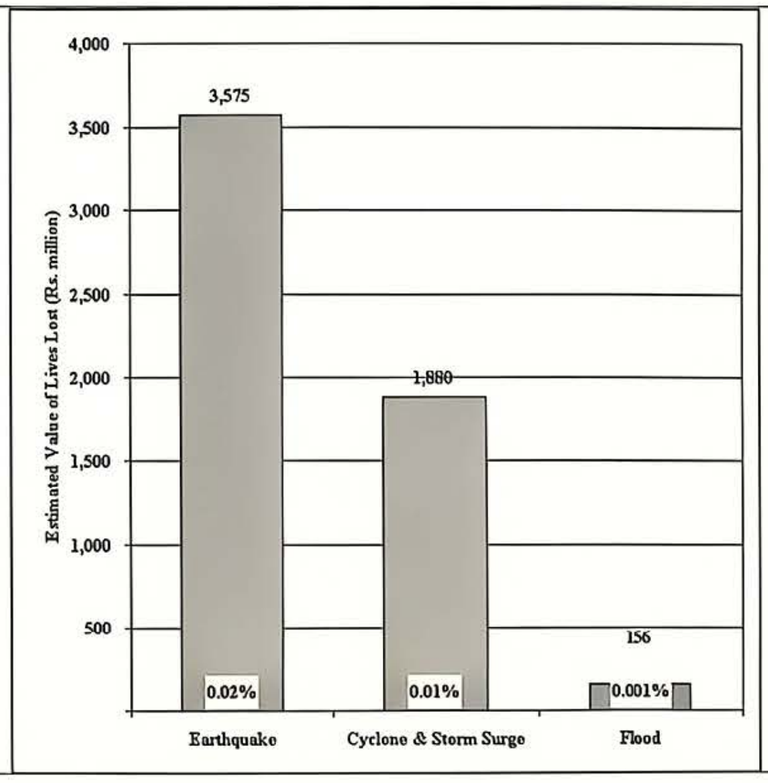
Population Density (Person/Sq. Km.)

- < 100
- > 100 to 200
- > 200 to 300
- > 300 to 500
- > 500 to 1000
- > 1000

LEGEND

Flood





Estimated Value of Loss of Life (Rs. Million)

- < 10
- > 10 to 50
- > 50 to 100
- > 100 to 500
- > 500 to 1000
- > 1000
- No loss of life

These estimates are only indicative and based on specific hazard risk exceedance probabilities over a defined return period. They do not purport to correspond to a particular historical, future event or other hazards. Please see the detailed Technical paper for methods used to estimate the potential loss of life based on hazard intensity and historical data.

Source: TARU Analysis, 2004; Jonkman et al., 2003; Nathwani et al., 1997; Gujarat SDP, 2000-2001, DSE, GoG; CRED, 2002; BMTPC 2000; BISAG.

0 100 km

N

Projection : Lambert Azimuthal Equal Area
Datum : WGS 84

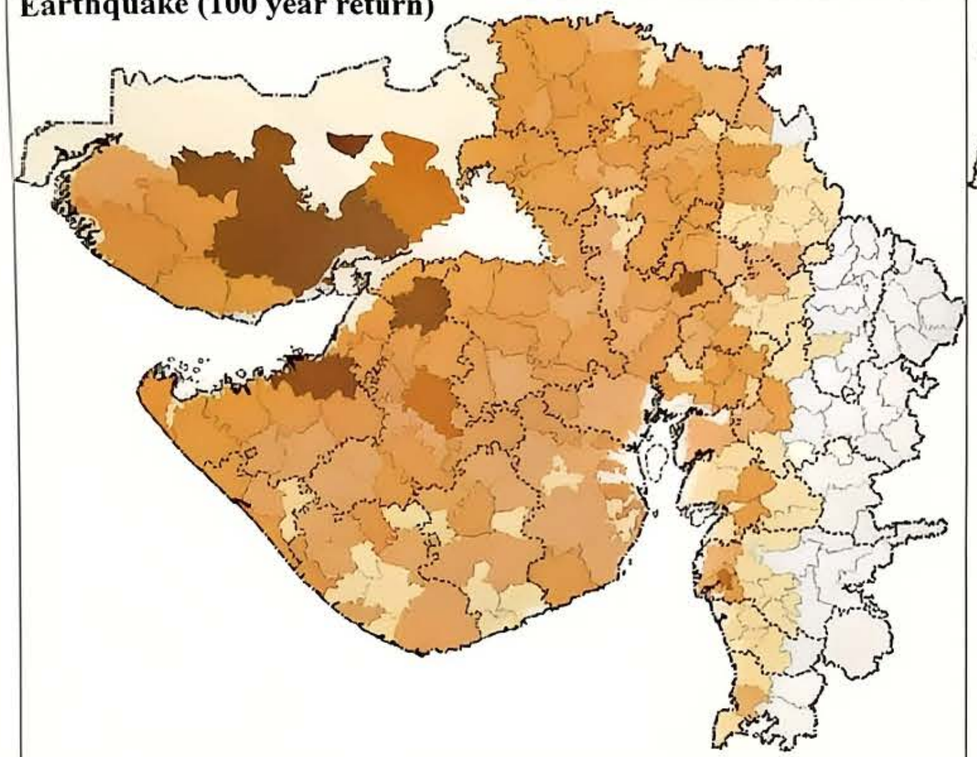
MAP No. : CLLM - 03 OF 06

Date : 18/6/2005

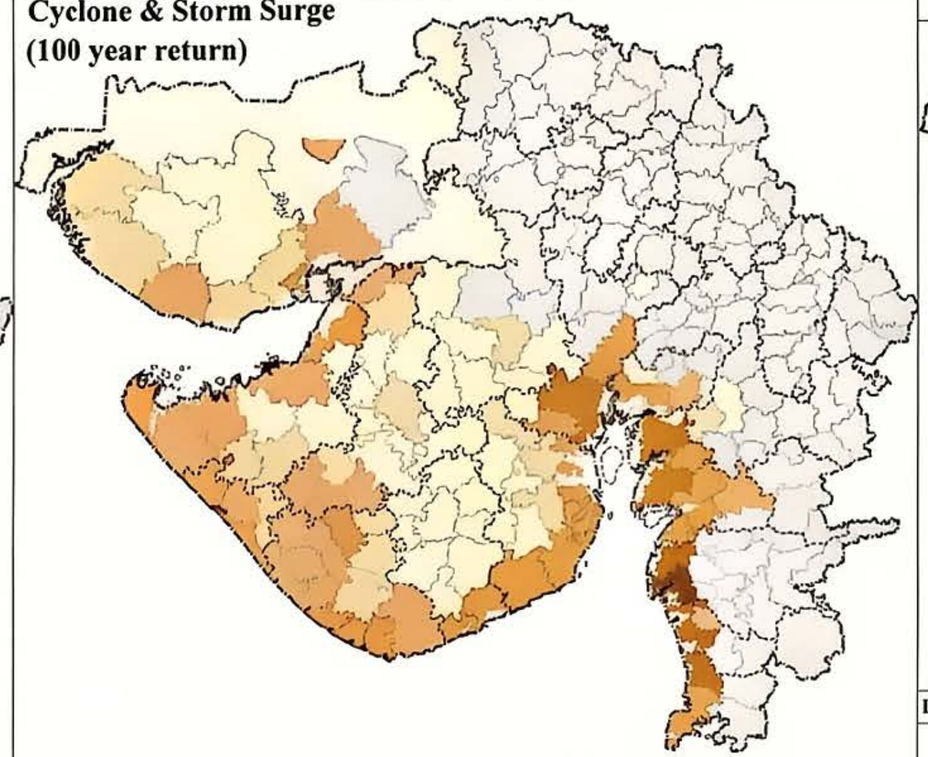
Gujarat Risk Zonation: Estimated Value of Loss of Life due to Key Hazards
(Probabilistic 100 year return period estimates based on 2001 Taluka populations and per capita SDP estimates)

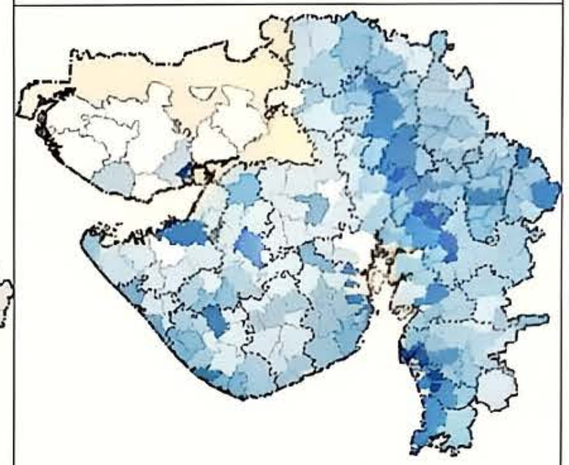
GSDMA

Earthquake (100 year return)



Cyclone & Storm Surge (100 year return)



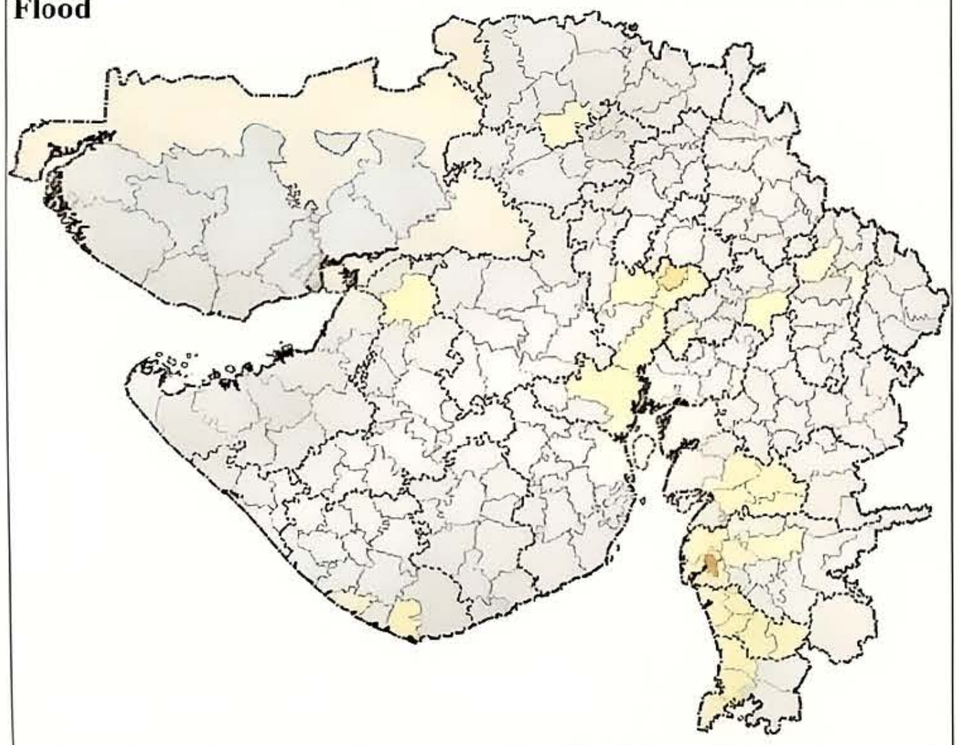


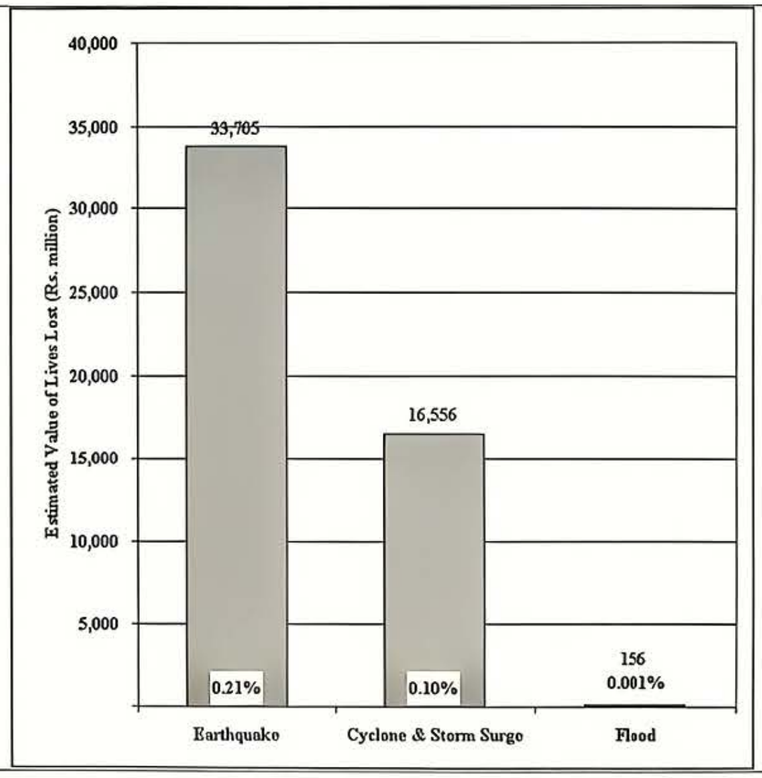
Population Density (Person/Sq. Km.)

- < 100
- > 100 to 200
- > 200 to 300
- > 300 to 500
- > 500 to 1000
- > 1000

LEGEND

Flood





Estimated Value of Loss of Life (Rs. Million)

- < 10
- > 10 to 50
- > 50 to 100
- > 100 to 500
- > 500 to 1000
- > 1000
- No loss of life

These estimates are only indicative and based on specific hazard risk exceedance probabilities over a defined return period. They do not purport to correspond to a particular historical, future event or other hazards. Please see the detailed Technical paper for methods used to estimate the potential loss of life based on hazard intensity and historical data.

Source: TARU Analysis, 2004; Jonkman et al., 2003, Nathwani et al., 1997; Gujarat SDP, 2000-2001, DSE, GoG; CRED, 2002, BMTPC, 2000, BISAG, GoG.

0 100 km

N

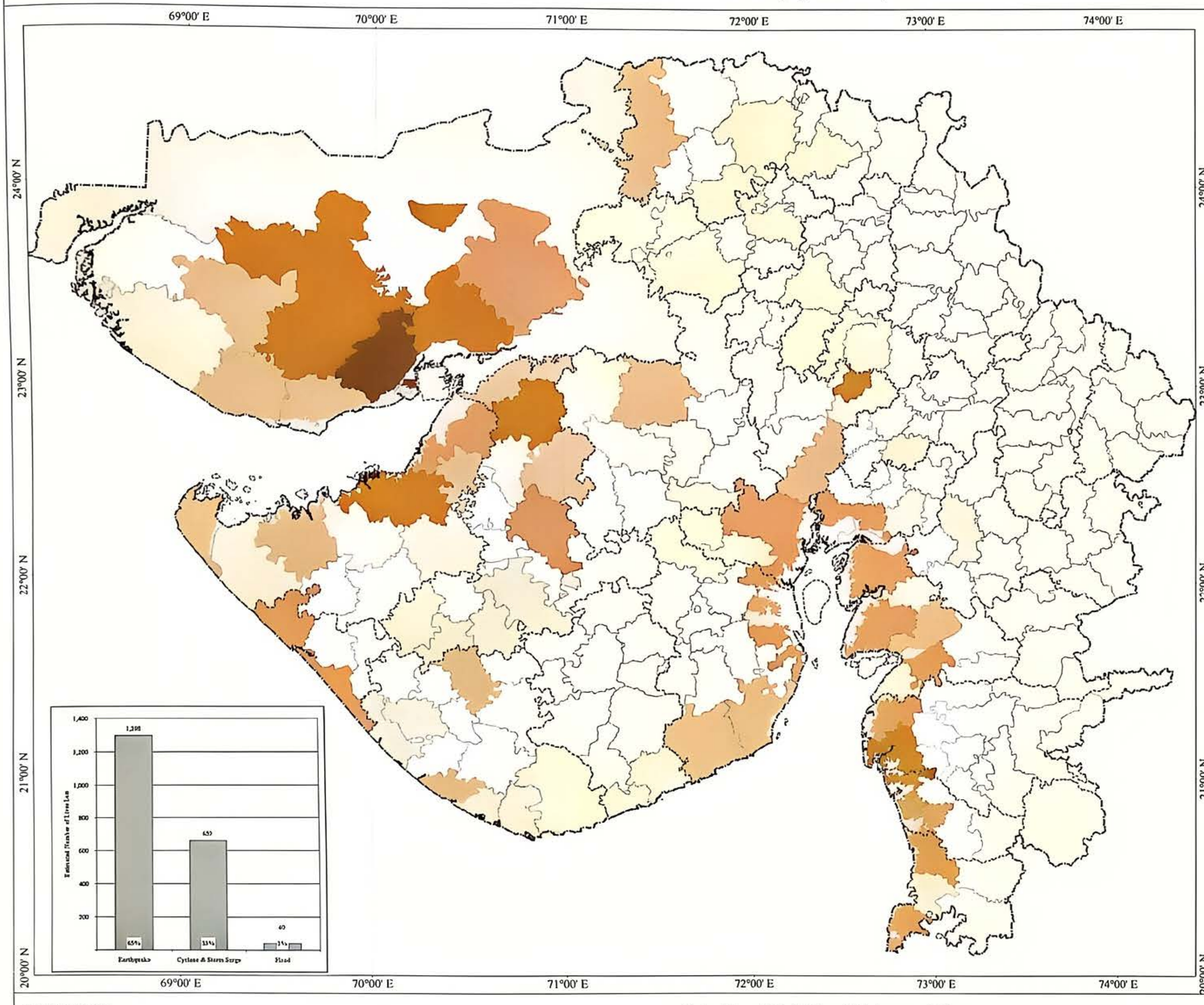
Projection : Lambert Azimuthal Equal Area
Datum : WGS 84

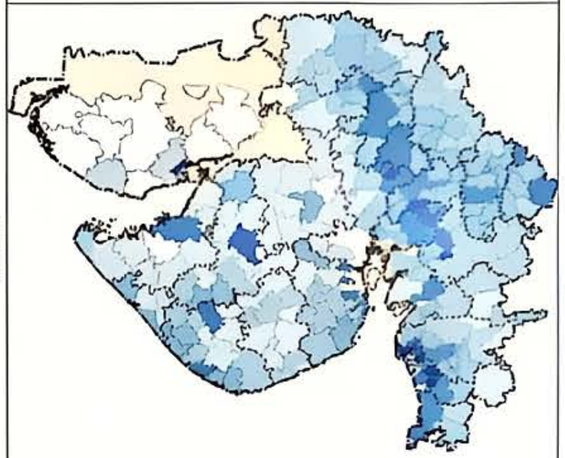
MAP No. : CLLM - 04 OF 06

Date : 18/6/2005

Gujarat Risk Zonation: Estimated Annualised Loss of Life due to Earthquake, Cyclone, Storm Surge & Flood Hazards
(Probabilistic estimates based on 2001 Taluka populations)

GSDMA





Population Density (Person/Sq. Km.)

< 100
> 100 to 200
> 200 to 300
> 300 to 500
> 500 to 1000
> 1000

LEGEND

Estimated Annualised Number of Lives Lost

< 5
> 5 to 10
> 10 to 20
> 20 to 50
> 50 to 100
> 100

These estimates are only indicative and based on specific hazard risk exceedance probabilities over a defined return period. They do not purport to correspond to a particular historical, future event or other hazards. Please see the detailed Technical paper for methods used to estimate the potential loss of life based on hazard intensity and historical data.

Sources: TARU Analysis, 2004; Jonkman et al., 2003; Nathwani et al., 1997; CRED, 2002, BMTPC, 2000; BISAG, GoG

0 100 km

N

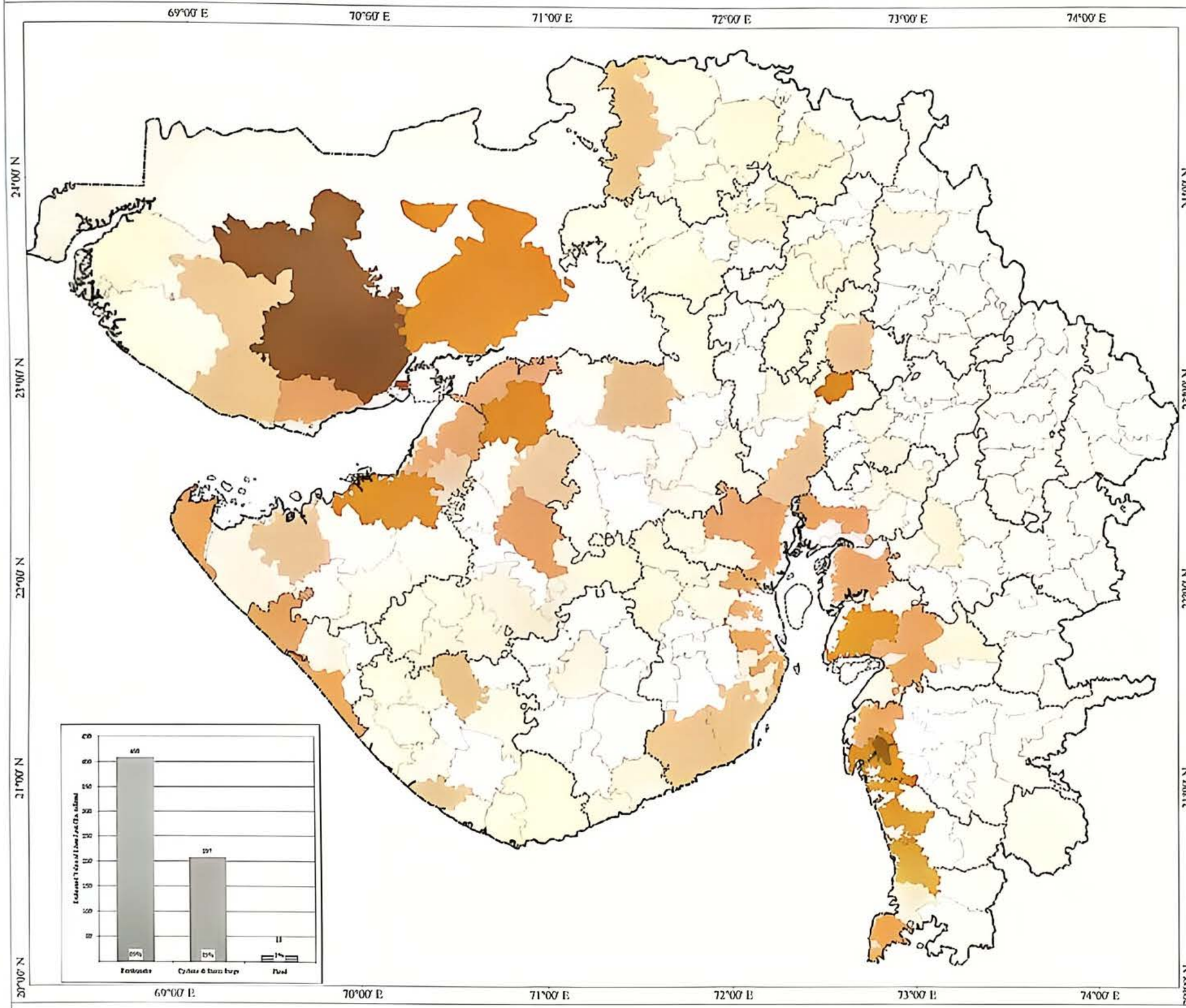
Projection : Lambert Azimuthal Equal Area
Datum : WGS 84

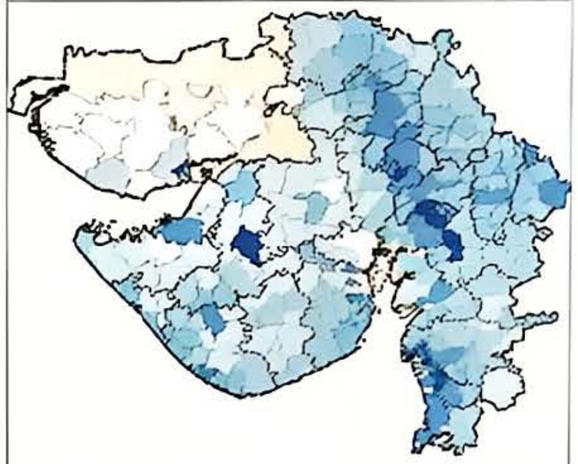
MAP No. : CLLM - 05 OF 06

Date : 24/6/2005

Gujarat Risk Zonation: Estimated Annualised Value of Loss of Life due to Earthquake, Cyclone, Storm Surge & Flood Hazards
(Probabilistic estimates based on 2001 Taluka populations and per capita SDP estimates)

GSDMA





LEGEND

Estimated Annualised Value of Loss of Life
(Rs. Million)
< 1
> 1 to 3
> 3 to 5
> 5 to 10
> 10 to 25
> 25
(Exponential class intervals)

These estimates are only indicative and based on specific hazard risk exceedance probabilities over a defined return period. They do not purport to correspond to a particular historical, future event or other hazards. Please see the detailed Technical paper for methods used to estimate the potential loss of life based on hazard intensity and historical data.

Source: TARU Analysis, 2004, Jonkman et al., 2003; Nathwani et al., 1997, Gujarat SDP, 2000-2001, DSE, GoG. CRED, 2002, BMTPC, 2000; BISAG, GoG.

0 100 km

N

Projection : Lambert Azimuthal Equal Area
Datum : WGS 84

MAP No. : CLLM - 06 OF 06

Date : 18/6/2005

GUJARAT RISK ZONATION: ESTIMATED LOSS OF LIFE DUE TO KEY HAZARDS
(PROBABILISTIC ESTIMATES BASED ON 2001 TALUKA POPULATIONS) Table No. CLLT - 01 of 03

GSDMA

Sr. No	District	Taluka	Earthquake		Cyclone & Surge		Flood (Annualised)	Population Density (Person/ Sqkm)
			50 year return	100 year return	50 year return	100 year return		
1	Ahmadabad	Ahmadabad City	-	7,174	-	20	51	19,846
2	Ahmadabad	Barwala	27	175	3	698	-	136
3	Ahmadabad	Bavla	-	230	-	-	-	178
4	Ahmadabad	Daskroi	-	781	-	-	8	671
5	Ahmadabad	Detroj-Rampura	-	132	-	-	-	229
6	Ahmadabad	Dhandhuka	-	229	118	2,112	3	97
7	Ahmadabad	Dholka	-	365	-	592	17	226
8	Ahmadabad	Mandal	-	171	-	-	-	136
9	Ahmadabad	Ranpur	70	434	-	18	-	165
10	Ahmadabad	Sanand	-	329	-	-	3	242
11	Ahmadabad	Viramgam	-	293	-	-	-	192
12	Amreli	Amreli	-	370	29	29	-	262
13	Amreli	Babra	-	209	-	17	-	154
14	Amreli	Bagasara	-	133	25	25	-	225
15	Amreli	Dhari	-	232	14	14	-	131
16	Amreli	Jafrabad	-	83	28	444	-	254
17	Amreli	Khambha	-	77	16	16	-	141
18	Amreli	Kunkavav Vadia	-	163	19	19	-	174
19	Amreli	Lathi	-	225	-	23	-	208
20	Amreli	Lilia	-	103	-	17	-	154
21	Amreli	Rajula	-	133	72	522	-	221
22	Amreli	Savar Kundla	-	210	-	22	-	196
23	Anand	Anand	-	470	-	-	-	1,195
24	Anand	Anklav	-	123	-	-	3	744
25	Anand	Borsad	-	591	-	270	-	808
26	Anand	Khambhat	-	444	176	1,400	-	332
27	Anand	Petlad	-	451	-	-	-	873
28	Anand	Sojitra	-	163	-	-	-	599
29	Anand	Tarapur	-	129	-	29	-	234
30	Anand	Umreth	-	149	-	-	-	690
31	Banas Kantha	Amirgadh	-	172	-	-	-	150
32	Banas Kantha	Bhabhar	39	254	-	-	-	220
33	Banas Kantha	Danta	-	159	-	-	-	190
34	Banas Kantha	Dantiwada	-	149	-	-	-	205
35	Banas Kantha	Deesa	-	779	-	-	-	312
36	Banas Kantha	Deodar	-	381	-	-	-	255
37	Banas Kantha	Dhanera	-	308	-	-	-	217
38	Banas Kantha	Kankrej	-	587	-	-	4	267
39	Banas Kantha	Palanpur	-	647	-	-	-	479
40	Banas Kantha	Tharad	-	430	-	-	-	186
41	Banas Kantha	Vadgam	-	350	-	-	-	352
42	Banas Kantha	Vav	77	1,102	-	-	-	109
43	Bharuch	Amod	-	85	19	812	-	216
44	Bharuch	Anklesvar	241	447	155	1,305	6	471
45	Bharuch	Bharuch	154	652	79	829	5	614
46	Bharuch	Hansot	-	63	20	474	-	232
47	Bharuch	Jambusar	-	162	60	1,903	-	216
48	Bharuch	Jhagadia	-	69	56	171	3	214
49	Bharuch	Vagra	-	76	429	2,949	-	111
50	Bharuch	Valia	-	52	-	-	5	258
51	Bhavnagar	Bhavnagar	-	1,127	28	1,419	-	712
52	Bhavnagar	Botad	91	388	-	34	-	304
53	Bhavnagar	Gadhada	-	299	-	22	-	198
54	Bhavnagar	Gariadhar	-	196	-	26	-	239
55	Bhavnagar	Ghogha	-	78	9	378	-	205
56	Bhavnagar	Mahuva	-	344	21	618	-	300
57	Bhavnagar	Palitana	-	182	-	30	-	271
58	Bhavnagar	Sihor	-	176	-	77	-	268
59	Bhavnagar	Talaja	-	247	41	906	-	312
60	Bhavnagar	Umrala	-	151	-	24	-	219
61	Bhavnagar	Vallabhipur	30	195	-	114	-	123
62	Dohad	Devgadbaria	-	-	-	-	-	359
63	Dohad	Dhanpur	-	-	-	-	-	258
64	Dohad	Dohad	-	-	-	-	-	603
65	Dohad	Fatepura	-	-	-	-	-	603
66	Dohad	Garbada	-	-	-	-	-	581
67	Dohad	Jhalod	-	-	-	-	-	489
68	Dohad	Limkheda	-	-	-	-	-	386
69	Gandhinagar	Dehgam	-	229	-	-	-	400
70	Gandhinagar	Gandhinagar	-	971	-	-	-	835
71	Gandhinagar	Kalol	-	527	-	-	-	640
72	Gandhinagar	Mansa	-	345	-	-	-	573
73	Jamnagar	Bhanvad	-	186	17	132	-	150
74	Jamnagar	Dhrol	30	1,177	-	15	-	133
75	Jamnagar	Jamjodhpur	-	200	12	93	-	106
76	Jamnagar	Jamnagar	305	4,340	68	227	-	575
77	Jamnagar	Jodiya	152	1,406	4	668	-	106
78	Jamnagar	Kalavad	-	776	-	12	-	109
79	Jamnagar	Kalyanpur	-	417	13	288	-	116
80	Jamnagar	Khambhalia	-	1,190	19	208	-	172
81	Jamnagar	Lalpur	-	579	10	17	-	95
82	Jamnagar	Okhamandal	-	375	22	1,171	-	203
83	Junagadh	Bhesan	-	125	19	148	-	169
84	Junagadh	Junagadh	-	647	62	494	-	563
85	Junagadh	Keshod	-	299	34	271	-	309
86	Junagadh	Kodinar	-	181	43	366	2	384
87	Junagadh	Malia	-	133	30	236	-	269
88	Junagadh	Manavadar	-	217	24	188	-	214
89	Junagadh	Mangrol	-	321	37	311	-	330
90	Junagadh	Mendarda	-	112	20	159	-	181
91	Junagadh	Patan-Veraval	-	257	86	684	8	779
92	Junagadh	Sutrapada	-	112	42	335	-	381
93	Junagadh	Talala	-	117	14	115	-	131
94	Junagadh	Una	-	303	24	207	-	214
95	Junagadh	Vanthali	-	165	28	219	-	249
96	Junagadh	Visavadar	-	226	16	131	-	149
97	Kachchh	Abdasa	89	556	5	69	-	42
98	Kachchh	Anjar	2,517	5,129	-	50	-	136
99	Kachchh	Bhachau	843	4,733	-	170	-	74
100	Kachchh	Bhuj	1,967	5,417	-	8	-	74
101	Kachchh	Gandhidham	3,165	6,450	-	1,035	-	1,046
102	Kachchh	Lakhpat	85	286	-	40	-	27
103	Kachchh	Mandvi	156	972	13	175	-	120
104	Kachchh	Mundra	216	1,303	-	134	-	94
105	Kachchh	Nakhatrana	220	737	-	7	-	66
106	Kachchh	Rapar	337	3,109	-	-	-	69
107	Kheda	Balasinor	-	52	-	-	-	430
108	Kheda	Kapadvanj	-	210	-	-	-	369
109	Kheda	Kathlal	-	73	-	-	-	522
110	Kheda	Kheda	-	201	-	-	-	409
111	Kheda	Mahudha	-	105	-	-	-	455
112	Kheda	Matar	-	250	-	-	2	381
113	Kheda	Mehmedabad	-	374	-	-		555
114	Kheda	Nadiad	-	831	-	-	-	1,206

GUJARAT RISK ZONATION: ESTIMATED LOSS OF LIFE DUE TO KEY HAZARDS
(PROBABILISTIC ESTIMATES BASED ON 2001 TALUKA POPULATIONS) Table No. CLLT - 01 of 03

GSDMA

Sr. No	District	Taluka	Earthquake		Cyclone & Surge		Flood (Annualised)	Population Density (Person/ Sqkm)
			50 year return	100 year return	50 year return	100 year return		
115	Kheda	Thasra	-	123	-	-	7	453
116	Kheda	Virpur	-	35	-	-	-	337
117	Mahesana	Becharaji	-	157	-	-	-	225
118	Mahesana	Kadi	-	505	-	-	-	351
119	Mahesana	Kheralu	-	195	-	-	-	350
120	Mahesana	Mahesana	-	784	-	-	-	542
121	Mahesana	Satlasana	-	70	-	-	-	244
122	Mahesana	Unjha	-	296	-	-	-	541
123	Mahesana	Vadnagar	-	222	-	-	-	418
124	Mahesana	Vijapur	-	406	-	-	-	426
125	Mahesana	Visnagar	-	430	-	-	-	526
126	Narmada	Dediapada	-	-	-	-	-	144
127	Narmada	Nandod	-	-	-	-	-	204
128	Narmada	Sagbara	-	-	-	-	-	230
129	Narmada	Tilakwada	-	22	-	-	-	233
130	Navsari	Bansda	-	-	-	-	20	334
131	Navsari	Chikhli	-	117	-	-	17	500
132	Navsari	Gandevi	-	96	599	2,678	18	1,084
133	Navsari	Jalalpore	-	88	1,042	2,910	3	516
134	Navsari	Navsari	-	110	14	206	6	1,111
135	Panch Mahals	Ghoghamba	-	-	-	-	-	362
136	Panch Mahals	Godhra			-	-	-	515
137	Panch Mahals	Halol	-	-	-	-	-	376
138	Panch Mahals	Jambughoda	-	-	-	-	-	272
139	Panch Mahals	Kadana		-	-	-	-	269
140	Panch Mahals	Kalol	-	77	-	-	-	479
141	Panch Mahals	Khanpur	-		-	-	-	271
142	Panch Mahals	Lunawada	-	-	-	-	3	370
143	Panch Mahals	Morwa (Hadaf)	-	-	-	-	2	473
144	Panch Mahals	Santrampur	-	-	-	-	-	392
145	Panch Mahals	Shehera	-	-	-	-	-	369
146	Patan	Chanasma	-	219	-	-	-	283
147	Patan	Harij	-	221	-	-	-	211
148	Patan	Patan	-	503	-	-	-	400
149	Patan	Radhanpur	48	685	-	-	-	200
150	Patan	Sami	-	939	-	-	-	109
151	Patan	Santalpur	100	624	-	-	-	84
152	Patan	Sidhpur	-	325	-	-	-	513
153	Patan	Vagdod	-	150	-	-	-	317
154	Porbandar	Kutiyana	-	141	16	130	-	141
155	Porbandar	Porbandar	-	596	34	1,402	-	308
156	Porbandar	Ranavav	-	176	20	251	-	182
157	Rajkot	Dhoraji	-	253	34	267	-	304
158	Rajkot	Gondal	-	691	-	24	-	221
159	Rajkot	Jamkandorna	-	197	15	117	-	133
160	Rajkot	Jasdan	-	447	-	22	-	195
161	Rajkot	Jetpur	-	387	37	293	-	334
162	Rajkot	Kotda Sangani	-	208	-	20	-	179
163	Rajkot	Lodhika	-	264	-	14	-	123
164	Rajkot	Maliya	76	1,310	-	205	-	111
165	Rajkot	Morvi	131	5,134	-	34	7	308
166	Rajkot	Paddhari	-	417	-	14	-	124
167	Rajkot	Rajkot	-	2,959	-	116	-	1,047
168	Rajkot	Tankara	34	482	-	14	-	129
169	Rajkot	Upleta	-	289	24	188	-	214
170	Rajkot	Wankaner	-	1,060	-	19	-	169

Sr. No	District	Taluka	Earthquake		Cyclone & Surge		Flood (Annualised)	Population Density (Person/ Sqkm)
			50 year return	100 year return	50 year return	100 year return		
171	Sabar Kantha	Bayad	-	171	-	-	-	313
172	Sabar Kantha	Bhiloda	-	83	-	-	-	249
173	Sabar Kantha	Dhansura	-	88	-	-	-	258
174	Sabar Kantha	Himatnagar	-	235	-	-	-	333
175	Sabar Kantha	Idar	-	401	-	-	-	282
176	Sabar Kantha	Khedbrahma	-	205	-	-	-	229
177	Sabar Kantha	Malpur	-	34	-	-	-	235
178	Sabar Kantha	Meghraj	-	57	-	-	-	269
179	Sabar Kantha	Modasa	-	77	-	-	-	305
180	Sabar Kantha	Prantij	-	134	-	-	-	368
181	Sabar Kantha	Talod	-	126	-	-	-	316
182	Sabar Kantha	Vadali	-	140	-	-	-	249
183	Sabar Kantha	Vijaynagar	-	-	-	-	-	159
184	Surat	Bardoli	-	84	-	-	-	550
185	Surat	Chorasi	-	536	943	5,128	19	1,236
186	Surat	Kamrej	-	69	-	-	5	449
187	Surat	Mahuva	-	57	-	-	-	398
188	Surat	Mandvi	-	-	-	-	3	255
189	Surat	Mangrol	-	69	-	-	-	299
190	Surat	Nizar	-	-	-	-	-	255
191	Surat	Olpad	-	170	72	2,407	6	409
192	Surat	Palsana	-	48	-	-	-	609
193	Surat	Songadh	-	-	-	-	-	218
194	Surat	Surat City	-	2,228	-	5,236	211	21,714
195	Surat	Uchchhal	-	-	-	-	-	137
196	Surat	Umarpada	-	-	-	-	-	166
197	Surat	Valod	-	35	-	-	-	430
198	Surat	Vyara	-	-	-	-	-	305
199	Surendranagar	Chotila	-	448	-	18	-	167
200	Surendranagar	Chuda	81	501	-	19	-	169
201	Surendranagar	Dasada	-	440	-	-	-	105
202	Surendranagar	Dhrangadhra	-	1,112	-	-	-	143
203	Surendranagar	Halvad	-	823	-	13	-	117
204	Surendranagar	Lakhtar	-	181	-	-	-	94
205	Surendranagar	Limbdi	-	411	-	21		145
206	Surendranagar	Muli	-	579	-	12	-	107
207	Surendranagar	Sayla	-	263	-	11	-	104
208	Surendranagar	Wadhwan	-	822	-	44		394
209	The Dangs	The Dangs	-	-	-	-	-	107
210	Vadodara	Chhota Udaipur	-	-	-	-	-	265
211	Vadodara	Dabhoi	-	-	-	-	-	290
212	Vadodara	Jetpur Pavi	-	-	-	-	-	279
213	Vadodara	Karjan	-	65	-	-	-	276
214	Vadodara	Kavant		-	-	-	-	285
215	Vadodara	Nasvadi	-	-	-	-	-	239
216	Vadodara	Padra	-	220	5	151	-	476
217	Vadodara	Sankheda	-	-	-	-	-	255
218	Vadodara	Savli	-	95	-	-	-	299
219	Vadodara	Sinor	-	28	-	-	-	242
220	Vadodara	Vadodara	-	683	-	3	-	2,566
221	Vadodara	Vaghodia	-	-	-	-	-	245
222	Valsad	Dharampur	-	-	-	-	-	249
223	Valsad	Kaprada	-	-	-	-		214
224	Valsad	Pardi	-	162	103	424	13	967
225	Valsad	Umbergaon	-	95	330	1,229	15	682
226	Valsad	Valsad	-	154	565	1,829	17	782

GUJARAT RISK ZONATION: ESTIMATED VALUE OF LOSS OF LIFE DUE TO KEY HAZARDS (PROBABILISTIC ESTIMATES BASED ON 2001 TALUKA POPULATIONS AND PER CAPITA SDP ESTIMATES) (Rs. MILLION) Table No. CLLT - 02 of 03

GSDMA

Sr. No	District	Taluka	Earthquake		Cyclone & Surge		Flood (Annualised)	Population Density (Person/ Sqkm)
			50 year return	100 year return	50 year return	100 year return		
1	Ahmadabad	Ahmadabad City	-	2,274.0	-	6.3	16.2	19,846
2	Ahmadabad	Barwala	8.5	55.5	0.9	221.3	-	136
3	Ahmadabad	Bavla	-	72.8	-	-	-	178
4	Ahmadabad	Daskroi	-	247.4	-	-	2.6	671
5	Ahmadabad	Detroj-Rampura	-	41.9	-	-	-	229
6	Ahmadabad	Dhandhuka	-	72.6	37.4	669.5	0.8	97
7	Ahmadabad	Dholka	-	115.8	-	187.6	5.4	226
8	Ahmadabad	Mandal	-	54.2	-	-	-	136
9	Ahmadabad	Ranpur	22.1	137.5	-	5.8	-	165
10	Ahmadabad	Sanand	-	104.2	-	-	0.9	242
11	Ahmadabad	Viramgam	-	92.9	-	-	-	192
12	Amreli	Amreli	-	117.2	9.2	9.2	-	262
13	Amreli	Babra	-	66.3	-	5.4	-	154
14	Amreli	Bagasara	-	42.2	7.9	7.9	-	225
15	Amreli	Dhari	-	73.4	4.6	4.6	-	131
16	Amreli	Jafrabad	-	26.3	8.9	140.7	-	254
17	Amreli	Khambha	-	24.5	4.9	4.9	-	141
18	Amreli	Kunkavav Vadia	-	51.7	6.1	6.1	-	174
19	Amreli	Lathi	-	71.2	-	7.3	-	208
20	Amreli	Lilia	-	32.7	-	5.4	-	154
21	Amreli	Rajula	-	42.3	22.9	165.5	-	221
22	Amreli	Savar Kundla	-	66.5	-	6.9	-	196
23	Anand	Anand	-	149.1	-	-	-	1,195
24	Anand	Anklav	-	39.1	-	-	0.9	744
25	Anand	Borsad	-	187.2	-	85.7	-	808
26	Anand	Khambhat	-	140.6	55.8	443.8	-	332
27	Anand	Petlad	-	143.0	-	-	-	873
28	Anand	Sojitra	-	51.8	-	-	-	599
29	Anand	Tarapur	-	40.9	-	9.3	-	234
30	Anand	Umreth	-	47.1	-	-	-	690
31	Banas Kantha	Amirgadh	-	54.5	-	-	-	150
32	Banas Kantha	Bhabhar	12.4	80.4	-	-	-	220
33	Banas Kantha	Danta	-	50.3	-	-	-	190
34	Banas Kantha	Dantiwada	-	47.1	-	-	-	205
35	Banas Kantha	Deesa	-	247.0	-	-	-	312
36	Banas Kantha	Deodar	-	120.6	-	-	-	255
37	Banas Kantha	Dhanera	-	97.6	-	-	-	217
38	Banas Kantha	Kankrej	-	186.0	-	-	1.3	267
39	Banas Kantha	Palanpur	-	205.1	-	-	-	479
40	Banas Kantha	Tharad	-	136.4	-	-	-	186
41	Banas Kantha	Vadgam	-	111.0	-	-	-	352
42	Banas Kantha	Vav	24.5	349.2	-	-	-	109
43	Bharuch	Amod	-	27.0	6.1	257.2	-	216
44	Bharuch	Ankleswar	76.3	141.6	49.3	413.7	1.9	471
45	Bharuch	Bharuch	48.7	206.8	25.2	262.8	1.5	614
46	Bharuch	Hansot	-	20.0	6.3	150.2	-	232
47	Bharuch	Jambusar	-	51.2	19.1	603.3	-	216
48	Bharuch	Jhagadia	-	21.9	17.9	54.1	0.9	214
49	Bharuch	Vagra	-	24.0	136.0	934.8	-	111
50	Bharuch	Valia	-	16.6	-	-	1.6	258
51	Bhavnagar	Bhavnagar	-	357.1	9.0	449.9	-	712
52	Bhavnagar	Botad	29.0	123.1	-	10.7	-	304
53	Bhavnagar	Gadhada	-	94.6	-	6.9	-	198
54	Bhavnagar	Gariadhar	-	62.2	-	8.4	-	239
55	Bhavnagar	Ghogha	-	24.8	2.9	119.9	-	205
56	Bhavnagar	Mahuva	-	109.0	6.6	195.9	-	300
57	Bhavnagar	Palitana	-	57.8	-	9.5	-	271
58	Bhavnagar	Sihor	-	55.9	-	24.4	-	268
59	Bhavnagar	Talaja	-	78.3	12.9	287.1	-	312
60	Bhavnagar	Umrala	-	48.0	-	7.7	-	219
61	Bhavnagar	Vallabhipur	9.5	61.7	-	36.2	-	123
62	Dohad	Devgadbaria	-	-	-	-	-	359
63	Dohad	Dhanpur	-	-	-	-	-	258
64	Dohad	Dohad	-	-	-	-	-	603
65	Dohad	Fatepura	-	-	-	-	-	603
66	Dohad	Garbada	-	-	-	-	-	581
67	Dohad	Jhalod	-	-	-	-	-	489
68	Dohad	Limkheda	-	-	-	-	-	386
69	Gandhinagar	Dehgam	-	72.6	-	-	-	400
70	Gandhinagar	Gandhinagar	-	307.8	-	-	-	835
71	Gandhinagar	Kalol	-	167.1	-	-	-	640
72	Gandhinagar	Mansa	-	109.3	-	-	-	573
73	Jamnagar	Bhanvad	-	59.0	5.2	41.7	-	150
74	Jamnagar	Dhrol	9.5	372.9	-	4.7	-	133
75	Jamnagar	Jamjodhpur	-	63.3	3.7	29.5	-	106
76	Jamnagar	Jamnagar	96.6	1,375.6	21.6	72.1	-	575
77	Jamnagar	Jodiya	48.3	445.8	1.1	211.9	-	106
78	Jamnagar	Kalavad	-	246.0	-	3.8	-	109
79	Jamnagar	Kalyanpur	-	132.3	4.1	91.4	-	116
80	Jamnagar	Khambhalia	-	377.1	6.0	65.9	-	172
81	Jamnagar	Lalpur	-	183.6	3.3	5.4	-	95
82	Jamnagar	Okhamandal	-	118.9	7.1	371.0	-	203
83	Junagadh	Bhesan	-	39.7	5.9	47.0	-	169
84	Junagadh	Junagadh	-	205.2	19.7	156.7	-	563
85	Junagadh	Keshod	-	94.9	10.8	86.0	-	309
86	Junagadh	Kodinar	-	57.5	13.5	116.2	0.7	384
87	Junagadh	Malia	-	42.1	9.4	74.8	-	269
88	Junagadh	Manavadar	-	68.7	7.5	59.5	-	214
89	Junagadh	Mangrol	-	101.9	11.6	98.5	-	330
90	Junagadh	Mendarda	-	35.6	6.4	50.5	-	181
91	Junagadh	Patan-Veraval	-	81.4	27.3	216.9	2.5	779
92	Junagadh	Sutrapada	-	35.5	13.4	106.1	-	381
93	Junagadh	Talala	-	37.1	4.6	36.4	-	131
94	Junagadh	Una	-	96.0	7.5	65.7	-	214
95	Junagadh	Vanthali	-	52.4	8.7	69.4	-	249
96	Junagadh	Visavadar	-	71.6	5.2	41.5	-	149
97	Kachchh	Abdasa	28.3	176.2	1.5	21.8	-	42
98	Kachchh	Anjar	797.7	1,625.8	-	16.0	-	136
99	Kachchh	Bhachau	267.2	1,500.1	-	53.8	-	74
100	Kachchh	Bhuj	623.3	1,716.9	-	2.6	-	74
101	Kachchh	Gandhidham	1,003.1	2,044.5	-	328.0	-	1,046
102	Kachchh	Lakhpat	27.0	90.6	-	12.6	-	27
103	Kachchh	Mandvi	49.5	308.2	4.2	55.3	-	120
104	Kachchh	Mundra	68.4	413.1	-	42.5	-	94
105	Kachchh	Nakhatrana	69.6	233.5	-	2.3	-	66
106	Kachchh	Rapar	106.7	985.3	-	-	-	69
107	Kheda	Balasinor	-	16.5	-	-	-	430
108	Kheda	Kapadvanj	-	66.6	-	-	-	369
109	Kheda	Kathlal	-	23.0	-	-	-	522
110	Kheda	Kheda	-	63.8	-	-	-	409
111	Kheda	Mahudha	-	33.3	-	-	-	455
112	Kheda	Matar	-	79.3	-	-	0.8	381
113	Kheda	Mehmedabad	-	118.5	-	-	-	555
114	Kheda	Nadiad	-	263.3	-			1,206

GUJARAT RISK ZONATION: ESTIMATED VALUE OF LOSS OF LIFE DUE TO KEY HAZARDS (PROBABILISTIC ESTIMATES BASED ON 2001 TALUKA POPULATIONS AND PER CAPITA SDP ESTIMATES) (Rs. MILLION) Table No. CLLT - 02 of 03

GSDMA

Sr. No	District	Taluka	Earthquake		Cyclone & Surge		Flood (Annualised)	Population Density (Person/ Sqkm)
			50 year return	100 year return	50 year return	100 year return		
115	Kheda	Thasra	-	38.9	-	-	2.2	453
116	Kheda	Virpur	-	11.1	-	-	-	337
117	Mahesana	Becharaji	-	49.6	-	-	-	225
118	Mahesana	Kadi	-	160.0	-	-	-	351
119	Mahesana	Kheralu	-	61.8	-	-	-	350
120	Mahesana	Mahesana	-	248.6	-	-	-	542
121	Mahesana	Satlasana	-	22.0	-	-	-	244
122	Mahesana	Unjha	-	93.9	-	-	-	541
123	Mahesana	Vadnagar	-	70.4	-	-	-	418
124	Mahesana	Vijapur	-	128.7	-	-	-	426
125	Mahesana	Visnagar	-	136.4	-	-	-	526
126	Narmada	Dediapada	-	-	-	-	-	144
127	Narmada	Nandod	-	-	-	-	-	204
128	Narmada	Sagbara	-	-	-	-	-	230
129	Narmada	Tilakwada	-	7.1	-	-	-	233
130	Navsari	Bansda	-	-	-	-	6.4	334
131	Navsari	Chikhli	-	37.2	-	-	5.3	500
132	Navsari	Gandevi	-	30.5	190.0	848.9	5.8	1,084
133	Navsari	Jalalpore	-	27.9	330.3	922.5	0.8	516
134	Navsari	Navsari	-	34.9	4.5	65.3	1.8	1,111
135	Panch Mahals	Ghoghamba	-	-	-	-	-	362
136	Panch Mahals	Godhra	-	-	-	-	-	515
137	Panch Mahals	Halol	-	-	-	-	-	376
138	Panch Mahals	Jambughoda	-	-	-	-	-	272
139	Panch Mahals	Kadana	-	-	-	-	-	269
140	Panch Mahals	Kalol	-	24.4	-	-	-	479
141	Panch Mahals	Khanpur	-	-	-	-	-	271
142	Panch Mahals	Lunawada	-	-	-	-	1.0	370
143	Panch Mahals	Morwa (Hadaf)	-	-	-	-	0.7	473
144	Panch Mahals	Santrampur	-	-	-	-	-	392
145	Panch Mahals	Shehera	-	-	-	-	-	369
146	Patan	Chanasma	-	69.3	-	-	-	283
147	Patan	Harij	-	69.9	-	-	-	211
148	Patan	Patan	-	159.3	-	-	-	400
149	Patan	Radhanpur	15.2	217.1	-	-	-	200
150	Patan	Sami	-	297.6	-	-	-	109
151	Patan	Santalpur	31.8	197.8	-	-	-	84
152	Patan	Sidhpur	-	102.9	-	-	-	513
153	Patan	Vagdod	-	47.6	-	-	-	317
154	Porbandar	Kutiyana	-	44.6	5.0	41.1	-	141
155	Porbandar	Porbandar	-	188.8	10.8	444.3	-	308
156	Porbandar	Ranavav	-	55.9	6.4	79.5	-	182
157	Rajkot	Dhoraji	-	80.3	10.7	84.6	-	304
158	Rajkot	Gondal	-	219.2	-	7.8	-	221
159	Rajkot	Jamkandorna	-	62.4	4.7	37.0	-	133
160	Rajkot	Jasdan	-	141.7	-	6.9	-	195
161	Rajkot	Jetpur	-	122.7	11.7	93.0	-	334
162	Rajkot	Kotda Sangani	-	65.8	-	6.3	-	179
163	Rajkot	Lodhika	-	83.6	-	4.3	-	123
164	Rajkot	Maliya	24.2	415.4	-	65.0	-	111
165	Rajkot	Morvi	41.5	1,627.3	-	10.8	2.3	308
166	Rajkot	Paddhari	-	132.1	-	4.4	-	124
167	Rajkot	Rajkot	-	937.8	-	36.7	-	1,047
168	Rajkot	Tankara	10.7	152.7	-	4.5	-	129
169	Rajkot	Upleta	-	91.8	7.5	59.7	-	214
170	Rajkot	Wankaner	-	336.1	-	5.9	-	169

Sr. No	District	Taluka	Earthquake		Cyclone & Surge		Flood (Annualised)	Population Density (Person/ Sqkm)
			50 year return	100 year return	50 year return	100 year return		
171	Sabar Kantha	Bayad	-	54.1	-	-	-	313
172	Sabar Kantha	Bhiloda	-	26.2	-	-	-	249
173	Sabar Kantha	Dhansura	-	28.0	-	-	-	258
174	Sabar Kantha	Himatnagar	-	74.5	-	-	-	333
175	Sabar Kantha	Idar	-	127.2	-	-	-	282
176	Sabar Kantha	Khedbrahma	-	64.9	-	-	-	229
177	Sabar Kantha	Malpur	-	10.9	-	-	-	235
178	Sabar Kantha	Meghraj	-	18.0	-	-	-	269
179	Sabar Kantha	Modasa	-	24.4	-	-	-	305
180	Sabar Kantha	Prantij	-	42.5	-	-	-	368
181	Sabar Kantha	Talod	-	40.1	-	-	-	316
182	Sabar Kantha	Vadali	-	44.3	-	-	-	249
183	Sabar Kantha	Vijaynagar	-	-	-	-	-	159
184	Surat	Bardoli	-	26.7	-	-	-	550
185	Surat	Chorasi	-	170.0	298.9	1,625.4	6.0	1,236
186	Surat	Kamrej	-	21.9	-	-	1.5	449
187	Surat	Mahuva	-	18.1	-	-	-	398
188	Surat	Mandvi	-	-	-	-	1.0	255
189	Surat	Mangrol	-	21.8	-	-	-	299
190	Surat	Nizar	-	-	-	-	-	255
191	Surat	Olpad	-	53.9	22.8	763.1	1.8	409
192	Surat	Palsana	-	15.1	-	-	-	609
193	Surat	Songadh	-	-	-	-	-	218
194	Surat	Surat City	-	706.0	-	1,659.6	67.0	21,714
195	Surat	Uchchhal	-	-	-	-	-	137
196	Surat	Umarpada	-	-	-	-	-	166
197	Surat	Valod	-	11.1	-	-	-	430
198	Surat	Vyara	-	-	-	-	-	305
199	Surendranagar	Chotila	-	142.1	-	5.9	-	167
200	Surendranagar	Chuda	25.5	158.9	-	5.9	-	169
201	Surendranagar	Dasada	-	139.4	-	-	-	105
202	Surendranagar	Dhrangadhra	-	352.5	-	-	-	143
203	Surendranagar	Halvad	-	260.7	-	4.1	-	117
204	Surendranagar	Lakhtar	-	57.3	-	-	-	94
205	Surendranagar	Limbdi	-	130.2	-	6.7	-	145
206	Surendranagar	Muli	-	183.5	-	3.8	-	107
207	Surendranagar	Sayla	-	83.4	-	3.6	-	104
208	Surendranagar	Wadhwan	-	260.4	-	13.8	-	394
209	The Dangs	The Dangs	-	-	-	-	-	107
210	Vadodara	Chhota Udaipur	-	-	-	-	-	265
211	Vadodara	Dabhoi	-	-	-	-	-	290
212	Vadodara	Jetpur Pavi	-	-	-	-	-	279
213	Vadodara	Karjan	-	20.6	-	-	-	276
214	Vadodara	Kavant	-	-	-	-	-	285
215	Vadodara	Nasvadi	-	-	-	-	-	239
216	Vadodara	Padra	-	69.7	1.7	47.8	-	476
217	Vadodara	Sankheda	-	-	-	-	-	255
218	Vadodara	Savli	-	30.2	-	-	-	299
219	Vadodara	Sinor	-	8.8	-	-	-	242
220	Vadodara	Vadodara	-	216.5	-	0.8	-	2,566
221	Vadodara	Vaghodia	-	-	-	-	-	245
222	Valsad	Dharampur	-	-	-	-	-	249
223	Valsad	Kaprada	-	-	-	-	-	214
224	Valsad	Pardi	-	51.5	32.5	134.5	4.2	967
225	Valsad	Umbergaon	-	30.0	104.7	389.6	4.9	682
226	Valsad	Valsad	-	48.9	179.0	579.8	5.4	782

GUJARAT RISK ZONATION: ESTIMATED ANNUALISED LOSS OF LIFE AND VALUE DUE TO ALL HAZARDS (PROBABILISTIC ESTIMATES BASED ON 2001 TALUKA POPULATIONS) Table No. CLLT - 03 of 03

GSDMA

Sr. No	District	Taluka	All Hazard (Nos.)	All Hazard (Rs. million)	Population Density (Person/ Sqkm)
1	Ahmadabad	Ahmadabad City	77	24.4	19,846
2	Ahmadabad	Barwala	9	3.0	136
3	Ahmadabad	Bavla	3	0.7	178
4	Ahmadabad	Daskroi	9	2.7	671
5	Ahmadabad	Detroj-Rampura	1	0.4	229
6	Ahmadabad	Dhandhuka	26	8.2	97
7	Ahmadabad	Dholka	11	3.6	226
8	Ahmadabad	Mandal	2	0.5	136
9	Ahmadabad	Ranpur	6	1.9	165
10	Ahmadabad	Sanand	4	1.1	242
11	Ahmadabad	Viramgam	3	0.9	192
12	Amreli	Amreli	5	1.4	262
13	Amreli	Babra	2	0.7	154
14	Amreli	Bagasara	2	0.7	225
15	Amreli	Dhari	3	0.9	131
16	Amreli	Jafrabad	6	1.8	254
17	Amreli	Khambha	1	0.4	141
18	Amreli	Kunkavav Vadia	2	0.7	174
19	Amreli	Lathi	2	0.8	208
20	Amreli	Lilia	1	0.4	154
21	Amreli	Rajula	8	2.5	221
22	Amreli	Savar Kundla	2	0.7	196
23	Anand	Anand	5	1.5	1,195
24	Anand	Anklav	2	0.5	744
25	Anand	Borsad	9	2.7	808
26	Anand	Khambhat	22	7.0	332
27	Anand	Petlad	5	1.4	873
28	Anand	Sojitra	2	0.5	599
29	Anand	Tarapur	2	0.5	234
30	Anand	Umreth	2	0.5	690
31	Banas Kantha	Amirgadh	2	0.5	150
32	Banas Kantha	Bhabhar	3	1.1	220
33	Banas Kantha	Danta	2	0.5	190
34	Banas Kantha	Dantiwada	2	0.5	205
35	Banas Kantha	Deesa	8	2.5	312
36	Banas Kantha	Deodar	4	1.2	255
37	Banas Kantha	Dhanera	3	1.0	217
38	Banas Kantha	Kankrej	6	2.0	267
39	Banas Kantha	Palanpur	6	2.1	479
40	Banas Kantha	Tharad	4	1.4	186
41	Banas Kantha	Vadgam	4	1.1	352
42	Banas Kantha	Vav	13	4.0	109
43	Bharuch	Amod	9	3.0	216
44	Bharuch	Anklesvar	26	8.2	471
45	Bharuch	Bharuch	20	6.3	614
46	Bharuch	Hansot	6	1.8	232
47	Bharuch	Jambusar	22	6.9	216
48	Bharuch	Jhagadia	4	1.2	214
49	Bharuch	Vagra	39	12.3	111
50	Bharuch	Valia	1	0.3	258
51	Bhavnagar	Bhavnagar	26	8.2	712
52	Bhavnagar	Botad	6	1.9	304
53	Bhavnagar	Gadhada	3	1.0	198
54	Bhavnagar	Gariadhar	2	0.7	239
55	Bhavnagar	Ghogha	5	1.5	205
56	Bhavnagar	Mahuva	10	3.2	300
57	Bhavnagar	Palitana	2	0.7	271
58	Bhavnagar	Sihor	3	0.8	268
59	Bhavnagar	Talaja	13	3.9	312
60	Bhavnagar	Umrala	2	0.6	219
61	Bhavnagar	Vallabhipur	4	1.2	123
62	Dohad	Devgadbaria	-	-	359
63	Dohad	Dhanpur	-	-	258
64	Dohad	Dohad	-	-	603
65	Dohad	Fatepura	-	-	603
66	Dohad	Garbada	-	-	581
67	Dohad	Jhalod	-	-	489
68	Dohad	Limkheda	-	-	386
69	Gandhinagar	Dehgam	2	0.7	400
70	Gandhinagar	Gandhinagar	10	3.1	835
71	Gandhinagar	Kalol	5	1.7	640
72	Gandhinagar	Mansa	3	1.1	573
73	Jamnagar	Bhanvad	4	1.1	150
74	Jamnagar	Dhrol	13	4.0	133
75	Jamnagar	Jamjodhpur	3	1.0	106
76	Jamnagar	Jamnagar	54	16.8	575
77	Jamnagar	Jodiya	24	7.6	106
78	Jamnagar	Kalavad	8	2.5	109
79	Jamnagar	Kalyanpur	8	2.3	116
80	Jamnagar	Khambhalia	14	4.6	172
81	Jamnagar	Lalpur	6	2.0	95
82	Jamnagar	Okhamandal	16	5.0	203
83	Junagadh	Bhesan	3	1.0	169
84	Junagadh	Junagadh	13	4.0	563
85	Junagadh	Keshod	6	2.0	309
86	Junagadh	Kodinar	7	2.1	384
87	Junagadh	Malia	4	1.4	269
88	Junagadh	Manavadar	5	1.4	214
89	Junagadh	Mangrol	7	2.2	330
90	Junagadh	Mendarda	3	1.0	181
91	Junagadh	Patan-Veraval	12	3.8	779
92	Junagadh	Sutrapada	5	1.7	381
93	Junagadh	Talala	3	0.8	131
94	Junagadh	Una	6	1.8	214
95	Junagadh	Vanthali	4	1.4	249
96	Junagadh	Visavadar	4	1.2	149
97	Kachchh	Abdasa	8	2.6	42
98	Kachchh	Anjar	102	32.4	136
99	Kachchh	Bhachau	66	20.9	74
100	Kachchh	Bhuj	94	29.7	74
101	Kachchh	Gandhidham	138	43.8	1,046
102	Kachchh	Lakhpat	5	1.6	27
103	Kachchh	Mandvi	15	4.7	120
104	Kachchh	Mundra	19	5.9	94
105	Kachchh	Nakhatrana	12	3.8	66
106	Kachchh	Rapar	38	12.0	69
107	Kheda	Balasinor	1	0.2	430
108	Kheda	Kapadvanj	2	0.7	369
109	Kheda	Kathlal	1	0.2	522
110	Kheda	Kheda	2	0.6	409
111	Kheda	Mahudha	1	0.3	455
112	Kheda	Matar	3	0.9	381
113	Kheda	Mehmedabad	4	1.2	555
114	Kheda	Nadiad	9	2.6	1,206

GUJARAT RISK ZONATION: ESTIMATED ANNUALISED LOSS OF LIFE AND VALUE DUE TO ALL HAZARDS
(PROBABILISTIC ESTIMATES BASED ON 2001 TALUKA POPULATIONS) Table No. CLLT - 03 of 03

GSDMA

Sr. No	District	Taluka	All Hazard (Nos.)	All Hazard (Rs. million)	Population Density (Person/ Sqkm)
115	Kheda	Thasra	2	0.6	453
116	Kheda	Virpur		0.1	337
117	Mahesana	Becharaji	2	0.5	225
118	Mahesana	Kadi	5	1.6	351
119	Mahesana	Kheralu	2	0.6	350
120	Mahesana	Mahesana	8	2.5	542
121	Mahesana	Satlasana	1	0.2	244
122	Mahesana	Unjha	3	0.9	541
123	Mahesana	Vadnagar	2	0.7	418
124	Mahesana	Vijapur	4	1.3	426
125	Mahesana	Visnagar	4	1.4	526
126	Narmada	Dediapada	-	-	144
127	Narmada	Nandod	-	-	204
128	Narmada	Sagbara	-	-	230
129	Narmada	Tilakwada	-	0.1	233
130	Navsari	Bansda	2	0.6	334
131	Navsari	Chikhli	3	0.9	500
132	Navsari	Gandevi	42	13.2	1,084
133	Navsari	Jalalpore	51	16.2	516
134	Navsari	Navsari	4	1.3	1,111
135	Panch Mahals	Ghoghamba	-	-	362
136	Panch Mahals	Godhra	-	-	515
137	Panch Mahals	Halol	-	-	376
138	Panch Mahals	Jambughoda	-	-	272
139	Panch Mahals	Kadana	-	-	269
140	Panch Mahals	Kalol	1	0.2	479
141	Panch Mahals	Khanpur	-	-	271
142	Panch Mahals	Lunawada	-	0.1	370
143	Panch Mahals	Morwa (Hadaf)		0.1	473
144	Panch Mahals	Santrampur	-	-	392
145	Panch Mahals	Shehera	-	-	369
146	Patan	Chanasma	2	0.7	283
147	Patan	Harij	2	0.7	211
148	Patan	Patan	5	1.6	400
149	Patan	Radhanpur	8	2.5	200
150	Patan	Sami	10	3.0	109
151	Patan	Santalpur	8	2.6	84
152	Patan	Sidhpur	3	1.0	513
153	Patan	Vagdod	2	0.5	317
154	Porbandar	Kutiyana	3	1.0	141
155	Porbandar	Porbandar	21	6.5	308
156	Porbandar	Ranavav	5	1.5	182
157	Rajkot	Dhoraji	6	1.9	304
158	Rajkot	Gondal	7	2.3	221
159	Rajkot	Jamkandorna	3	1.1	133
160	Rajkot	Jasdan	5	1.5	195
161	Rajkot	Jetpur	8	2.4	334
162	Rajkot	Kotda Sangani	2	0.7	179
163	Rajkot	Lodhika	3	0.9	123
164	Rajkot	Maliya	17	5.3	111
165	Rajkot	Morvi	55	17.4	308
166	Rajkot	Paddhari	4	1.4	124
167	Rajkot	Rajkot	32	9.7	1,047
168	Rajkot	Tankara	6	1.8	129
169	Rajkot	Upleta	6	1.7	214
170	Rajkot	Wankaner	11	3.4	169
171	Sabar Kantha	Bayad	2	0.5	313
172	Sabar Kantha	Bhiloda	1	0.3	249
173	Sabar Kantha	Dhansura	1	0.3	258
174	Sabar Kantha	Himatnagar	2	0.7	333
175	Sabar Kantha	Idar	4	1.3	282
176	Sabar Kantha	Khedbrahma	2	0.6	229
177	Sabar Kantha	Malpur	-	0.1	235
178	Sabar Kantha	Meghraj	1	0.2	269
179	Sabar Kantha	Modasa	1	0.2	305
180	Sabar Kantha	Prantij	1	0.4	368
181	Sabar Kantha	Talod	1	0.4	316
182	Sabar Kantha	Vadali	2	0.4	249
183	Sabar Kantha	Vijaynagar	-	-	159
184	Surat	Bardoli	1	0.3	550
185	Surat	Chorasi	77	24.5	1,236
186	Surat	Kamrej	1	0.4	449
187	Surat	Mahuva	1	0.2	398
188	Surat	Mandvi	-	0.1	255
189	Surat	Mangrol	1	0.2	299
190	Surat	Nizar	-	-	255
191	Surat	Olpad	28	8.8	409
192	Surat	Palsana	1	0.2	609
193	Surat	Songadh	-	-	218
194	Surat	Surat City	96	30.0	21,714
195	Surat	Uchchhal	-	-	137
196	Surat	Umarpada	-	-	166
197	Surat	Valod	-	0.1	430
198	Surat	Vyara	-	-	305
199	Surendranagar	Chotila	5	1.5	167
200	Surendranagar	Chuda	7	2.2	169
201	Surendranagar	Dasada	4	1.4	105
202	Surendranagar	Dhrangadhra	11	3.5	143
203	Surendranagar	Halvad	9	2.6	117
204	Surendranagar	Lakhtar	2	0.6	94
205	Surendranagar	Limbdi	4	1.4	145
206	Surendranagar	Muli	6	1.9	107
207	Surendranagar	Sayla	3	0.9	104
208	Surendranagar	Wadhwan	9	2.7	394
209	The Dangs	The Dangs		-	107
210	Vadodara	Chhota Udaipur	-	-	265
211	Vadodara	Dabhoi	-	-	290
212	Vadodara	Jetpur Pavi		-	279
213	Vadodara	Karjan	1	0.2	276
214	Vadodara	Kavant	-	-	285
215	Vadodara	Nasvadi	-	-	239
216	Vadodara	Padra	4	1.2	476
217	Vadodara	Sankheda		-	255
218	Vadodara	Savli	1	0.3	299
219	Vadodara	Sinor		0.1	242
220	Vadodara	Vadodara	9	2.2	2,566
221	Vadodara	Vaghodia		-	245
222	Valsad	Dharampur		-	249
223	Valsad	Kaprada	-	-	214
224	Valsad	Pardi	9	2.9	967
225	Valsad	Umbergaon	22	6.8	682
226	Valsad	Valsad	33	10.4	782

COMPOSITE RISK & VULNERABILITY

Composite risk assessment of a large region is a relatively new area of application in disaster management and mitigation practice (FEMA, 1999; UNECLAC, 2002). Most such public assessments have been undertaken for advanced economies (FEMA, 1999; 2000) and for urban areas in transition or developing economies (UNECLAC, 2002). Other risk assessment assignments have been undertaken in South Asia for single hazards like cyclones (World Bank, 1997) and earthquakes (Arya, 1992, TARU, 1998; Geohazards, 2000); or as a rapid overview of multiple states (RSMI, 2002). This is, therefore, the first exercise at this scale.

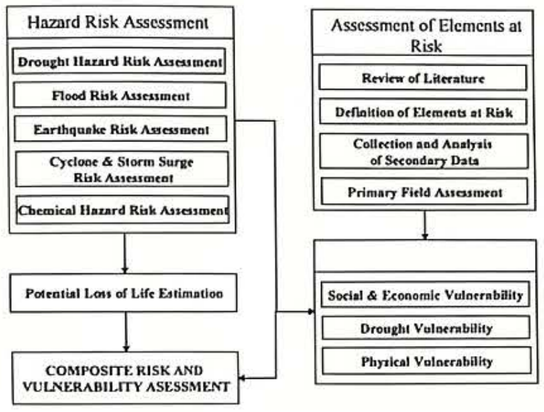
Composite Risk (CR) can be defined as the **expected total loss in a particular area due to the effect of expected hazard risks.**

Computation of composite risk is expressed mathematically as:

Composite Risk (CR) = $\sum$ Elements at Risk (E) x Specific Risk (Rs)

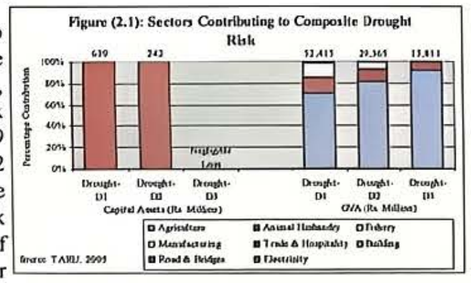
= $\sum$ Elements at Risk (E) x Hazard Risk (HR) x Vulnerability (V)

Composite risk assessment of key elements at risk was undertaken for earthquake, cyclone and storm surge, flood, and drought hazard. The estimation of capital risk was limited to 72 percent of the capital stock whereas GVA risk to 63 percent of the GSDP. The method used is presented below.



COMPOSITE DROUGHT RISK

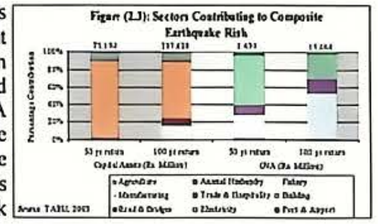
The main sectors contributing to Composite Drought Risk include agriculture, animal husbandry, manufacturing and trade. Capital risk due to drought was estimated at Rs. 639 million for extreme drought, Rs. 242 million for severe drought and negligible loss for moderate drought. The GVA risk was estimated at nearly two orders of magnitude larger, accounting for Rs.52,415 million in case of extreme drought, Rs.29,365 million in case of severe drought and Rs. 5,811 million in case of moderate drought.



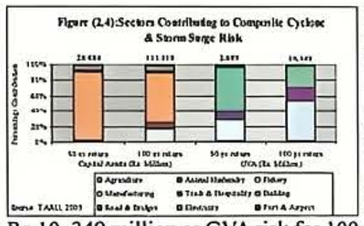
COMPOSITE EARTHQUAKE RISK

The main sectors contributing to composite earthquake risk include animal husbandry, manufacturing, trade and hospitality, building construction, roads and bridges, electricity and ports and airports. The composite probabilistic risk assessment for earthquakes suggests Rs. 73,130 million as the capital risk and Rs.1,630 million as GVA risk for 50-year return period earthquake, and Rs.237,628 million as the capital risk and Rs.15,066 million as GVA risk for 100-year return period event.

The composite earthquake risk to capital assets is largely on account of damage to buildings, plant and machinery with a significant impact on building construction sector, manufacturing and trade and hospitality sectors. The composite GVA risk also includes the moderate component the revenue losses due to business interruption in the manufacturing sector apart from a moderate loss of revenue in the power sector due to network dislocation.



COMPOSITE CYCLONE AND STORM SURGE RISK

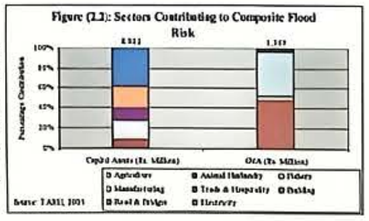


The main sectors contributing to composite cyclone and storm surge risk includes animal husbandry, fisheries, manufacturing, trade and hospitality, building construction, electricity, and ports and airports. The composite probabilistic cyclone and storm surge risk assessment suggests Rs. 28,648 million as the capital risk and Rs2,689 million as GVA risk for 50-year return period event, and Rs. 11,818 million as capital risk and Rs.10, 349 million as GVA risk for 100-year return period cyclone and storm surge.

Similar to earthquakes, the composite capital risk to cyclone and storm surge is largely due to damage to building and plant and machinery in the manufacturing sector, apart from physical damage to power transmission and distribution networks.

COMPOSITE FLOOD RISK

The main sectors contributing to composite flood risk include animal husbandry, inland fisheries, manufacturing, trade and hospitality, building construction, and roads and bridges. The probability composite risk assessment for flood in the state suggests Rs. 8,012 million as capital risk and Rs.1,349 million as GVA risk.



ALL HAZARDS COMPOSITE RISK

The Composite Capital risk of earthquake 100-year return period earthquakes is estimated at Rs. 237,628 million followed by 100-year return period cyclone and surge at Rs.111, 818 million. The Composite Capital risk is lowest for drought. The GVA risk is highest for Extreme drought at Rs 52,415 million followed by Severe Drought, Moderate drought, 100-year earthquake and 100-year cyclone and surge events.

Table (2.1): Composite Risk (Rs. Million - 2001 Prices)

Hazard	Capital Risk	GVA Risk
Extreme Drought (D1)	639	52,415
Severe Drought (D2)	242	29,365
Moderate Drought (D3)	-	15,811
Flood	8,012	1,349
Earthquake-50 yrs return period	73,130	1,630
Earthquake-100 yrs return period	237,628	15,066
Cyclone & Surge -50 yrs return period	28,684	2,689
Cyclone & Surge -100 yrs return period	111,818	10,349

Source: TARU Analysis, 2005

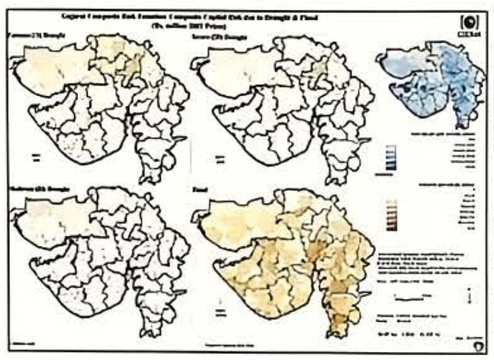
ALL HAZARD COMPOSITE VULNERABILITY

The composite capital vulnerability is highest for 100-year return earthquake (7.2 percent) followed by cyclone and surge (3.4 percent) and 50-year return earthquake (2.2 percent). The composite GVA vulnerability is, however, highest for extreme drought (9 percent), followed by severe drought (5 percent) and moderate drought (2.7 percent). 100-year earthquake and cyclone and surge are estimated at 2.6 percent and 1.8 percent of composite GVA vulnerability.

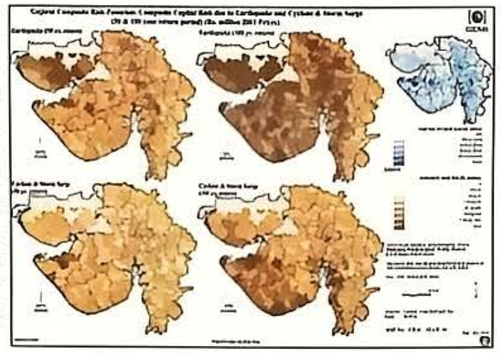
Table (2.3): Composite Vulnerability (Rs. Million - 2001 Prices)

Hazard	Capital Vulnerability	GVA Vulnerability
Extreme Drought (D1)	0.02%	9.05%
Severe Drought (D2)	0.01%	5.07%
Moderate Drought (D3)	0.00%	2.73%
Flood	0.34%	0.23%
Earthquake-50 yrs return period	2.23%	0.28%
Earthquake-100 yrs return period	7.23%	2.60%
Cyclone & Surge -50 yrs return period	0.87%	0.46%
Cyclone & Surge -100 yrs return period	3.46%	1.79%

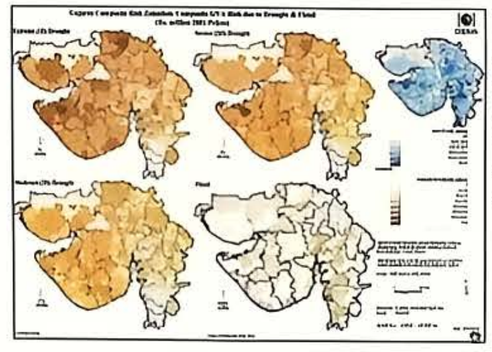
Source: TARU Analysis, 2005



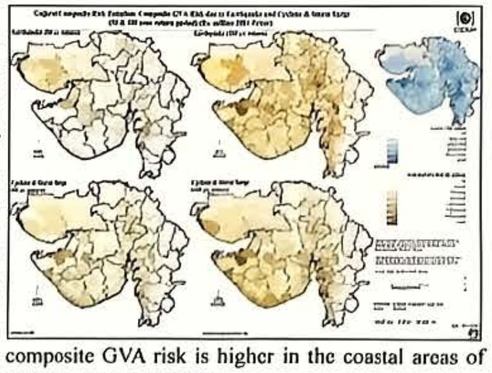
The extreme and severe drought zonation suggests talukas of Mahesana, Banaskantha, Kachchh and Patan are among the most vulnerable in Gujarat. Flood vulnerability is highest in south Gujarat, Ahmedabad, Bhavnagar, parts of Saurashtra and Kachchh, and the talukas of Banaskantha and Patan along the river Banas.



The 50-year and 100-year return period maps for earthquake suggests moderate to high vulnerability of talukas across most of Gujarat with an emphasis on Kachchh, though the eastern tribal talukas are relatively less vulnerable. The 50-year and 100-year return cyclone and surge also suggests relatively higher vulnerability along the coastal Gujarat especially Saurashtra.



The extreme, severe and moderate drought zonation suggests risk to talukas across most of Gujarat except in high rainfall areas in south Gujarat. Flood risk is relatively high in the talukas of southern Gujarat.

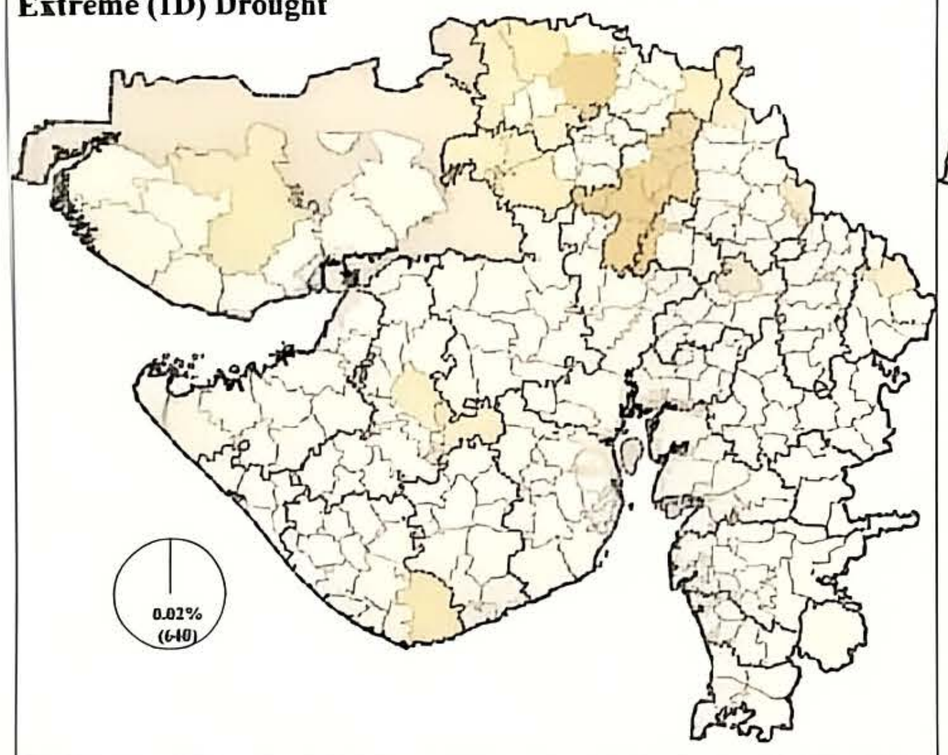


The 50-year return period maps for earthquake suggest that Kachchh district is the most vulnerable, along with the neighbouring talukas of Jamnagar, Rajkot and Banaskantha and the cities of Ahmedabad, Bharuch and Surat. The 100-year return period earthquake map shows an increased vulnerability across most of Gujarat except most eastern talukas. The 50-year and 100-year return period cyclone and surge zonation suggests that composite GVA risk is higher in the coastal areas of Gujarat apart from most talukas of Saurashtra and Kachchh.

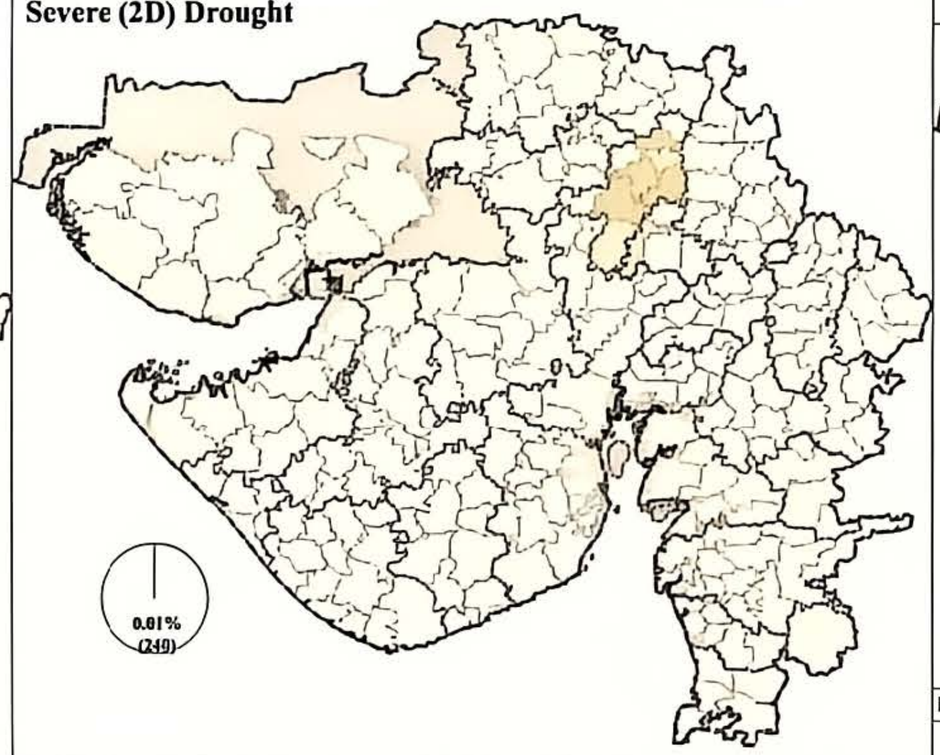
Gujarat Composite Risk Zonation: Composite Capital Risk due to Drought & Flood
(Rs. Million 2001 prices)

GSDMA

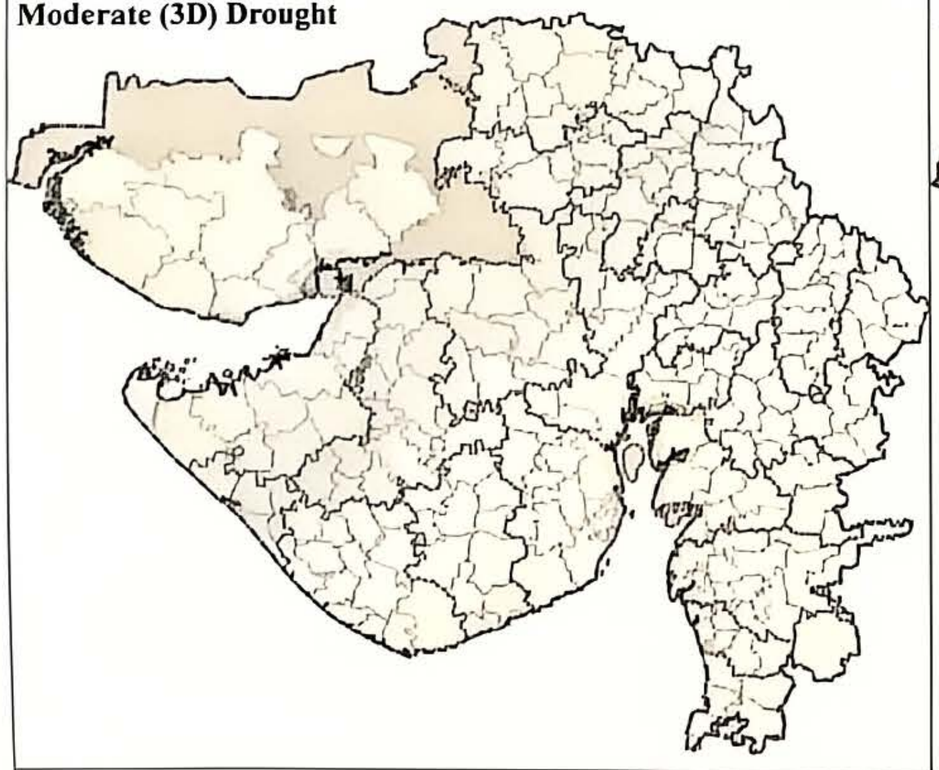
Extreme (1D) Drought



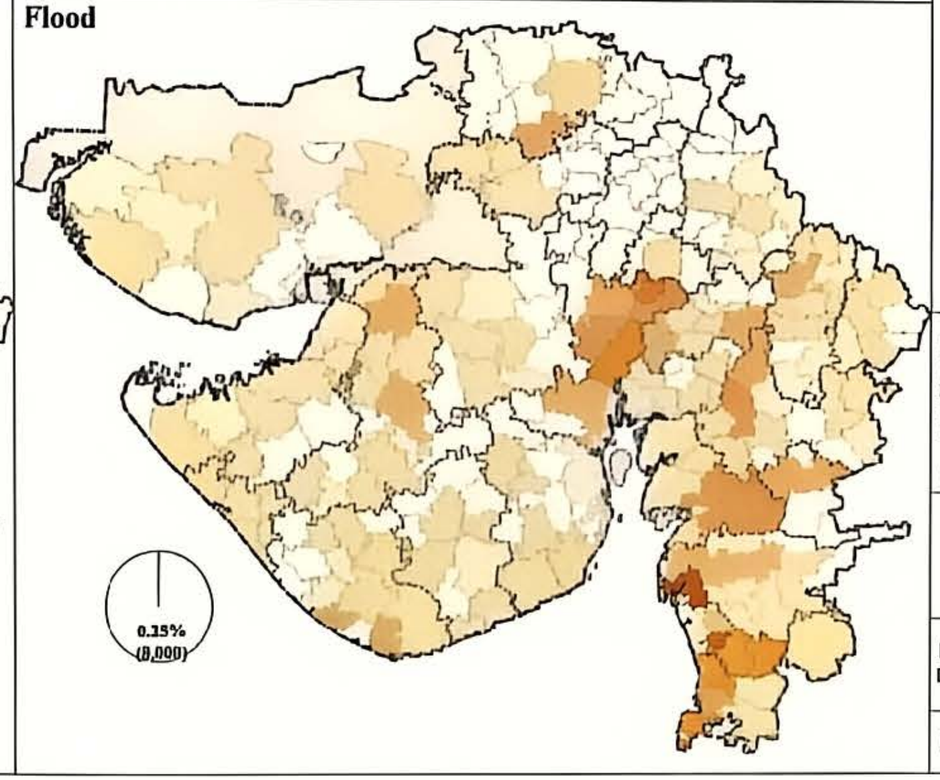
Severe (2D) Drought

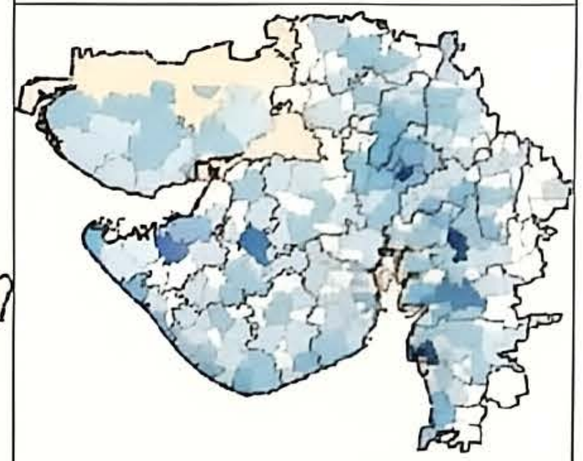


Moderate (3D) Drought



Flood





Total Value of Capital Assets (Rs. Million)
- < 5000
- > 5000 to 10000
- > 10000 to 20000
- > 20000 to 50000
- > 50000 to 100000
- > 100000

LEGEND

Estimated Capital Risk (Rs. Million)
- < 5
- > 5 to 10
- > 10 to 50
- > 50 to 100
- > 100 to 200
- > 200 to 500
- > 500 to 1000
- > 1000

Sectors covered Agriculture, Animal Husbandry, Fisheries, Manufacturing,Trade & Hospitality, Building, Electricity, Roads & Bridges, Ports & Airports
Main map pie charts show the proportion of loss to total capital assets
Figure in parenthesis denotes absolute value in Rs million.

Source: TARU Analysis, 2006, BISAG, GoG.

0 100 km

N

Projection : Lambert Azimuthal Equal Area
Datum : WGS 84

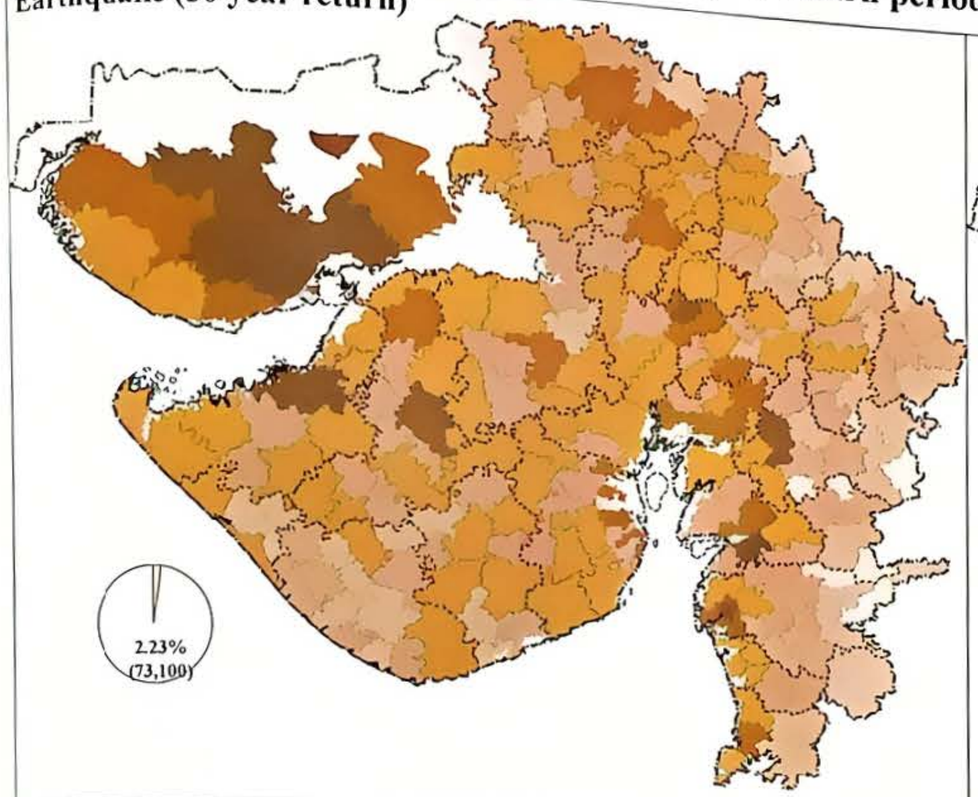
MAP No. : COMM - 01 OF 08

Date : 18/6/2009

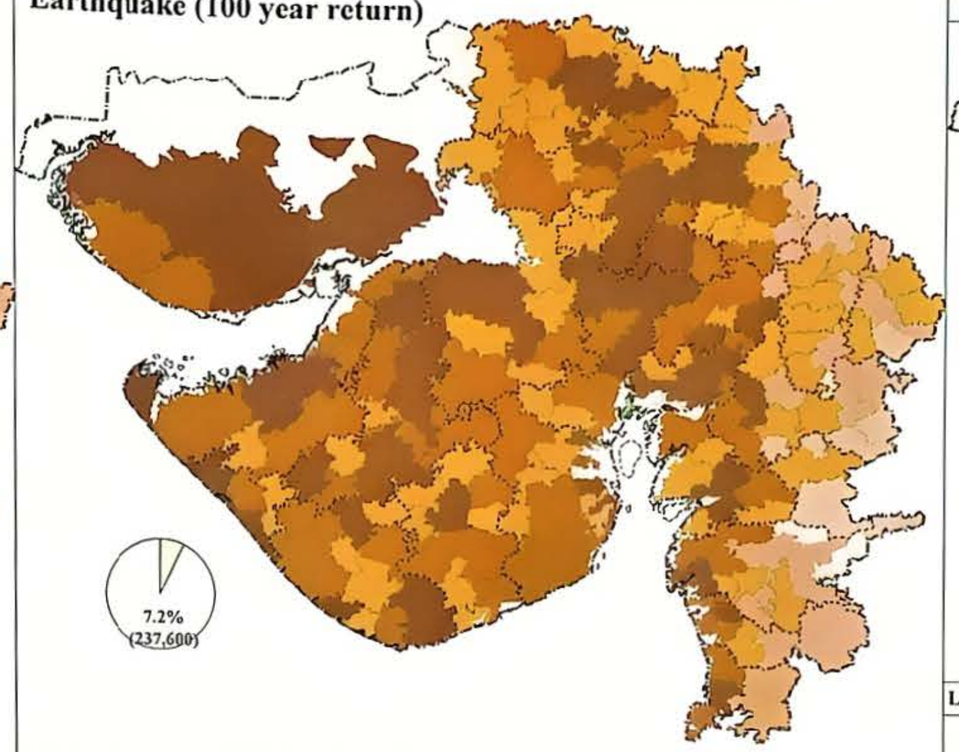
Gujarat Composite Risk Zonation: Composite Capital Risk due to Earthquake and Cyclone & Storm Surge (50 & 100 year return period) (Rs. Million 2001 prices)

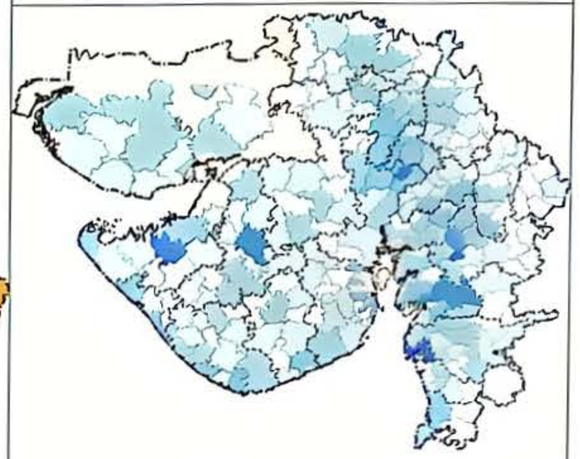
GSDMA

Earthquake (50 year return)



Earthquake (100 year return)

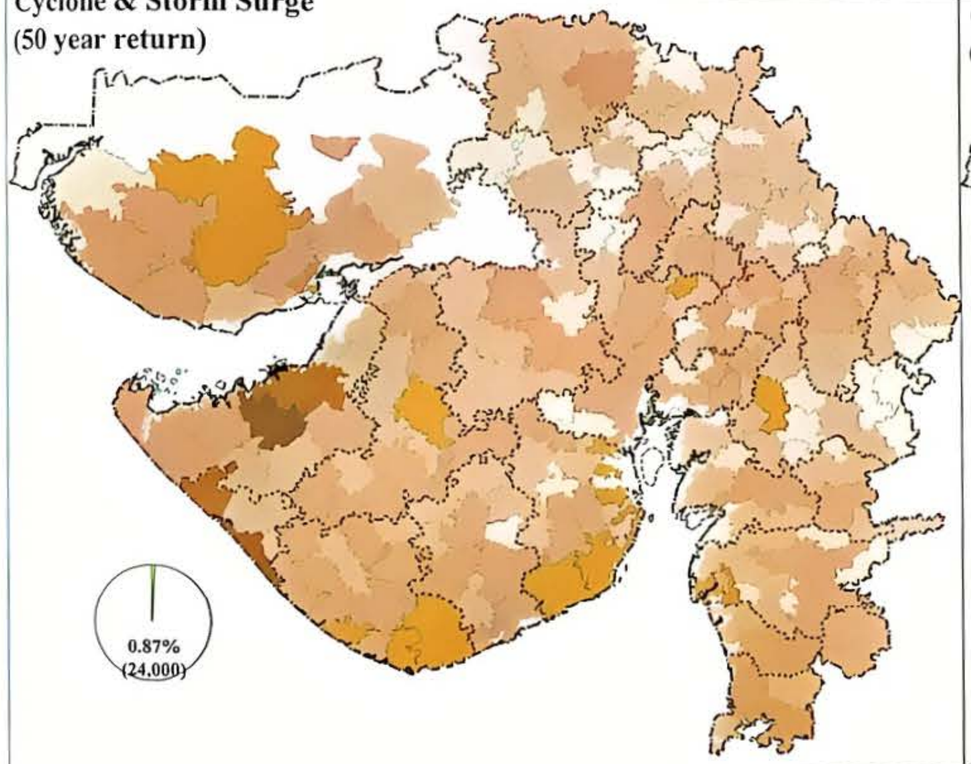




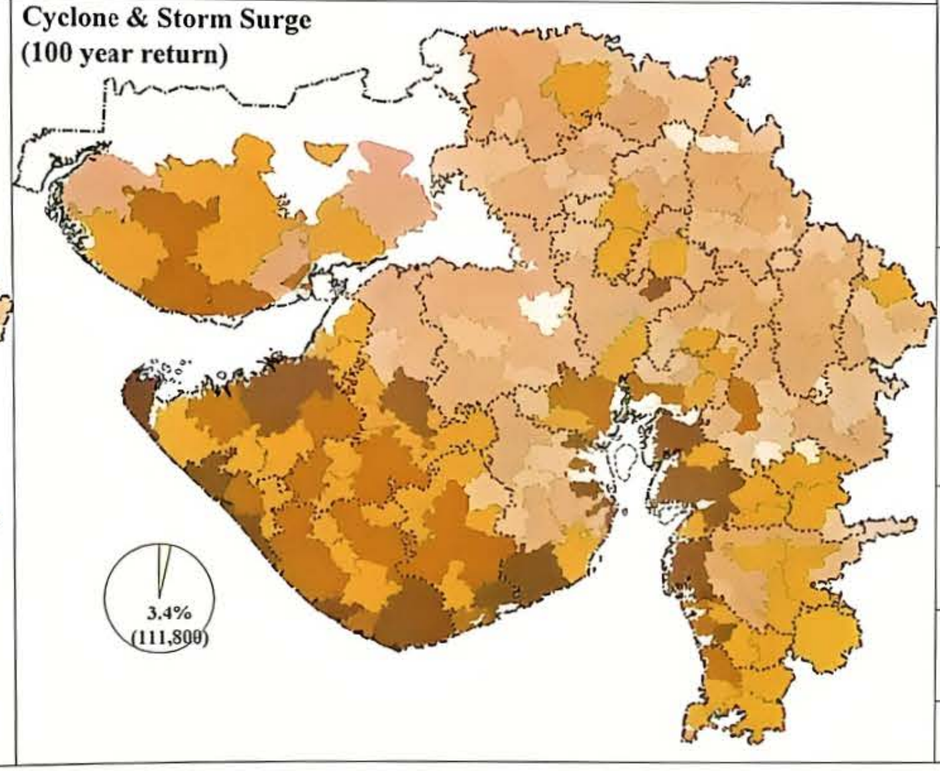
Total Value of Capital Assets (Rs. Million)
- < 5000
- > 5000 to 10000
- > 10000 to 20000
- > 20000 to 50000
- > 50000 to 100000
- > 100000

LEGEND

Cyclone & Storm Surge
(50 year return)



Cyclone & Storm Surge
(100 year return)



Estimated Capital Risk (Rs. Million)
- < 5
- > 5 to 10
- > 10 to 50
- > 50 to 100
- > 100 to 200
- > 200 to 500
- > 500 to 1000
- > 1000

Sectors covered. Agriculture, Animal Husbandary, Fisheries, Manufacturing,Trade & Hospitality, Building, Electricity, Roads & Bridges, Ports & Airports.

Main map pie charts show the proportion of loss to total capital assets. Figure in parantheses denotes absolute value in Rs. million.

Source: TARU Analysis, 2004; BISAG, GoG

0 100 km

N

Projection : Lambert Azimuthal Equal Area
Datum : WGS 84

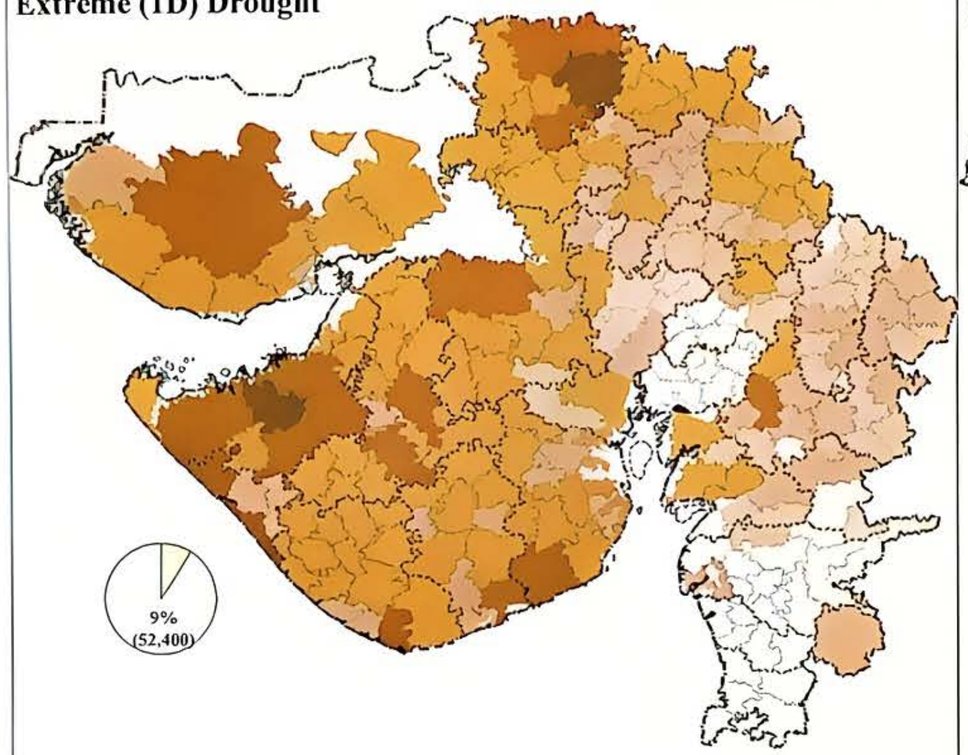
MAP No. : COMM - 02 OF 08

Date : 18/6/2005

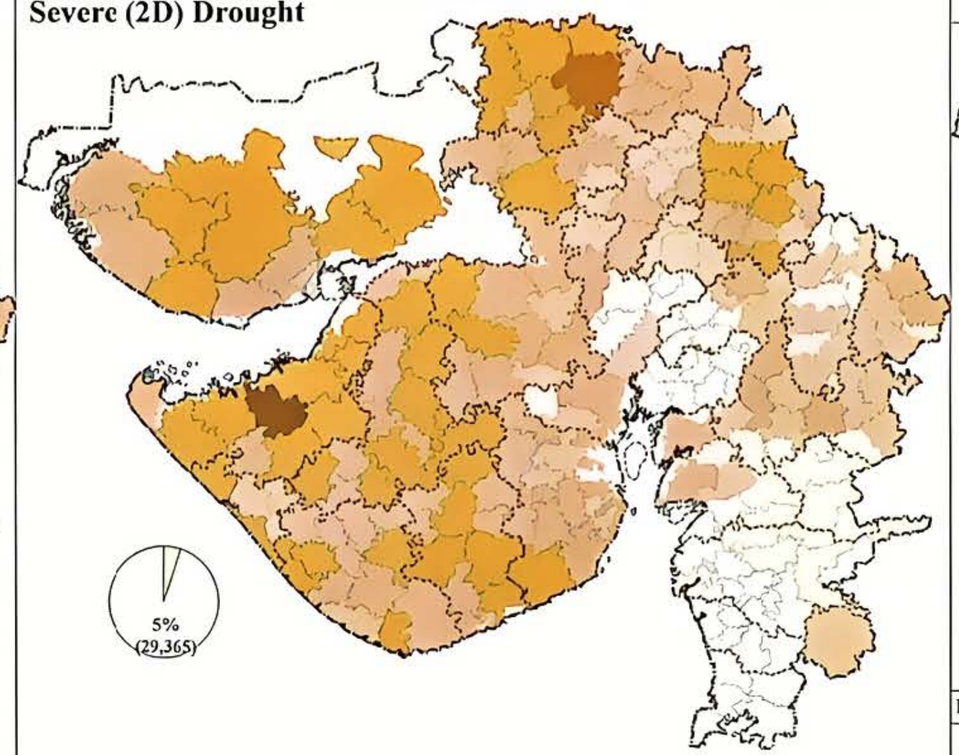
Gujarat Composite Risk Zonation: Composite GVA Risk due to Drought & Flood
(Rs. Million 2001 prices)

GSDMA

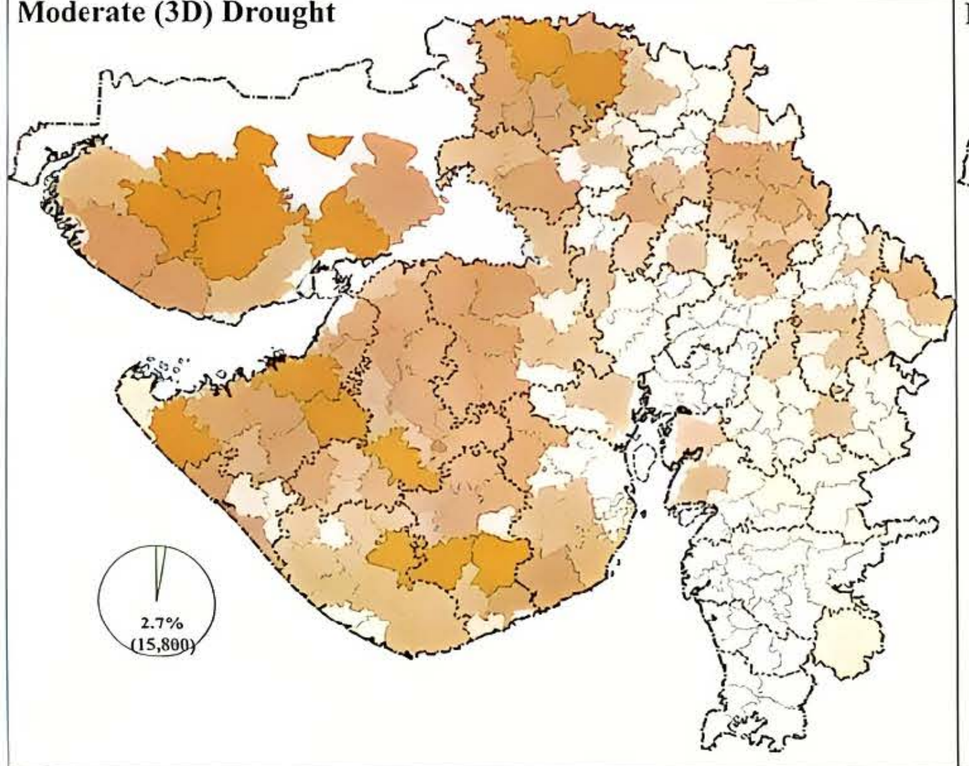
Extreme (1D) Drought



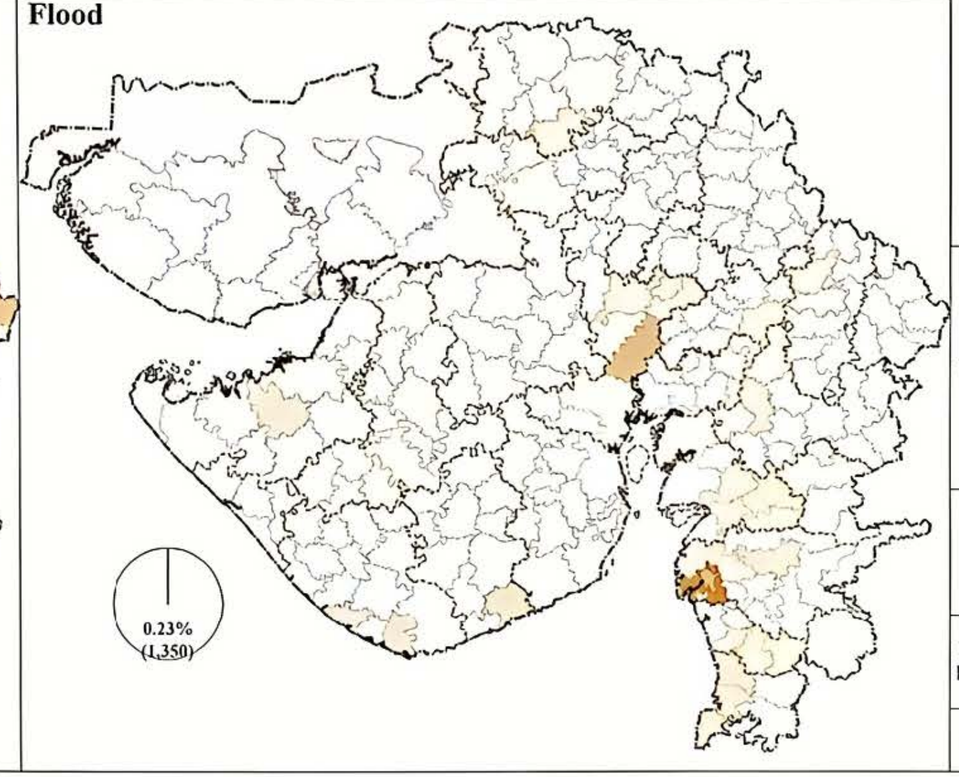
Severe (2D) Drought

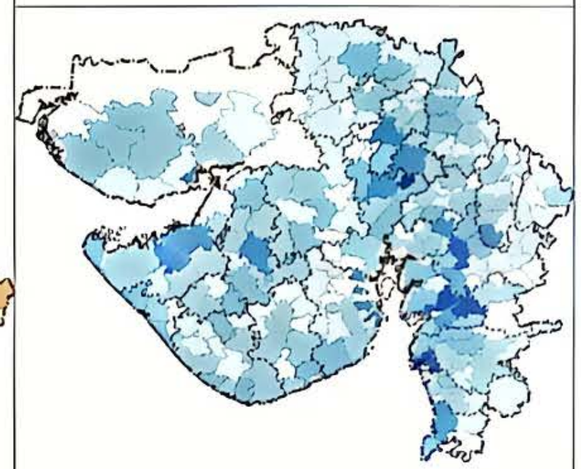


Moderate (3D) Drought



Flood





Total GVA (Rs. Million)
- < 500
- > 500 to 1000
- > 1000 to 2000
- > 2000 to 5000
- > 5000 to 10000
- >10000

LEGEND

Estimated GVA Risk (Rs. Million)
- < 5
- > 5 to 10
- > 10 to 50
- > 50 to 100
- > 100 to 200
- > 200 to 500
- > 500 to 1000
- > 1000

Sectors covered: Agriculture, Animal Husbandary, Fisheries, Manufacturing,Trade & Hospitality, Building, Electricity, Roads & Bridges, Ports & Airports.

Main map pie charts show the proportion of loss to total GVA. Figure in parantheses denotes absolute value in Rs. million.

Source: TARU Analysis, 2004, BISAG, GoG

0 — 100 km

N

Projection : Lambert Azimuthal Equal Area
Datum : WGS 84

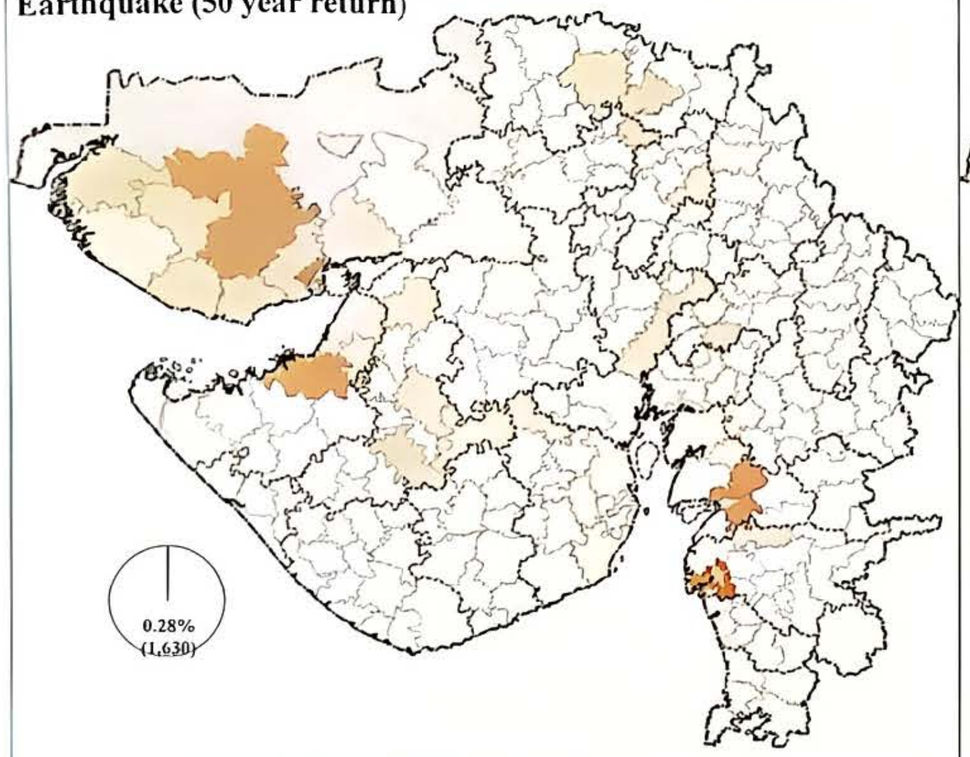
MAP No. : COMM - 03 OF 08

Date : 18/6/2005

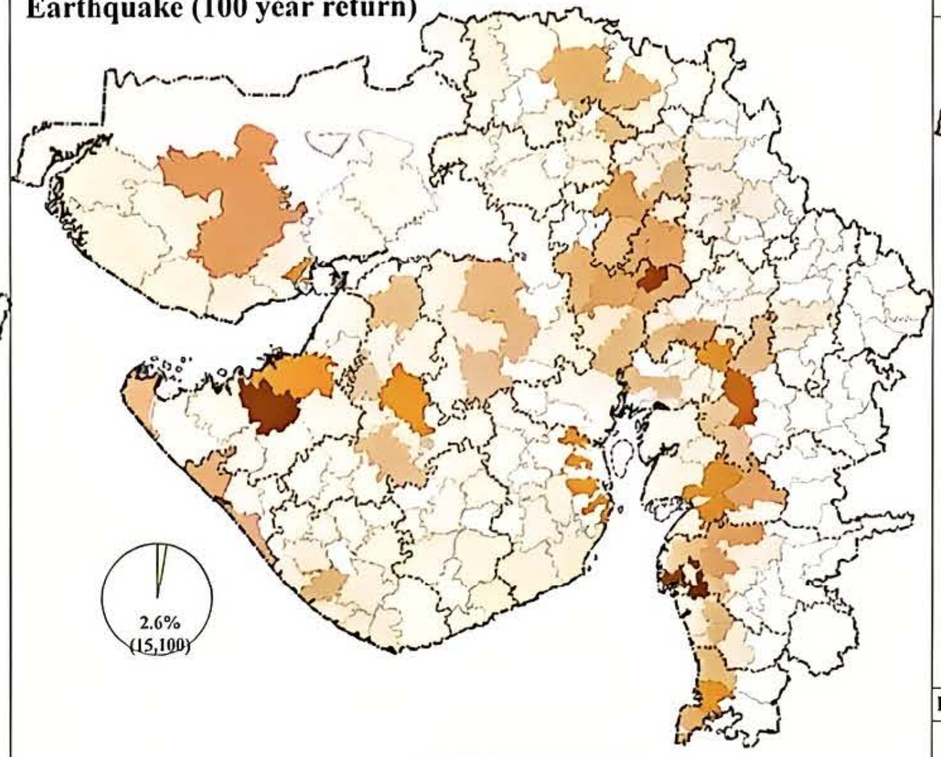
Gujarat Composite Risk Zonation: Composite GVA Risk due to Earthquake and Cyclone & Storm Surge (50 & 100 year return period) (Rs. Million 2001 prices)

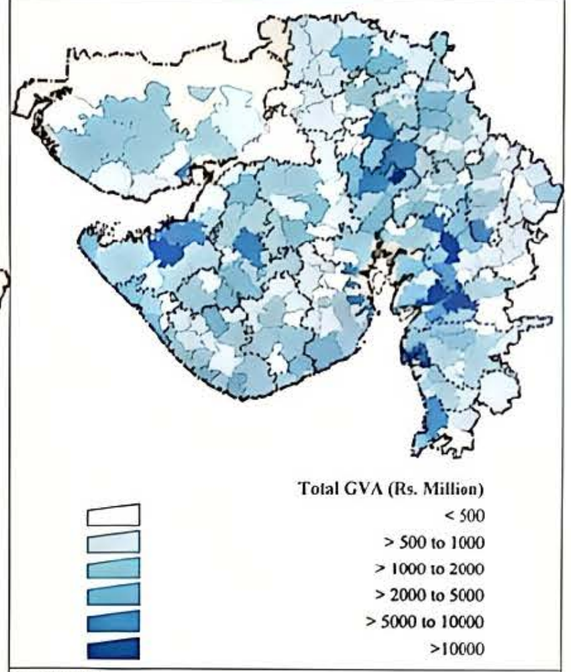
GSDMA

Earthquake (50 year return)



Earthquake (100 year return)

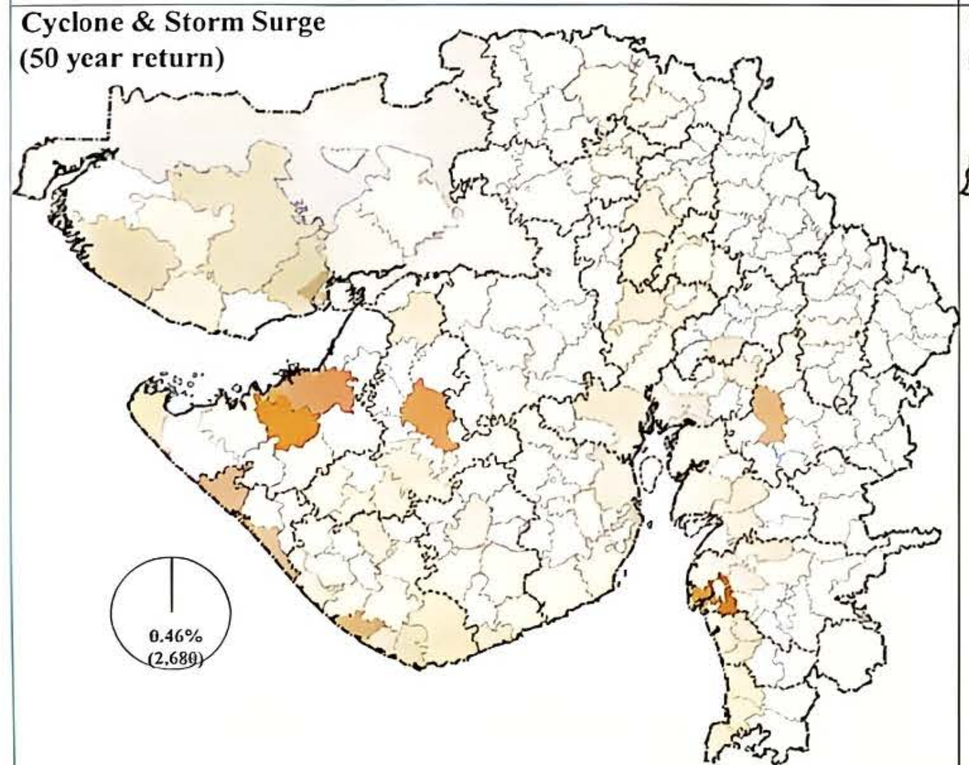




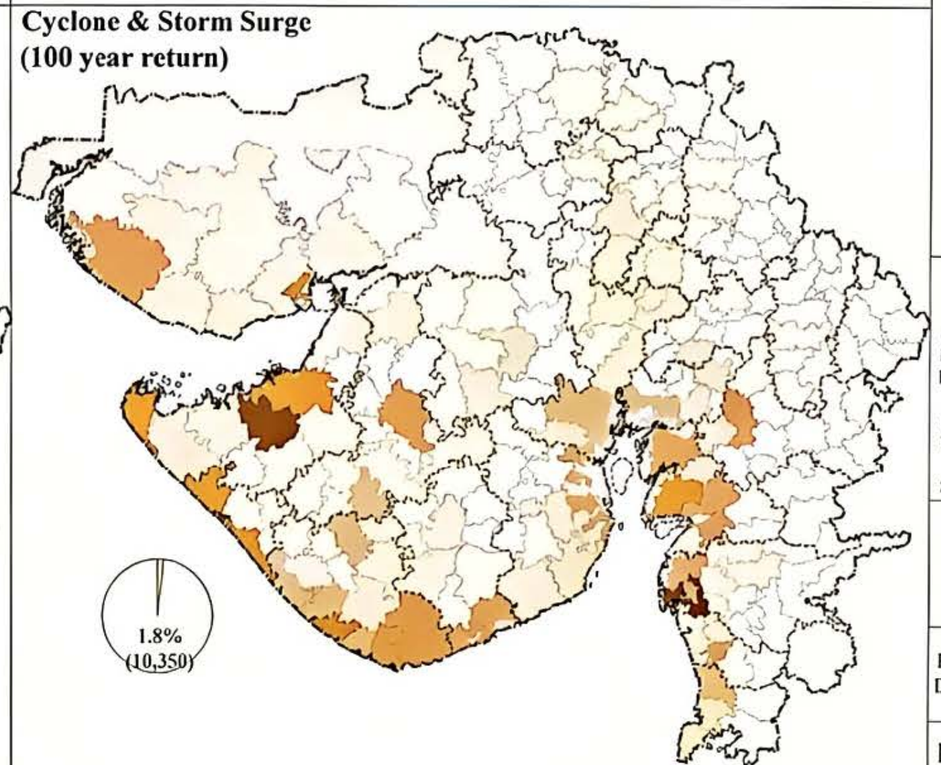
LEGEND

Estimated GVA Risk (Rs. Million)
< 5
> 5 to 10
> 10 to 50
> 50 to 100
> 100 to 200
> 200 to 500
> 500 to 1000
> 1000

Cyclone & Storm Surge (50 year return)



Cyclone & Storm Surge (100 year return)



Sectors covered: Agriculture, Animal Husbandary, Fisheries, Manufacturing, Trade & Hospitality, Building, Electricity, Roads & Bridges, Ports & Airports.

Main map pie charts show the proportion of loss to total GVA. Figure in parantheses denotes absolute value in Rs. million.

Source: TARU Analysis, 2004, BISAG, GoG

0 100 km

N

Projection : Lambert Azimuthal Equal Area
Datum : WGS 84

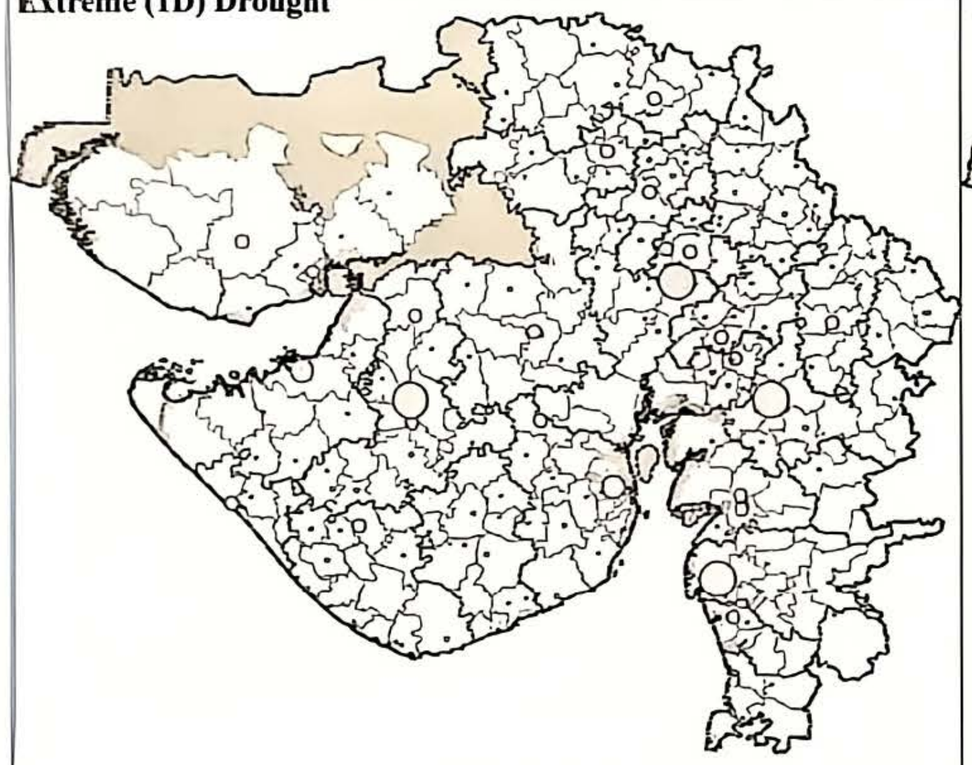
MAP No. : COMM - 04 OF 08

Date : 18/6/2005

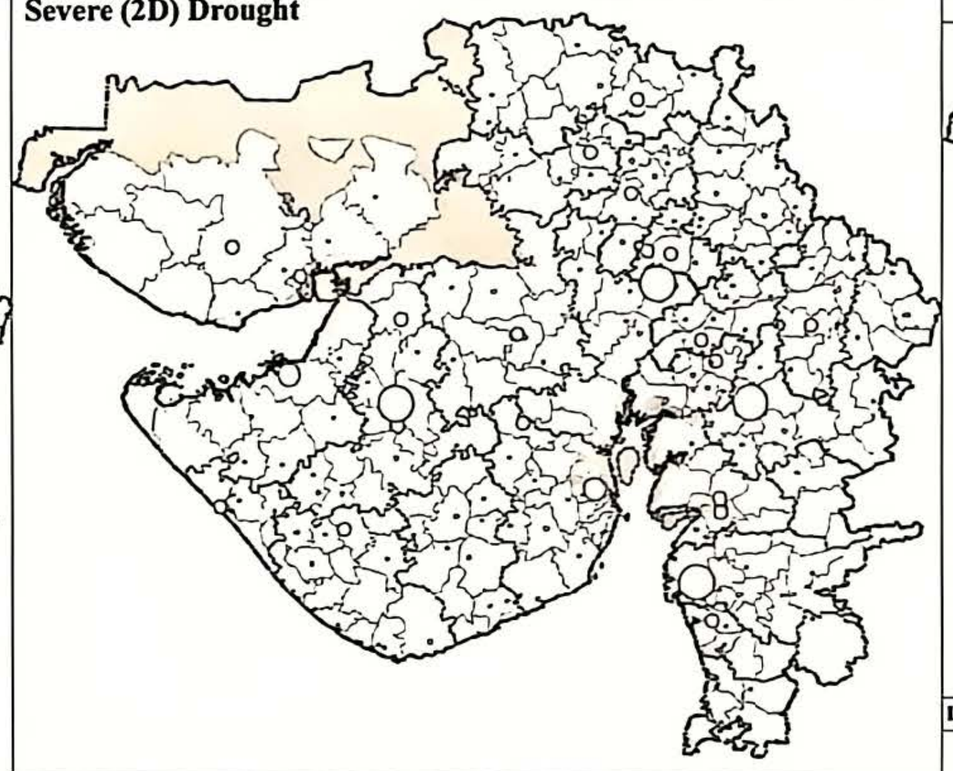
Gujarat Composite Risk Zonation: Urban Composite Capital Risk due to Drought & Flood
(Rs. Million 2001 prices)

GSDMA

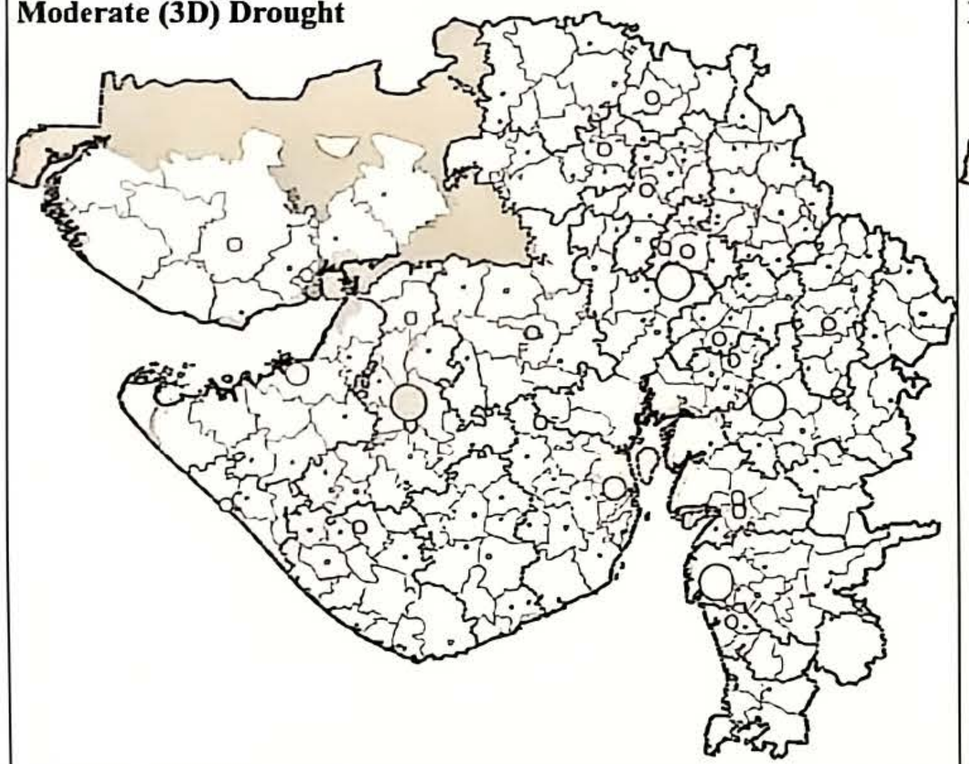
Extreme (1D) Drought



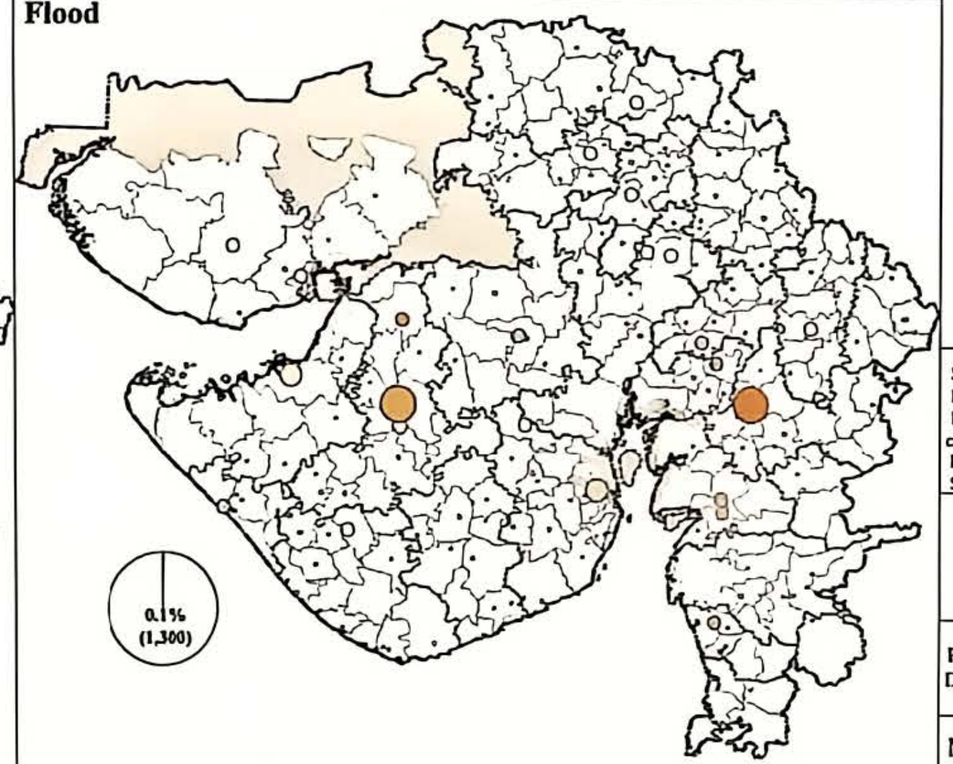
Severe (2D) Drought

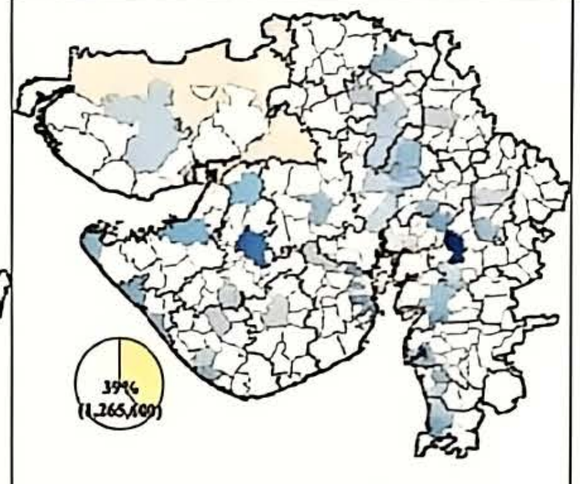


Moderate (3D) Drought



Flood





LEGEND

Estimated Capital Risk (Rs. Million)
- < 2
- > 2 to 7
- > 7 to 20
- > 20 to 60
- > 60 to 180
- > 180

(Exponential class interval)

Population
- < 10,000
- > 10,000 to 50,000
- > 50,000 to 100,000
- > 100,000 to 250,000
- > 250,000 to 1,000,000
- > 1,000,000

Sectors covered: Agriculture, Trade & Hospitality & Building.
Main map pie charts show the proportion of loss to total urban capital asset
Inset map pie chart shows the proportion of urban capital asset to total capital asset
Figure in parentheses denotes absolute value in Rs million
Source: TARU Analysis, 2004, BISAG, GoG

0 100 km

N

Projection : Lambert Azimuthal Equal Area
Datum : WGS 84

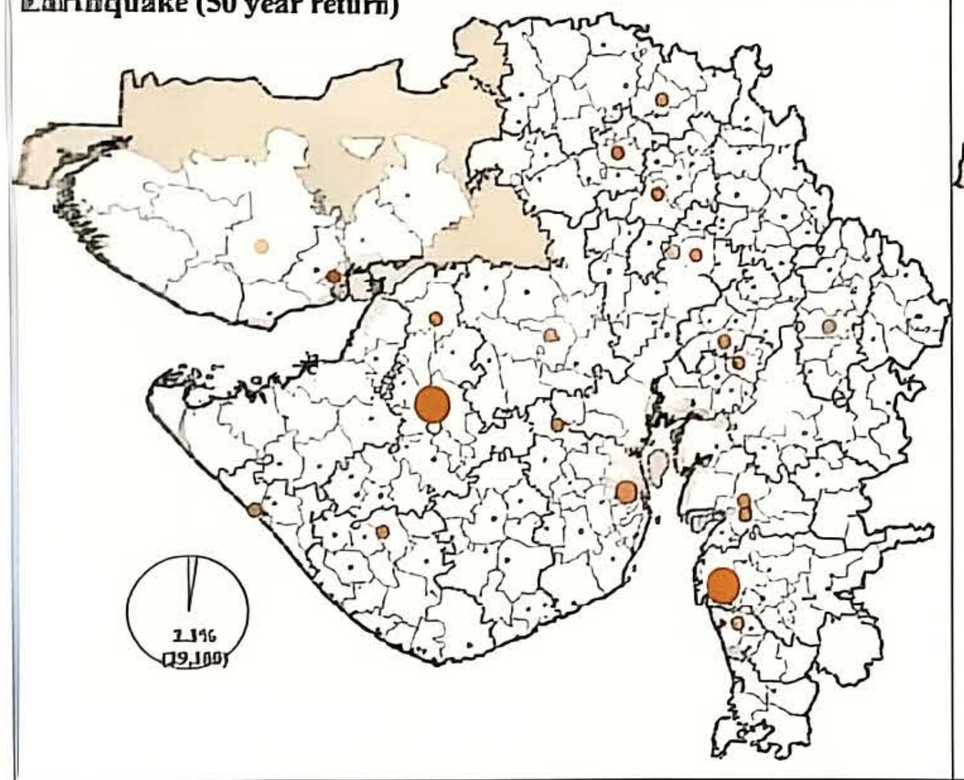
MAP No. : COMM - 05 OF 08

Date : 18/6/2005

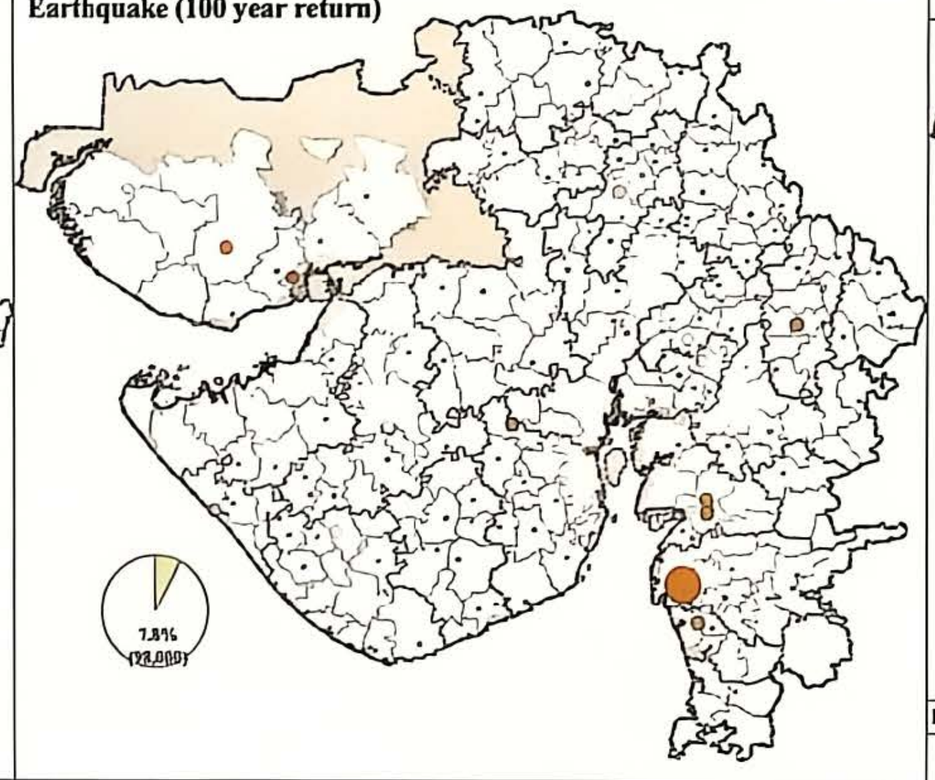
Gujarat Composite Risk Zonation: Urban Composite Capital Risk due to Earthquake and Cyclone & Storm Surge (50 & 100 year return period) (Rs. Million 2001 prices)

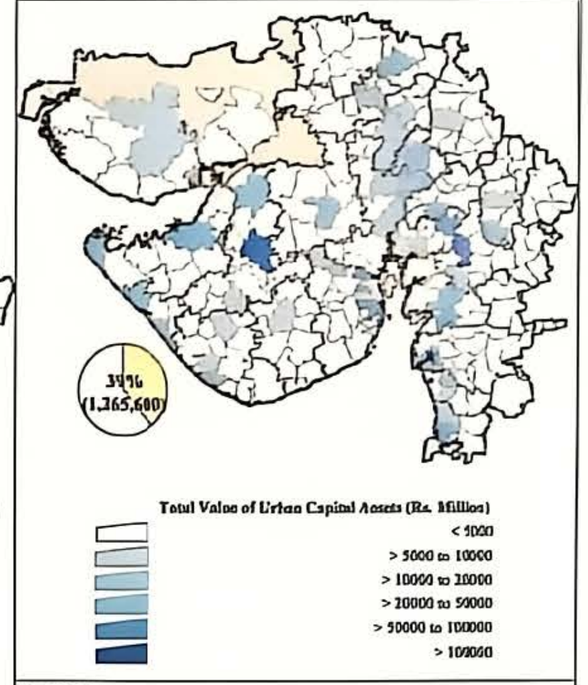
GSDMA

Earthquake (50 year return)

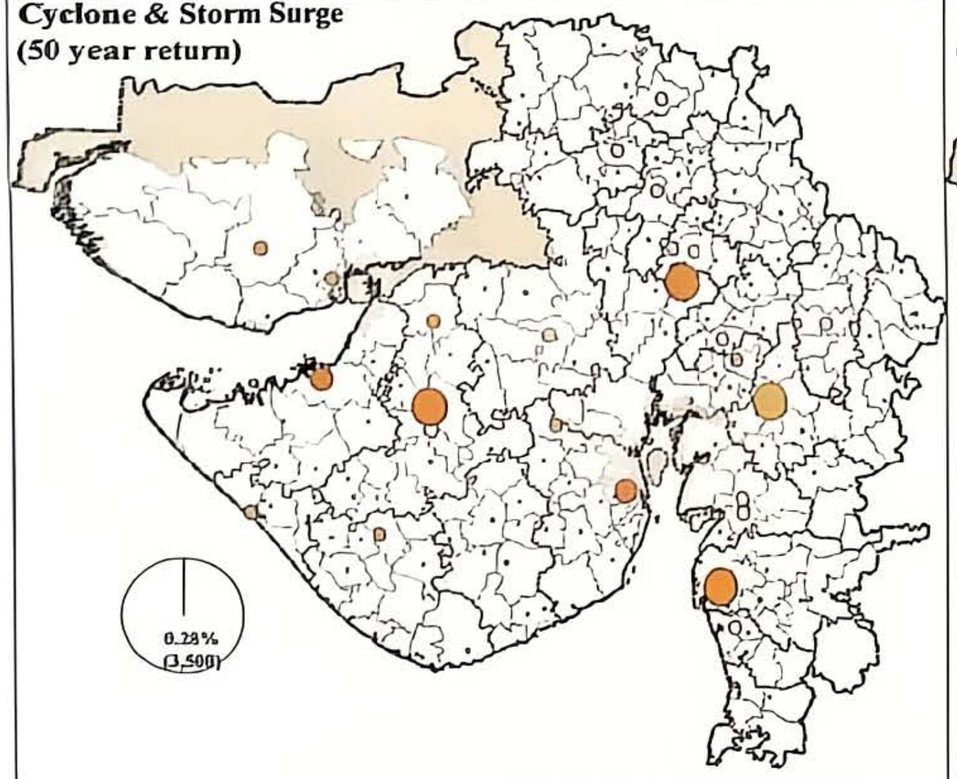


Earthquake (100 year return)

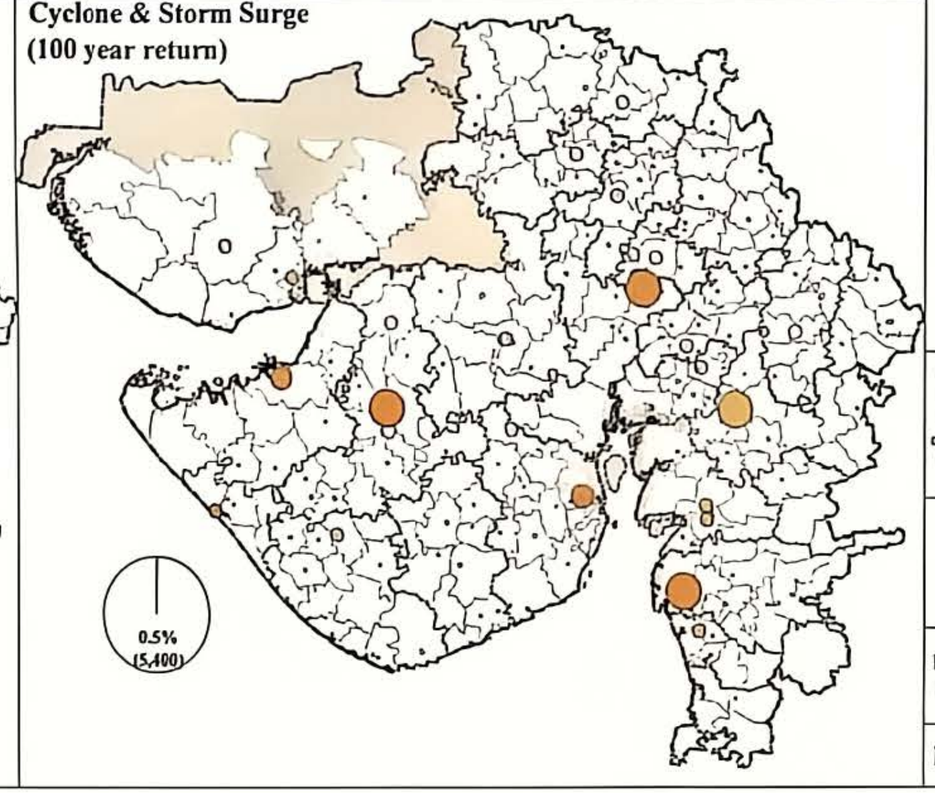




Cyclone & Storm Surge (50 year return)



Cyclone & Storm Surge (100 year return)



LEGEND

Estimated Capital Risk (Rs. Million)
- < 5
- > 5 to 30
- > 30 to 150
- > 150 to 800
- > 800 to 5000
- > 5000

(Exponential class intervals)

Population
- < 10,000
- > 10,000 to 50,000
- > 50,000 to 100,000
- > 100,000 to 250,000
- > 250,000 to 1,000,000
- > 1,000,000

Sectors covered Manufacturing, Trade & Hospitality & Building
Main map pie charts show the proportion of loss to total urban capital asset.
Inset map pie chart shows the proportion of urban capital asset to total capital asset.
Figure in parantheses denotes absolute value in Rs. million
Source: TARU Analysis, 2004, Census of India, 2001, BISAG, GoG

0 100 km

N

Projection : Lambert Azimuthal Equal Area
Datum : WGS 84

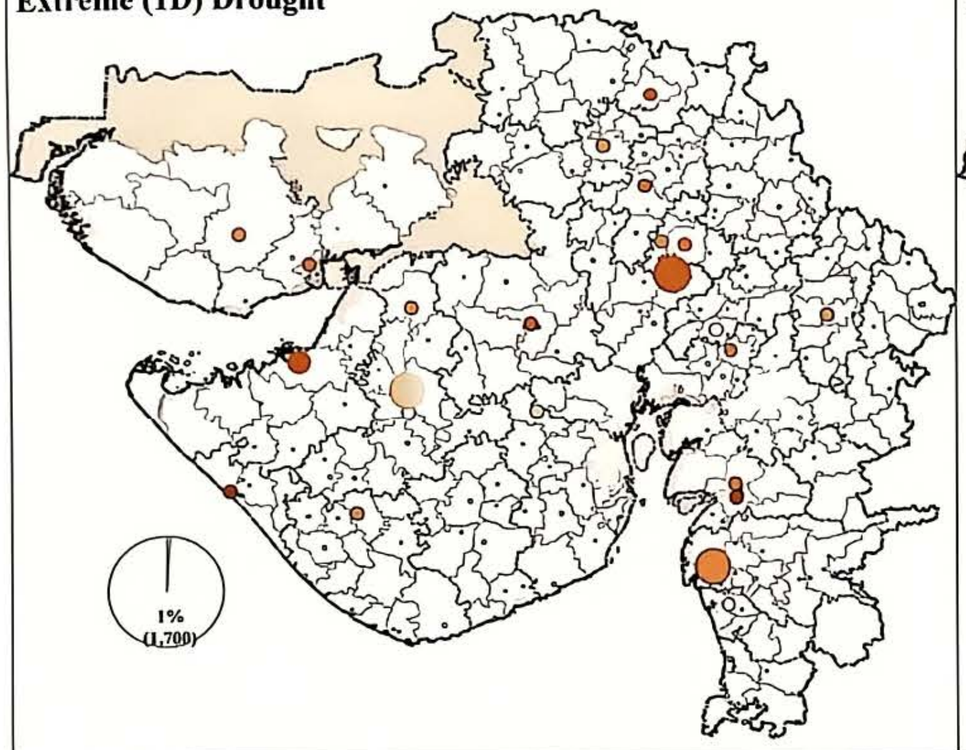
MAP No. : COMM - 06 OF 08

Date : 18/6/2005

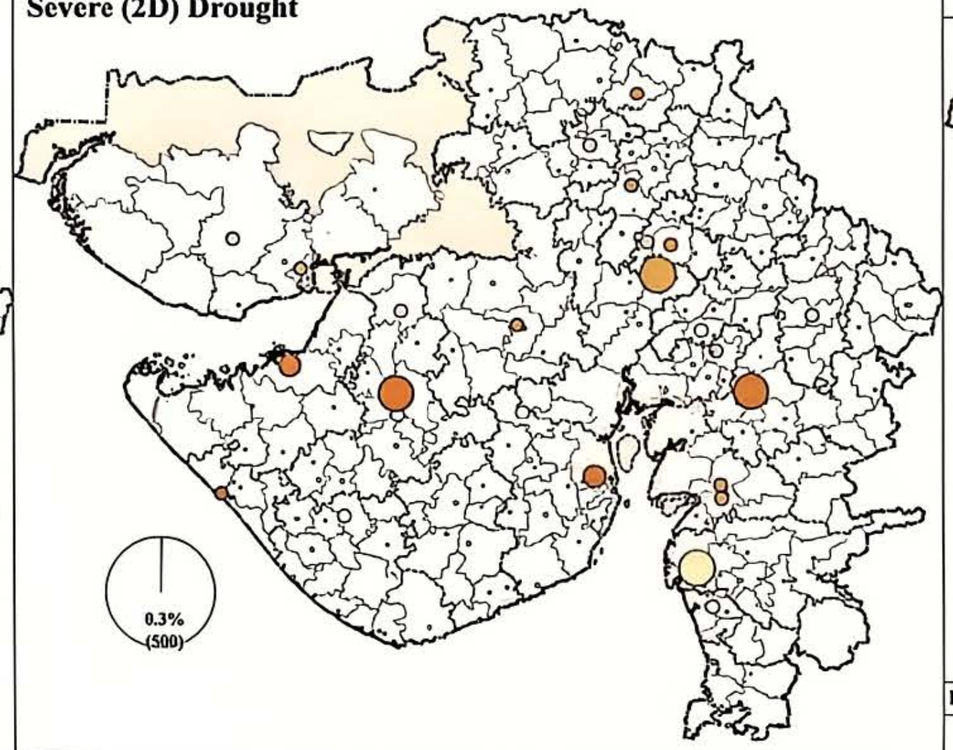
Gujarat Composite Risk Zonation: Urban Composite GVA Risk due to Drought & Flood
(Rs. Million 2001 prices)

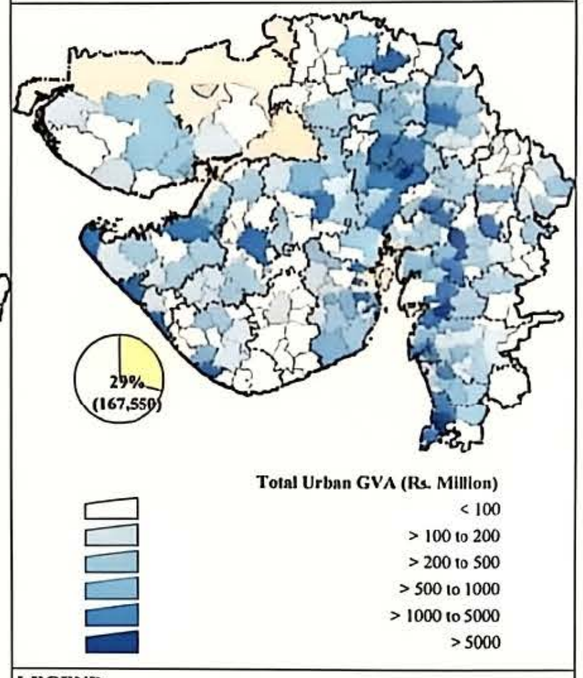
GSDMA

Extreme (1D) Drought

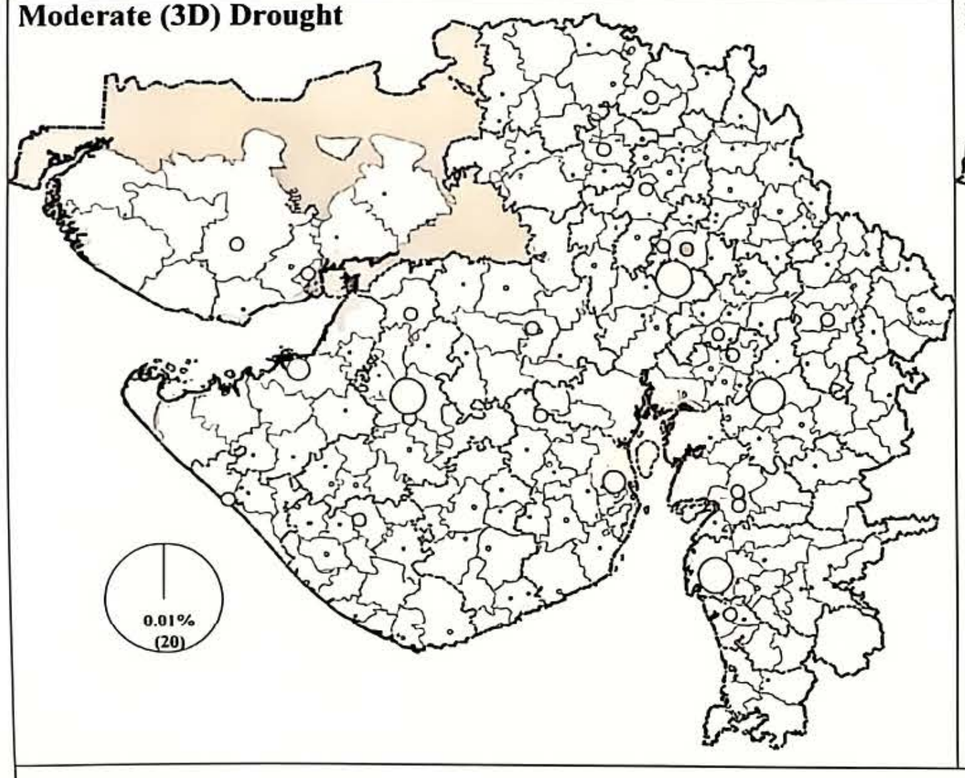


Severe (2D) Drought

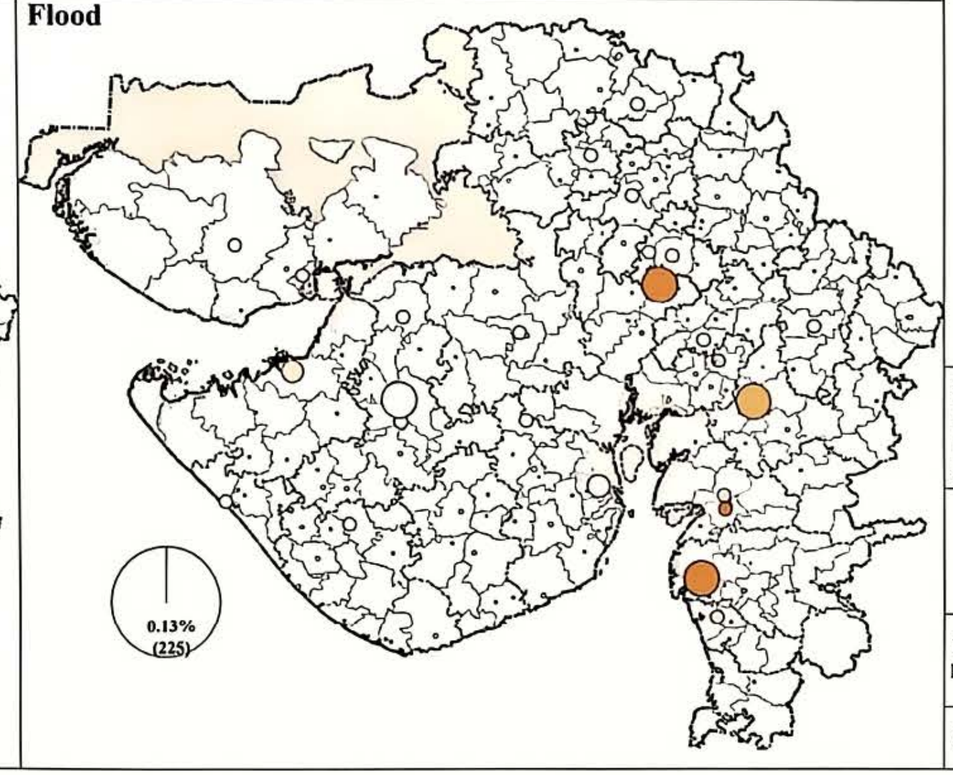




Moderate (3D) Drought



Flood



LEGEND

Estimated GVA Risk (Rs. Million)
- < 2
- > 2 to 5
- > 5 to 15
- > 15 to 40
- > 40 to 100
- > 100

(Exponential class intervals)

Population
- < 10,000
- > 10,000 to 50,000
- > 50,000 to 100,000
- > 100,000 to 250,000
- > 250,000 to 1,000,000
- > 1,000,000

Sectors covered Manufacturing, Trade & Hospitality & Building.
Main map pie charts show the proportion of loss to total urban GVA.
Inset map pie chart shows the proportion of urban GVA to total GVA.
Figure in parantheses denotes absolute value in Rs million.
Source: TARU Analysis, 2004, BISAG, GoG

0 100 km

N

Projection : Lambert Azimuthal Equal Area
Datum : WGS 84

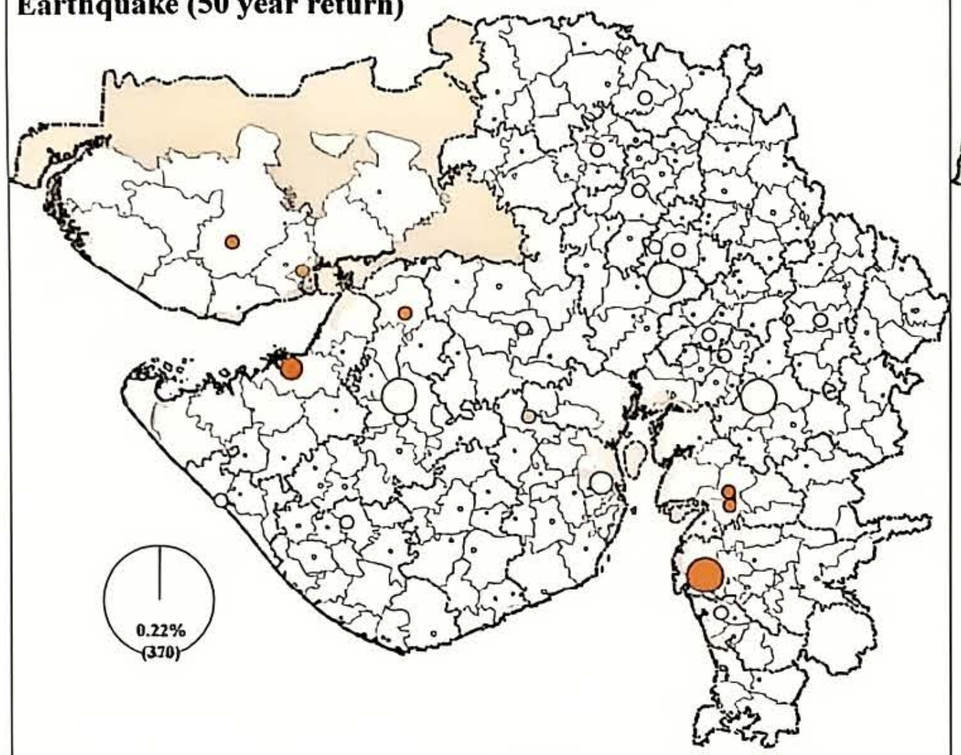
MAP No. : COMM - 07 OF 08

Date : 3/7/2005

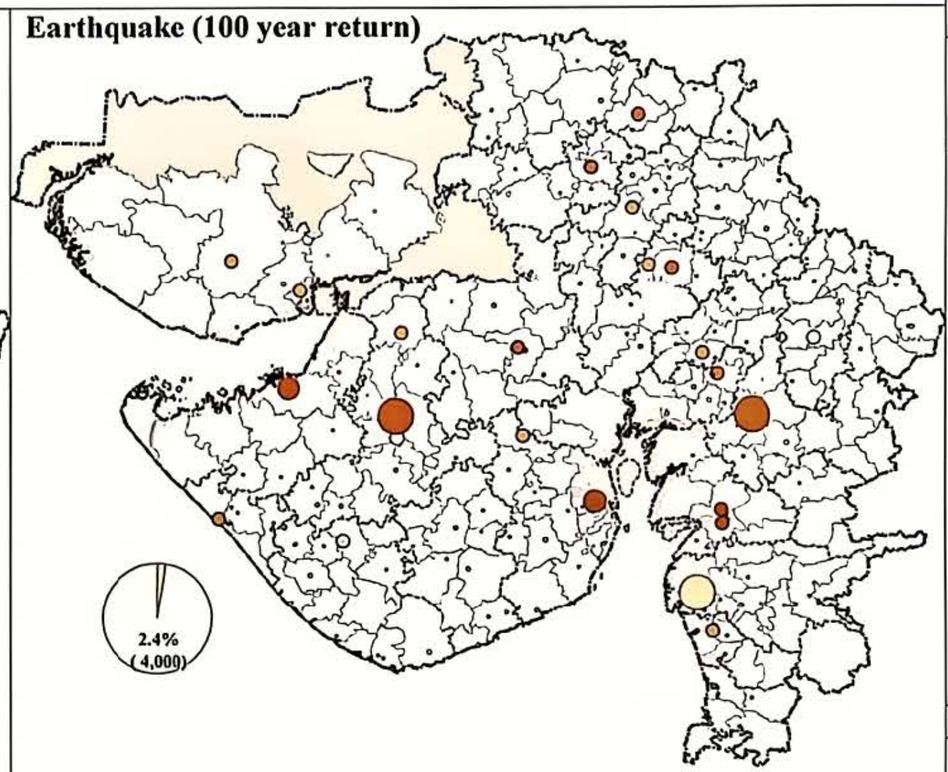
Gujarat Composite Risk Zonation: Urban Composite GVA Risk due to Earthquake and Cyclone & Storm Surge (50 & 100 year return period) (Rs. Million 2001 prices)

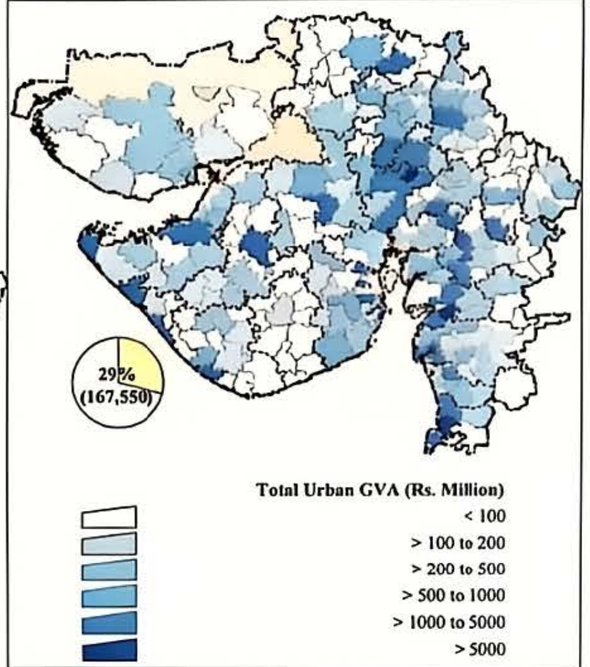
GSDMA

Earthquake (50 year return)

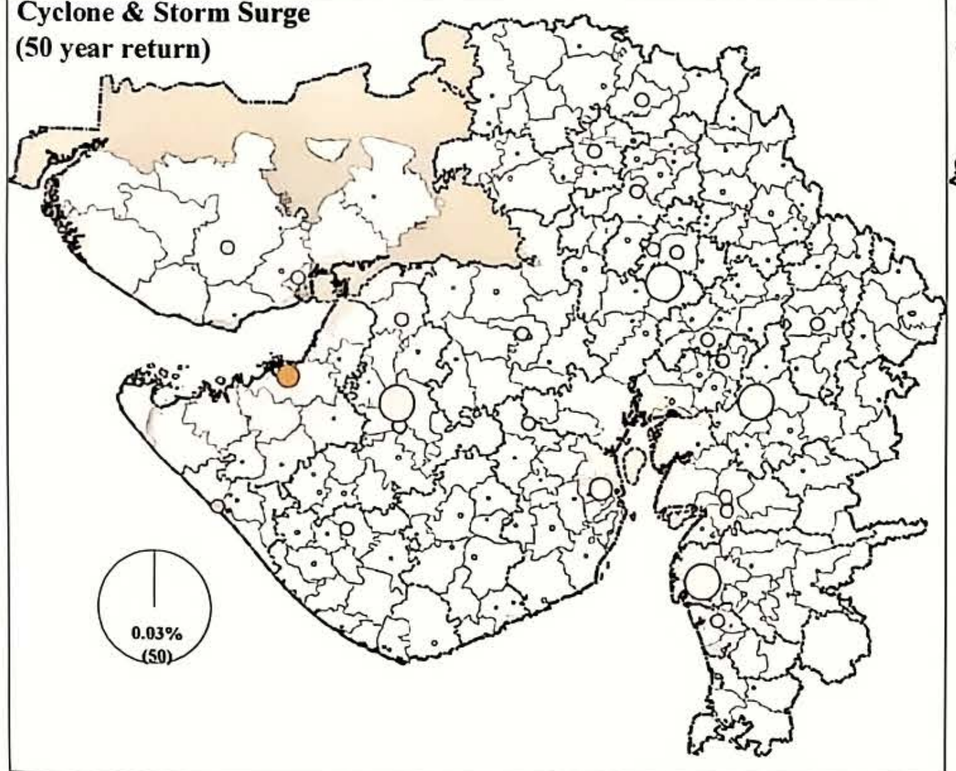


Earthquake (100 year return)

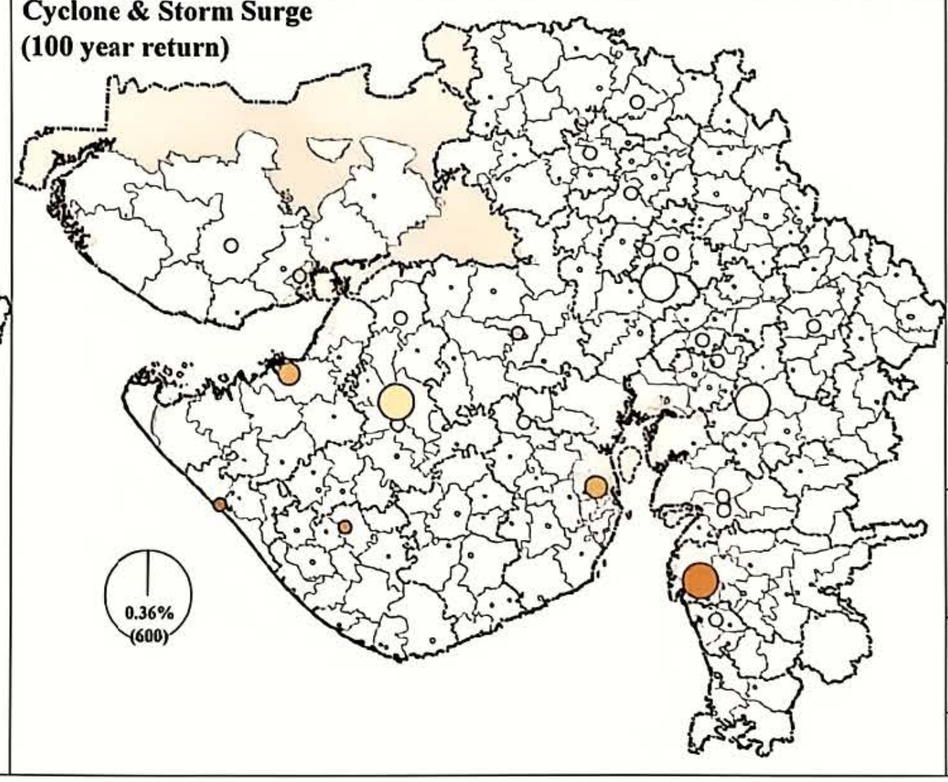




Cyclone & Storm Surge (50 year return)



Cyclone & Storm Surge (100 year return)



LEGEND

Estimated GVA Risk (Rs. Million)
- < 2
- > 2 to 10
- > 10 to 30
- > 30 to 100
- > 100 to 300
- > 300

(Exponential class intervals)

Population
- < 10,000
- > 10,000 to 50,000
- > 50,000 to 100,000
- > 100,000 to 250,000
- > 250,000 to 1,000,000
- > 1,000,000

Sectors covered: Manufacturing,Trade & Hospitality & Building
Main map pie charts show the proportion of loss to total urban GVA.
Inset map pie chart shows the proportion of urban GVA to total GVA.
Figure in parantheses denotes absolute value in Rs. million.
Source: TARU Analysis, 2004; BISAG, GoG.

0 100 km

N

Projection : Lambert Azimuthal Equal Area
Datum : WGS 84

MAP No. : COMM - 08 OF 08

Date : 18/6/2005

GUJARAT COMPOSITE RISK ZONATION: COMPOSITE CAPITAL RISK DUE TO DROUGHT & FLOOD
(Rs. MILLION 2001 PRICES) Table No. COMT - 01 of 04

GSDMA

Sr. No	District	Taluka	Drought			Flood	Total Capital Assets
			Extreme	Severe	Moderate		
1	Ahmadabad	Ahmadabad City	0.5	0.2	-	219.2	281,507
2	Ahmadabad	Barwala	1.5	0.5	-	-	2,115
3	Ahmadabad	Bavla	0.6	0.2	-	116.2	7,679
4	Ahmadabad	Daskroi	0 3	0.1	-	105.4	27,551
5	Ahmadabad	Detroj-Rampura	0.7	0.3	-	-	2,378
6	Ahmadabad	Dhandhuka	3.1	1.0	-	60.0	6,274
7	Ahmadabad	Dholka	0.8	0.3	-	302.7	13,092
8	Ahmadabad	Mandal	1.8	0.7	-	1.5	2,664
9	Ahmadabad	Ranpur	1.0	0.3	-	2.4	2,169
10	Ahmadabad	Sanand	0.3	0.1	-	88.5	20,041
11	Ahmadabad	Viramgam	1.6	0.6	-	2.7	13,487
12	Amreli	Amreli	1.5	0.6	-	17.4	11,493
13	Amreli	Babra	2.1	0.8	-	-	4,256
14	Amreli	Bagasara	0.6	0.2	-	3.5	3,548
15	Amreli	Dhari	2.3	1.0	-	12.1	5,756
16	Amreli	Jafrabad	1.9	0.9	-	13.2	8,651
17	Amreli	Khambha	1.3	0.7	-	-	3,064
18	Amreli	Kunkavav Vadia	1.0	0.4	-	-	3,827
19	Amreli	Lathi	1.8	0.6	-	-	5,462
20	Amreli	Lilia	0.6	0.2	-	11.2	2,389
21	Amreli	Rajula	2.5	1.1	-	49.9	21,417
22	Amreli	Savar Kundla	2.0	0.9	-	7.0	9,157
23	Anand	Anand	0.6	0.2	-	26.1	35,652
24	Anand	Anklav	0.4	0.1	-	40.4	5,244
25	Anand	Borsad	0.9	0.3	-	31.1	11,834
26	Anand	Khambhat	0.8	0.3	-	23.1	13,880
27	Anand	Petlad	0.5	0.2	-	-	10,402
28	Anand	Sojitra	0.2	0.1	-	-	3,412
29	Anand	Tarapur	0.7	0.2	-	47.7	3,112
30	Anand	Umreth	0.3	0.1	-	2.8	6,037
31	Banas Kantha	Amirgadh	3.0	1.0	-	-	2,764
32	Banas Kantha	Bhabhar	4.3	1.7	-	-	2,707
33	Banas Kantha	Danta	5.6	1.9	-	-	4,574
34	Banas Kantha	Dantiwada	3.6	1.4	-	3.5	2,398
35	Banas Kantha	Deesa	11.0	4.5	-	37.5	13,820
36	Banas Kantha	Deodar	3.6	1.4	-	-	3,719
37	Banas Kantha	Dhanera	4.1	1.6	-	-	4,801
38	Banas Kantha	Kankrej	5.7	2.2	-	69.6	5,140
39	Banas Kantha	Palanpur	2.5	0.8	-	-	18,845
40	Banas Kantha	Tharad	6.2	2.9	-	0.3	5,628
41	Banas Kantha	Vadgam	1.9	0.7	-	2.3	6,498
42	Banas Kantha	Vav	5.9	2.4	-	-	3,503
43	Bharuch	Amod	0.2	0.1	-	18.7	4,354
44	Bharuch	Anklesvar	0.2	0.1	-	130.2	44,240
45	Bharuch	Bharuch	0.3	0.1	-	153 5	51,831
46	Bharuch	Hansot	-	-	-	16.0	8,047
47	Bharuch	Jambusar	0.6	0.2	-	35.9	11,728
48	Bharuch	Jhagadia	1.1	0.3	-	155 0	64,393
49	Bharuch	Vagra	0.2	0.1	-	11.6	22,189
50	Bharuch	Valia	1.2	0 4	-	133.5	11,046
51	Bhavnagar	Bhavnagar	2.9	1.0	-	7.7	45,365
52	Bhavnagar	Botad	3.1	1.1	-	3.3	9,047
53	Bhavnagar	Gadhada	4.0	1.5	-	11.4	5,975
54	Bhavnagar	Gariadhar	1.3	0.5	-	2.7	3,640
55	Bhavnagar	Ghogha	1.3	0.5	-	-	4,143
56	Bhavnagar	Mahuva	3.1	1.4	-	22.8	12,041
57	Bhavnagar	Palitana	3 1	1.2	-	16.4	6,847
58	Bhavnagar	Sihor	2.8	1.1	-	3.4	8,117
59	Bhavnagar	Talaja	1.1	0.4	-	22.6	9,099
60	Bhavnagar	Umrala	1.1	0.4	-	12.2	3,073
61	Bhavnagar	Vallabhipur	1.5	0.5	-	1.7	3,129
62	Dohad	Devgadbaria	2.5	1.1	-	8.7	4,691
63	Dohad	Dhanpur	2.2	0 9	-	10.0	3,739
64	Dohad	Dohad	2 1	0.8	-	2.3	7,133
65	Dohad	Fatepura	1.5	0.7	-	-	2,062
66	Dohad	Garbada	2.8	1 1	-	1.5	1,965
67	Dohad	Jhalod	6.6	2.6	-	22.3	4,716
68	Dohad	Limkheda	2.5	1.1	-	34 4	3,376
69	Gandhinagar	Dehgam	4.0	1.4	-	-	10,753
70	Gandhinagar	Gandhinagar	1.9	0.7	-	17.8	45,766
71	Gandhinagar	Kalol	20.8	7.4	-	0 4	42,412
72	Gandhinagar	Mansa	2.8	1.1	-	-	9,262
73	Jamnagar	Bhanvad	1.9	0 6	-	25.6	3,673
74	Jamnagar	Dhrol	1 6	0.6	-	17.9	5,268
75	Jamnagar	Jamjodhpur	3.6	1.4	-	2.2	4,959
76	Jamnagar	Jamnagar	4.6	1.8	-	31.8	43,205
77	Jamnagar	Jodiya	1.2	0.6	-	34.8	4,440
78	Jamnagar	Kalavad	4.1	1.4	-	3 4	6,792
79	Jamnagar	Kalyanpur	3.6	1.3	-	29.0	6,306
80	Jamnagar	Khambhalia	2.4	0.8	-	8.1	9,667
81	Jamnagar	Lalpur	2.8	1.0	-	24.2	206,986
82	Jamnagar	Okhamandal	2.5	1.2	-	-	29,583
83	Junagadh	Bhesan	0.9	0.3	-	-	2,834
84	Junagadh	Junagadh	2.2	0 6	-	22.4	14,708
85	Junagadh	Keshod	1.2	0.4	-	3.4	7,728
86	Junagadh	Kodinar	3.9	1.2	-	76.4	26,598
87	Junagadh	Malia	2.3	0.7	-	6.2	12,278
88	Junagadh	Manavadar	0.9	0.3	-	1.2	5,662
89	Junagadh	Mangrol	1.9	0.7	-	1 0	10,306
90	Junagadh	Mendarda	1.1	0 3	-	9.8	2,548
91	Junagadh	Patan-Veraval	2.1	0 8	-	85.3	26,193
92	Junagadh	Sutrapada	2.0	0.8	-	0 3	9,979
93	Junagadh	Talala	2.3	0.7	-	19.2	5,133
94	Junagadh	Una	6.8	2.7	-	34 0	13,455
95	Junagadh	Vanthali	0 6	0.2	-	24.1	8,047
96	Junagadh	Visavadar	2.2	0.8	-	14 4	6,600
97	Kachchh	Abdasa	3.3	1.5	-	15 8	7,621
98	Kachchh	Anjar	1.9	0.8	-	3 4	7,801
99	Kachchh	Bhachau	2.6	1.2		-	10,052
100	Kachchh	Bhuj	5.7	2 3	-	10.9	17,129
101	Kachchh	Gandhidham	0 7	0 3	-	-	13,793
102	Kachchh	Lakhpat	2.6	1.5	-	8.1	12,069
103	Kachchh	Mandvi	3 1	1.4	-	1 6	8,810
104	Kachchh	Mundra	1.9	0.8	-	5.6	6,014
105	Kachchh	Nakhatrana	2.3	0.9	-	9 6	6,352
106	Kachchh	Rapar	2.3	1 0	-	12.9	6,172
107	Kheda	Balasinor	1 6	0 5		-	4,690
108	Kheda	Kapadvanj	6.0	2.0	-	4.1	8,918
109	Kheda	Kathlal	0.6	0.2	-	5 9	5,818
110	Kheda	Kheda	0.4	0.1	-	53.6	5,975
111	Kheda	Mahudha	0.3	0.1	-	13.8	5,319
112	Kheda	Matar	0.3	0.1		61.1	8,674
113	Kheda	Mehmedabad	0.5	0.2		13 8	7,101
114	Kheda	Nadiad	0 9	0 3	-	21.1	21,110

GUJARAT COMPOSITE RISK ZONATION: COMPOSITE CAPITAL RISK DUE TO DROUGHT & FLOOD
(Rs. MILLION 2001 PRICES) Table No. COMT - 01 of 04

GSDMA

Sr. No	District	Taluka	Drought			Flood	Total Capital Assets
			Extreme	Severe	Moderate		
115	Kheda	Thasra	1.2	0.4	-	70.5	21,785
116	Kheda	Virpur	3.8	1.3	-	6.4	2,279
117	Mahesana	Becharaji	10.1	3.5	-	-	4,181
118	Mahesana	Kadi	20.9	7.7	-	-	25,513
119	Mahesana	Kheralu	29.3	10.6	-	-	7,659
120	Mahesana	Mahesana	40.6	14.4	-	0.6	37,178
121	Mahesana	Satlasana	11.1	4.0	-	-	3,850
122	Mahesana	Unjha	0.9	0.4	-	0.2	8,631
123	Mahesana	Vadnagar	17.2	6.2	-	-	5,542
124	Mahesana	Vijapur	26.2	10.4	-	-	13,686
125	Mahesana	Visnagar	26.6	10.3	-	-	17,499
126	Narmada	Dediapada	0.8	0.2	-	3.5	3,174
127	Narmada	Nandod	1.0	0.3	-	56.9	9,367
128	Narmada	Sagbara	0.4	0.1	-	-	1,955
129	Narmada	Tilakwada	0.3	0.1	-	4.5	2,596
130	Navsari	Bansda	0.1	-	-	237.3	4,114
131	Navsari	Chikhli	-	-	-	324.0	9,206
132	Navsari	Gandevi	-	-	-	559.1	11,774
133	Navsari	Jalalpore		-	-	45.8	9,268
134	Navsari	Navsari	-	-	-	88.9	16,319
135	Panch Mahals	Ghoghamba	3.9	1.6	-	5.6	3,372
136	Panch Mahals	Godhra	4.1	1.6	-	20.5	14,948
137	Panch Mahals	Halol	2.1	1.1	-	8.4	22,727
138	Panch Mahals	Jambughoda	0.6	0.3	-	0.3	1,135
139	Panch Mahals	Kadana	0.7	0.3	-	12.4	2,883
140	Panch Mahals	Kalol	0.9	0.4	-	0.3	7,485
141	Panch Mahals	Khanpur	1.0	0.4	-	22.8	3,525
142	Panch Mahals	Lunawada	1.0	0.4	-	95.3	8,531
143	Panch Mahals	Morwa (Hadaf)	2.1	0.9	-	43.4	2,290
144	Panch Mahals	Santrampur	1.6	0.7	-	6.6	7,680
145	Panch Mahals	Shehera	2.7	1.0	-	38.4	4,662
146	Patan	Chanasma	1.8	0.6	-	0.9	5,379
147	Patan	Harij	2.1	0.7	-	-	3,556
148	Patan	Patan	2.8	1.1	-	3.4	14,916
149	Patan	Radhanpur	5.3	2.1	-	39.6	4,306
150	Patan	Sami	9.0	3.4	-	28.4	6,213
151	Patan	Santalpur	6.1	2.9	-	28.5	3,371
152	Patan	Sidhpur	1.5	0.6	-	1.1	8,192
153	Patan	Vagdod	1.2	0.4	-	-	2,445
154	Porbandar	Kutiyana	1.2	0.7	-	12.5	3,414
155	Porbandar	Porbandar	4.2	1.8	-	35.3	26,151
156	Porbandar	Ranavav	2.7	1.1	-	12.6	7,516
157	Rajkot	Dhoraji	1.0	0.4	-	8.4	7,658
158	Rajkot	Gondal	3.9	1.5	-	42.2	13,004
159	Rajkot	Jamkandorna	1.9	0.6	-	2.4	4,124
160	Rajkot	Jasdan	5.8	2.2	-	4.9	9,564
161	Rajkot	Jetpur	2.4	0.7	-	49.2	12,095
162	Rajkot	Kotda Sangani	1.7	0.7	-	8.0	6,840
163	Rajkot	Lodhika	0.9	0.4	-	3.5	3,546
164	Rajkot	Maliya	1.0	0.5	-	13.3	3,294
165	Rajkot	Morvi	1.8	0.9	-	75.2	18,624
166	Rajkot	Paddhari	1.5	0.6	-	22.5	5,039
167	Rajkot	Rajkot	6.1	2.4	-	54.9	72,014
168	Rajkot	Tankara	1.6	0.8	-	33.2	4,109
169	Rajkot	Upleta	2.1	0.8	-	30.5	8,611
170	Rajkot	Wankaner	4.3	1.7	-	12.5	8,236
171	Sabar Kantha	Bayad	2.7	1.1	-	5.6	6,032
172	Sabar Kantha	Bhiloda	4.9	2.0	-	7.2	6,558
173	Sabar Kantha	Dhansura	1.8	0.7	-	8.7	3,311
174	Sabar Kantha	Himatnagar	2.7	1.1	-	11.6	14,291
175	Sabar Kantha	Idar	3.1	1.1	-	-	11,304
176	Sabar Kantha	Khedbrahma	8.5	3.1	-	4.0	5,967
177	Sabar Kantha	Malpur	2.4	0.9	-	1.5	3,179
178	Sabar Kantha	Meghraj	7.2	2.9	-	8.8	4,282
179	Sabar Kantha	Modasa	3.8	1.6	-	39.5	8,166
180	Sabar Kantha	Prantij	0.6	0.2	-	-	7,754
181	Sabar Kantha	Talod	1.0	0.4	-	-	5,262
182	Sabar Kantha	Vadali	1.0	0.4	-	-	2,722
183	Sabar Kantha	Vijaynagar	2.6	1.1	-	3.2	2,811
184	Surat	Bardoli	-	-	-	44.4	9,919
185	Surat	Chorasi	0.1	-	-	736.9	223,042
186	Surat	Kamrej	-	-	-	88.2	6,918
187	Surat	Mahuva	-	-	-	21.7	4,259
188	Surat	Mandvi	0.4	0.1		74.3	10,777
189	Surat	Mangrol	0.6	0.2	-	6.8	13,631
190	Surat	Nizar	0.4	0.1	-	1.3	5,067
191	Surat	Olpad	-	-	-	81.1	13,296
192	Surat	Palsana	-	-	-	24.2	10,432
193	Surat	Songadh	0.5	0.2	-	17.7	8,109
194	Surat	Surat City	-	-	-	566.6	146,921
195	Surat	Uchchhal	0.1	-	-	2.8	5,333
196	Surat	Umarpada	0.5	0.1	-	1.0	1,450
197	Surat	Valod	0.1	-	-	18.6	2,349
198	Surat	Vyara	0.1	-	-	14.6	10,302
199	Surendranagar	Chotila	4.6	1.5	-	3.2	6,317
200	Surendranagar	Chuda	0.9	0.4	-	7.9	2,587
201	Surendranagar	Dasada	2.8	1.0	-	-	4,311
202	Surendranagar	Dhrangadhra	3.0	0.7	-	9.1	8,221
203	Surendranagar	Halvad	2.7	1.0	-	19.6	5,666
204	Surendranagar	Lakhtar	1.0	0.4	-	-	2,266
205	Surendranagar	Limbdi	1.5	0.6	-	4.2	7,724
206	Surendranagar	Muli	2.3	0.9	-	10.2	2,770
207	Surendranagar	Sayla	2.4	0.8	-	14.4	11,774
208	Surendranagar	Wadhwan	1.8	0.5	-	23.0	15,916
209	The Dangs	The Dangs	0.5	0.2	-	20.1	3,811
210	Vadodara	Chhota Udaipur	3.1	1.1	-	10.7	4,878
211	Vadodara	Dabhoi	0.7	0.3	-	10.6	6,946
212	Vadodara	Jetpur Pavi	2.5	1.0	-	18.6	3,934
213	Vadodara	Karjan	0.3	0.1	-	19.3	18,113
214	Vadodara	Kavant	2.5	0.9	-	8.1	2,389
215	Vadodara	Nasvadi	2.4	0.7	-	0.2	2,294
216	Vadodara	Padra	0.6	0.2	-	27.3	17,491
217	Vadodara	Sankheda	2.0	0.8	-	2.0	6,135
218	Vadodara	Savli	1.7	0.6	-	53.2	18,219
219	Vadodara	Sinor	0.1	-	-	3.7	2,400
220	Vadodara	Vadodara	1.5	0.5	-	157.6	197,554
221	Vadodara	Vaghodia	1.5	0.6	-	9.2	10,260
222	Valsad	Dharampur	-	-	-	17.2	3,719
223	Valsad	Kaprada	-	-	-	24.3	3,087
224	Valsad	Pardi	-	-	-	182.4	38,382
225	Valsad	Umbergaon	-	-	-	232.1	15,614
226	Valsad	Valsad	-	-	-	289.2	29,541

GUJARAT COMPOSITE RISK ZONATION: COMPOSITE CAPITAL RISK DUE TO EARTHQUAKE AND CYCLONE & STORM SURGE (50 & 100 YEAR RETURN PERIOD) (Rs. MILLION 2001 PRICES) Table No. COMT - 02 of 04

GSDMA

Sr. No	District	Taluka	EQ (50 year return)	Cyc. & Surge (50 year return)	EQ (100 year return)	Cyc. & Surge (100 year return)	Total Capital Assets
1	Ahmadabad	Ahmadabad City	6,461.2	408.2	24,800.6	1,043.5	281,507
2	Ahmadabad	Barwala	169.0	39.4	230.4	234.1	2,115
3	Ahmadabad	Bavla	249.3	103.4	750.3	107.3	7,679
4	Ahmadabad	Daskroi	674.7	96.6	2,206.4	177.7	27,551
5	Ahmadabad	Detroj-Rampura	123.2	38.5	284.1	64.5	2,378
6	Ahmadabad	Dhandhuka	221.2	128.9	624.6	895.1	6,274
7	Ahmadabad	Dholka	377.6	155.7	1,235.2	406.5	13,092
8	Ahmadabad	Mandal	125.9	35.2	305.1	54.5	2,664
9	Ahmadabad	Ranpur	204.4	47.2	290.9	55.2	2,169
10	Ahmadabad	Sanand	185.4	140.1	1,293.0	142.9	20,041
11	Ahmadabad	Viramgam	295.6	89.7	1,073.3	136.8	13,487
12	Amreli	Amreli	442.3	169.7	1,248.3	776.7	11,493
13	Amreli	Babra	106.9	85.2	446.3	436.1	4,256
14	Amreli	Bagasara	130.2	54.7	375.8	286.7	3,548
15	Amreli	Dhari	229.5	120.9	580.4	599.5	5,756
16	Amreli	Jafrabad	79.5	141.8	330.4	637.7	8,651
17	Amreli	Khambha	87.4	73.1	304.6	393.2	3,064
18	Amreli	Kunkavav Vadia	98.5	79.9	410.7	412.4	3,827
19	Amreli	Lathi	205.8	83.6	566.9	97.0	5,462
20	Amreli	Lilia	109.4	49.9	257.0	278.4	2,389
21	Amreli	Rajula	126.5	115.5	554.9	1,887.7	21,417
22	Amreli	Savar Kundla	227.4	177.6	876.2	931.5	9,157
23	Anand	Anand	821.4	147.7	2,315.5	252.2	35,652
24	Anand	Anklav	231.5	72.0	570.3	101.0	5,244
25	Anand	Borsad	534.2	157.2	1,319.6	290.5	11,834
26	Anand	Khambhat	503.9	131.6	1,373.6	614.0	13,880
27	Anand	Petlad	420.7	104.3	1,084.6	175.3	10,402
28	Anand	Sojitra	164.0	42.9	379.7	71.9	3,412
29	Anand	Tarapur	133.1	43.5	304.3	80.5	3,112
30	Anand	Umreth	138.4	57.5	516.5	88.5	6,037
31	Banas Kantha	Amirgadh	88.8	35.3	228.0	51.8	2,764
32	Banas Kantha	Bhabhar	95.7	41.4	234.6	58.9	2,707
33	Banas Kantha	Danta	132.9	51.7	304.7	86.5	4,574
34	Banas Kantha	Dantiwada	102.0	30.3	229.8	55.2	2,398
35	Banas Kantha	Deesa	505.6	152.8	1,402.1	232.6	13,820
36	Banas Kantha	Deodar	168.7	68.8	382.4	102.1	3,719
37	Banas Kantha	Dhanera	195.9	66.9	486.9	96.8	4,801
38	Banas Kantha	Kankrej	210.3	77.2	481.4	117.8	5,140
39	Banas Kantha	Palanpur	551.2	78.5	1,760.9	161.8	18,845
40	Banas Kantha	Tharad	210.0	87.0	533.5	129.7	5,628
41	Banas Kantha	Vadgam	278.2	53.3	663.5	107.8	6,498
42	Banas Kantha	Vav	158.6	66.7	377.8	100.8	3,503
43	Bharuch	Amod	171.9	46.6	362.8	318.2	4,354
44	Bharuch	Anklesvar	1,264.0	99.6	2,692.3	1,636.4	44,240
45	Bharuch	Bharuch	847.9	134.0	3,499.4	1,219.0	51,831
46	Bharuch	Hansot	131.8	37.7	284.9	489.4	8,047
47	Bharuch	Jambusar	369.8	95.6	785.3	1,106.7	11,728
48	Bharuch	Jhagadia	235.9	112.5	610.6	274.2	64,393
49	Bharuch	Vagra	175.1	96.0	390.9	3,691.7	22,189
50	Bharuch	Valia	173.5	91.6	383.0	211.4	11,046
51	Bhavnagar	Bhavnagar	981.0	246.7	3,743.4	1,187.2	45,365
52	Bhavnagar	Botad	309.1	111.8	896.8	140.4	9,047
53	Bhavnagar	Gadhada	209.1	88.8	593.5	111.3	5,975
54	Bhavnagar	Gariadhar	141.8	62.6	382.9	77.1	3,640
55	Bhavnagar	Ghogha	129.4	61.7	276.1	172.8	4,143
56	Bhavnagar	Mahuva	275.2	213.2	552.8	1,272.9	12,041
57	Bhavnagar	Palitana	235.6	108.0	591.2	139.7	6,847
58	Bhavnagar	Sihor	285.2	118.8	645.0	168.5	8,117
59	Bhavnagar	Talaja	352.0	200.7	787.3	436.6	9,099
60	Bhavnagar	Umrala	116.8	48.7	325.3	57.3	3,073
61	Bhavnagar	Vallabhipur	136.9	51.0	370.0	92.5	3,129
62	Dohad	Devgadbaria	133.8	70.2	211.8	112.8	4,691
63	Dohad	Dhanpur	59.5	38.2	84.7	58.0	3,739
64	Dohad	Dohad	172.7	81.6	268.7	137.4	7,133
65	Dohad	Fatepura	90.5	63.2	120.1	90.6	2,062
66	Dohad	Garbada	75.3	43.5	106.2	59.1	1,965
67	Dohad	Jhalod	141.4	112.2	206.5	209.9	4,716
68	Dohad	Limkheda	123.9	76.5	168.4	99.2	3,376
69	Gandhinagar	Dehgam	237.3	112.8	939.6	173.9	10,753
70	Gandhinagar	Gandhinagar	463.6	122.5	3,434.8	226.6	45,766
71	Gandhinagar	Kalol	271.5	96.1	1,914.5	170.6	42,412
72	Gandhinagar	Mansa	323.1	54.1	851.2	104.8	9,262
73	Jamnagar	Bhanvad	184.8	78.6	415.8	364.2	3,673
74	Jamnagar	Dhrol	327.9	60.9	945.8	306.7	5,268
75	Jamnagar	Jamjodhpur	234.4	94.8	582.9	420.4	4,959
76	Jamnagar	Jamnagar	2,962.0	748.4	6,963.0	2,192.0	43,205
77	Jamnagar	Jodiya	443.7	82.3	863.7	361.4	4,440
78	Jamnagar	Kalavad	295.2	123.1	748.8	616.0	6,792
79	Jamnagar	Kalyanpur	238.4	100.8	642.9	480.2	6,306
80	Jamnagar	Khambhalia	340.9	144.4	993.0	716.7	9,667
81	Jamnagar	Lalpur	173.7	1,220.6	23,305.6	11,754.8	206,986
82	Jamnagar	Okhamandal	201.7	169.7	1,056.5	1,088.1	29,583
83	Junagadh	Bhesan	61.5	59.6	296.3	297.4	2,834
84	Junagadh	Junagadh	265.2	193.2	1,716.2	858.2	14,708
85	Junagadh	Keshod	155.0	142.8	922.1	601.9	7,728
86	Junagadh	Kodinar	129.0	259.9	735.7	1,756.7	26,598
87	Junagadh	Malia	93.0	122.8	516.4	598.1	12,278
88	Junagadh	Manavadar	113.9	129.4	670.0	550.3	5,662
89	Junagadh	Mangrol	148.2	174.9	847.6	851.4	10,306
90	Junagadh	Mendarda	51.7	55.9	288.3	245.8	2,548
91	Junagadh	Patan-Veraval	169.2	247.2	1,057.4	1,257.5	26,193
92	Junagadh	Sutrapada	69.0	109.6	425.4	636.1	9,979
93	Junagadh	Talala	71.5	103.8	401.6	423.4	5,133
94	Junagadh	Una	480.2	213.3	1,044.7	1,014.8	13,455
95	Junagadh	Vanthali	84.0	84.6	934.5	411.1	8,047
96	Junagadh	Visavadar	123.1	132.5	720.8	606.9	6,600
97	Kachchh	Abdasa	417.7	100.5	575.2	484.2	7,621
98	Kachchh	Anjar	1,444.6	124.4	3,205.4	168.8	7,801
99	Kachchh	Bhachau	1,317.9	136.5	2,053.2	243.1	10,052
100	Kachchh	Bhuj	2,238.4	256.4	3,718.1	317.4	17,129
101	Kachchh	Gandhidham	2,282.6	486.1	5,500.2	809.0	13,793
102	Kachchh	Lakhpat	793.7	44.6	2,101.4	102.3	12,069
103	Kachchh	Mandvi	311.1	176.5	751.1	861.9	8,810
104	Kachchh	Mundra	530.6	88.1	1,013.3	625.3	6,014
105	Kachchh	Nakhatrana	709.1	127.5	1,274.2	512.9	6,352
106	Kachchh	Rapar	627.3	64.5	1,188.3	161.9	6,172
107	Kheda	Balasinor	111.2	55.8	180.1	83.7	4,690
108	Kheda	Kapadvanj	205.5	105.1	778.8	151.1	8,918
109	Kheda	Kathlal	162.8	86.8	521.0	120.5	5,818
110	Kheda	Kheda	198.4	42.9	597.3	74.1	5,975
111	Kheda	Mahudha	98.5	46.8	352.2	71.3	5,319
112	Kheda	Matar	203.2	59.9	710.9	99.8	8,674
113	Kheda	Mehmedabad	319.6	106.3	777.9	147.8	7,101
114	Kheda	Nadiad	675.3	140.4	1,855.4	230.8	21,110

GUJARAT COMPOSITE RISK ZONATION: COMPOSITE CAPITAL RISK DUE TO EARTHQUAKE AND CYCLONE & STORM SURGE (50 & 100 YEAR RETURN PERIOD) (Rs. MILLION 2001 PRICES) Table No. COMT - 02 of 04

GSDMA

Sr. No	District	Taluka	EQ (50 year return)	Cyc. & Surge (50 year return)	EQ (100 year return)	Cyc. & Surge (100 year return)	Total Capital Assets
115	Kheda	Thasra	244.3	112.0	1,527.4	161.9	21,785
116	Kheda	Virpur	70.3	37.1	106.7	52.6	2,279
117	Mahesana	Becharaji	151.4	32.1	396.0	60.5	4,181
118	Mahesana	Kadi	326.7	125.3	1,858.5	226 7	25,513
119	Mahesana	Kheralu	209.2	38.5	587.4	72.6	7,659
120	Mahesana	Mahesana	764.5	127.4	2,463.0	242.1	37,178
121	Mahesana	Satlasana	116.1	30.8	262.7	48.7	3,850
122	Mahesana	Unjha	312.7	41.4	820.6	81.2	8,631
123	Mahesana	Vadnagar	196.6	40.7	443.5	74.0	5,542
124	Mahesana	Vijapur	390.4	65.2	1,006.2	126.5	13,686
125	Mahesana	Visnagar	447.4	60.9	1,431.0	122.8	17,499
126	Narmada	Dediapada	68.9	110.9	94.4	315.5	3,174
127	Narmada	Nandod	131.6	93.9	240.0	246.0	9,367
128	Narmada	Sagbara	43.2	67.8	61.5	68.3	1,955
129	Narmada	Tilakwada	30.0	17.8	67.4	39.0	2,596
130	Navsari	Bansda	100.6	118.8	158.4	327.5	4,114
131	Navsari	Chikhli	196.6	131.6	376.3	349.0	9,206
132	Navsari	Gandevi	205.0	117.1	906.7	1,407.0	11,774
133	Navsari	Jalalpore	323.9	83.2	744.7	867.2	9,268
134	Navsari	Navsari	250.9	71.6	1,208.2	266.8	16,319
135	Panch Mahals	Ghoghamba	99.0	66.6	144.4	111.3	3,372
136	Panch Mahals	Godhra	288.6	116.2	485.9	176.8	14,948
137	Panch Mahals	Halol	138.4	69.5	242.5	135.7	22,727
138	Panch Mahals	Jambughoda	20.2	10.9	34.1	21.3	1,135
139	Panch Mahals	Kadana	87.2	55.8	118.7	70.9	2,883
140	Panch Mahals	Kalol	137.4	67.3	241.9	113.7	7,485
141	Panch Mahals	Khanpur	79.2	47.0	111.0	58.8	3,525
142	Panch Mahals	Lunawada	221.5	102.5	384.4	140.6	8,531
143	Panch Mahals	Morwa (Hadaf)	86.5	56.1	115.9	64.7	2,290
144	Panch Mahals	Santrampur	172.3	100.6	293.8	121.4	7,680
145	Panch Mahals	Shehera	196.6	112.8	267.4	134.6	4,662
146	Patan	Chanasma	203.4	39.6	539.7	76.8	5,379
147	Patan	Harij	133.7	33.8	355.8	64.1	3,556
148	Patan	Patan	497.6	88.4	1,512.7	159.1	14,916
149	Patan	Radhanpur	165.6	41.0	555.2	79.8	4,306
150	Patan	Sami	242.3	77.2	831.1	121.2	6,213
151	Patan	Santalpur	235.6	48.2	490.4	80.5	3,371
152	Patan	Sidhpur	284.0	43.5	871.6	82.1	8,192
153	Patan	Vagdod	116.5	29.9	257.8	51.0	2,445
154	Porbandar	Kutiyana	53.3	79.6	346.8	308.4	3,414
155	Porbandar	Porbandar	485.3	601.4	1,744.9	1,958.7	26,151
156	Porbandar	Ranavav	59.3	92.0	603.5	507.4	7,516
157	Rajkot	Dhoraji	301.5	106.5	881.7	457.2	7,658
158	Rajkot	Gondal	412.8	163.9	1,256.8	786.5	13,004
159	Rajkot	Jamkandorna	134.2	57.5	442.6	280.4	4,124
160	Rajkot	Jasdan	387.6	173.8	974.4	230.5	9,564
161	Rajkot	Jetpur	189.1	179.9	1,302.2	775.8	12,095
162	Rajkot	Kotda Sangani	153.1	57.2	526.9	319.5	6,840
163	Rajkot	Lodhika	113.5	50.3	423.7	256.3	3,546
164	Rajkot	Maliya	278.9	64.5	569.0	135.6	3,294
165	Rajkot	Morvi	618.2	154.4	3,366.4	181.1	18,624
166	Rajkot	Paddhari	188.3	74.8	949.9	373.5	5,039
167	Rajkot	Rajkot	1,942.2	392.2	6,677.9	2,029.4	72,014
168	Rajkot	Tankara	142.3	53.7	703.8	67.9	4,109
169	Rajkot	Upleta	356.0	118.3	1,036.0	531.9	8,611
170	Rajkot	Wankaner	298.3	103.9	1,448.4	119.6	8,236
171	Sabar Kantha	Bayad	156.9	79.7	598.4	112 0	6,032
172	Sabar Kantha	Bhiloda	183 5	97 3	278 2	144.0	6,558
173	Sabar Kantha	Dhansura	76.4	43.4	302.8	62.4	3,311
174	Sabar Kantha	Himatnagar	367.9	86.9	1,044.2	130.1	14,291
175	Sabar Kantha	Idar	419.3	89 1	1,146 6	144.1	11,304
176	Sabar Kantha	Khedbrahma	181.9	78.6	435.7	148 7	5,967
177	Sabar Kantha	Malpur	83.4	44.5	126.7	61.1	3,179
178	Sabar Kantha	Meghraj	136.4	81.4	191.3	101.0	4,282
179	Sabar Kantha	Modasa	169.8	74.4	637.4	110.5	8,166
180	Sabar Kantha	Prantij	195.2	49 2	472.1	77 8	7,754
181	Sabar Kantha	Talod	117.4	59.3	464.8	88.3	5,262
182	Sabar Kantha	Vadali	258.5	30.3	272.6	45 3	2,722
183	Sabar Kantha	Vijaynagar	96.6	60.2	136.8	75.4	2,811
184	Surat	Bardoli	155.7	66.1	314.8	165 4	9,919
185	Surat	Chorasi	878.2	389.1	2,540.7	22,922.1	223,042
186	Surat	Kamrej	201.9	51.4	542.1	106.5	6,918
187	Surat	Mahuva	83.4	72.1	161.1	187.6	4,259
188	Surat	Mandvi	101.4	108.7	168.1	288.2	10,777
189	Surat	Mangrol	141.4	78.7	500 8	175.1	13,631
190	Surat	Nizar	57.6	66.3	99.3	66.7	5,067
191	Surat	Olpad	281.4	74.1	630.7	1,286.2	13,296
192	Surat	Palsana	89.9	29.5	409 0	74.1	10,432
193	Surat	Songadh	94.5	126.9	146.1	357.6	8,109
194	Surat	Surat City	2,100.2	199.4	3,598.2	1,465.7	146,921
195	Surat	Uchchhal	27.5	38.2	43.0	108.0	5,333
196	Surat	Umarpada	33.3	48.4	49.7	134.2	1,450
197	Surat	Valod	54.3	43.4	101.4	111.6	2,349
198	Surat	Vyara	128.6	149.3	299.0	403.7	10,302
199	Surendranagar	Chotila	227.1	95.2	648.6	124.5	6,317
200	Surendranagar	Chuda	233.0	50.4	330.2	57.3	2,587
201	Surendranagar	Dasada	168.8	56.9	435.7	104.5	4,311
202	Surendranagar	Dhrangadhra	316.7	104.9	1,043.9	119.8	8,221
203	Surendranagar	Halvad	230.6	94.5	1,120.4	117.8	5,666
204	Surendranagar	Lakhtar	86.7	42.9	233.1	45.9	2,266
205	Surendranagar	Limbdi	322.5	119.5	869 3	135.6	7,724
206	Surendranagar	Muli	115.0	54.7	337.8	68.5	2,770
207	Surendranagar	Sayla	125.2	68.0	651.8	117.8	11,774
208	Surendranagar	Wadhwan	572.9	137.0	1,855.7	162.6	15,916
209	The Dangs	The Dangs	96.3	143.0	141.2	393.8	3,811
210	Vadodara	Chhota Udaipur	90.0	39.6	168.6	85.0	4,878
211	Vadodara	Dabhoi	119.5	40.6	256.9	89.4	6,946
212	Vadodara	Jetpur Pavi	80.9	41.5	150.6	93.5	3,934
213	Vadodara	Karjan	208.8	50.4	509.5	89.8	18,113
214	Vadodara	Kavant	44.2	44.4	73.8	106.5	2,389
215	Vadodara	Nasvadi	55.0	57.8	94.7	145.1	2,294
216	Vadodara	Padra	351.1	91.5	788.4	182.9	17,491
217	Vadodara	Sankheda	110.3	53.5	215.8	113 7	6,135
218	Vadodara	Savli	161.2	89.7	295.7	142.7	18,219
219	Vadodara	Sinor	40.3	18.0	92.5	37.1	2,400
220	Vadodara	Vadodara	1,633.1	258.5	7,988.4	536.5	197,554
221	Vadodara	Waghodia	87.3	41.9	177.1	83.5	10,260
222	Valsad	Dharampur	84.3	96.8	134.1	260.9	3,719
223	Valsad	Kaprada	85 1	106.1	122.3	273.8	3,087
224	Valsad	Pardi	503.7	121.3	1,323 1	399.5	38,382
225	Valsad	Umbergaon	234.6	89.0	648 3	408.7	15,614
226	Valsad	Valsad	498 1	140 0	615 6	875 7	29,541

GUJARAT COMPOSITE RISK ZONATION: COMPOSITE GVA RISK DUE TO DROUGHT & FLOOD

(Rs. MILLION 2001 PRICES) Table No. COMT - 03 of 04

GSDMA

Sr. No	District	Taluka	Drought			Flood	Total GVA
			Extreme	Severe	Moderate		
1	Ahmadabad	Ahmadabad City	56.8	14.0	1.4	40.1	38,134
2	Ahmadabad	Barwala	99.5	52.9	28.6	-	254
3	Ahmadabad	Bavla	78.3	48.9	24.7	7.1	1,152
4	Ahmadabad	Daskroi	86.7	46.5	19.2	15.9	4,863
5	Ahmadabad	Detroj-Rampura	81.4	53.2	31.9	-	259
6	Ahmadabad	Dhandhuka	321.8	173.8	95.0	7.8	1,179
7	Ahmadabad	Dholka	102.2	61.8	30.5	57.4	3,018
8	Ahmadabad	Mandal	116.8	76.1	45.6	-	383
9	Ahmadabad	Ranpur	90.5	48.2	26.1	0.4	257
10	Ahmadabad	Sanand	60.6	35.9	18.1	17.2	5,631
11	Ahmadabad	Viramgam	279.1	160.1	85.1	-	2,921
12	Amreli	Amreli	477.2	309.5	197.1	1.6	1,303
13	Amreli	Babra	340.5	219.2	173.6	-	707
14	Amreli	Bagasara	185.8	119.4	73.4	0.3	572
15	Amreli	Dhari	446.7	302.6	215.9	0.6	1,106
16	Amreli	Jafrabad	138.8	104.2	47.7	1.1	1,470
17	Amreli	Khambha	132.7	113.0	61.2	-	454
18	Amreli	Kunkavav Vadia	304.6	194.9	116.8	-	764
19	Amreli	Lathi	324.6	161.6	110.5	-	817
20	Amreli	Lilia	180.1	103.8	43.1	0.9	380
21	Amreli	Rajula	540.2	340.9	109.4	10.7	4,194
22	Amreli	Savar Kundla	473.7	339.6	247.8	1.2	1,476
23	Anand	Anand	45.1	16.3	6.4	6.0	5,974
24	Anand	Anklav	41.9	23.9	10.1	9.0	684
25	Anand	Borsad	14.8	6.4	2.0	6.6	1,143
26	Anand	Khambhat	43.3	23.8	11.9	2.2	1,460
27	Anand	Petlad	24.9	13.6	7.0	-	1,322
28	Anand	Sojitra	12.6	7.0	3.7	-	390
29	Anand	Tarapur	17.1	9.6	4.9	7.8	459
30	Anand	Umreth	11.4	6.0	2.8	1.4	901
31	Banas Kantha	Amirgadh	200.7	105.2	41.9	-	653
32	Banas Kantha	Bhabhar	321.0	187.4	117.8	-	502
33	Banas Kantha	Danta	228.2	115.5	31.9	-	861
34	Banas Kantha	Dantiwada	290.6	168.6	71.5	1.5	521
35	Banas Kantha	Deesa	1,054.0	672.3	291.3	7.9	2,310
36	Banas Kantha	Deodar	411.1	240.7	151.6	-	672
37	Banas Kantha	Dhanera	563.2	343.1	151.8	-	946
38	Banas Kantha	Kankrej	528.6	319.9	131.0	12.3	902
39	Banas Kantha	Palanpur	316.9	143.7	52.7	-	2,627
40	Banas Kantha	Tharad	620.4	479.9	309.2	0.3	999
41	Banas Kantha	Vadgam	242.6	134.1	49.3	1.8	1,387
42	Banas Kantha	Vav	408.0	261.8	156.9	-	548
43	Bharuch	Amod	60.1	37.1	20.7	1.4	745
44	Bharuch	Anklesvar	80.4	25.5	3.9	32.0	9,645
45	Bharuch	Bharuch	241.8	97.9	28.0	22.2	12,592
46	Bharuch	Hansot	12.4	4.9	2.2	0.8	1,523
47	Bharuch	Jambusar	257.2	153.3	83.6	6.4	2,113
48	Bharuch	Jhagadia	111.1	40.0	12.6	44.1	16,221
49	Bharuch	Vagra	233.2	114.8	55.1	-	3,502
50	Bharuch	Valia	56.6	23.4	8.9	24.6	2,389
51	Bhavnagar	Bhavnagar	399.2	155.9	49.4	1.6	7,006
52	Bhavnagar	Botad	264.8	152.7	109.3	0.4	941
53	Bhavnagar	Gadhada	321.8	188.3	133.2	1.3	794
54	Bhavnagar	Gariadhar	300.5	185.9	95.5	0.2	651
55	Bhavnagar	Ghogha	174.2	96.8	48.7	-	731
56	Bhavnagar	Mahuva	635.1	460.6	178.1	3.0	2,232
57	Bhavnagar	Palitana	254.0	158.2	71.3	3.0	899
58	Bhavnagar	Sihor	219.9	127.9	53.7	0.3	1,362
59	Bhavnagar	Talaja	238.6	130.9	53.3	4.0	1,035
60	Bhavnagar	Umrala	130.3	66.8	47.6	1.6	431
61	Bhavnagar	Vallabhipur	103.7	56.6	36.3	-	325
62	Dohad	Devgadbaria	133.4	88.6	57.5	1.0	606
63	Dohad	Dhanpur	94.7	58.8	40.0	1.3	511
64	Dohad	Dohad	169.3	111.1	76.4	0.2	1,008
65	Dohad	Fatepura	50.1	36.1	27.3	-	259
66	Dohad	Garbada	73.6	47.4	32.2	-	297
67	Dohad	Jhalod	199.6	145.7	107.5	2.2	884
68	Dohad	Limkheda	107.9	70.3	49.4	1.6	408
69	Gandhinagar	Dehgam	112.7	64.7	43.8	-	1,547
70	Gandhinagar	Gandhinagar	171.7	82.0	51.2	0.9	6,192
71	Gandhinagar	Kalol	160.1	74.7	42.3	0.2	7,718
72	Gandhinagar	Mansa	105.2	68.4	49.2	-	1,155
73	Jamnagar	Bhanvad	346.5	175.4	80.1	2.6	712
74	Jamnagar	Dhrol	332.8	203.9	152.7	1.7	1,073
75	Jamnagar	Jamjodhpur	509.3	321.6	168.8	0.6	1,083
76	Jamnagar	Jamnagar	727.8	419.9	295.2	8.7	8,622
77	Jamnagar	Jodiya	351.9	289.2	186.9	3.6	815
78	Jamnagar	Kalavad	696.8	392.9	232.0	0.5	1,250
79	Jamnagar	Kalyanpur	649.1	391.1	278.6	4.8	1,074
80	Jamnagar	Khambhalia	619.8	324.3	188.0	0.7	1,172
81	Jamnagar	Lalpur	3,916.0	1,217.8	114.1	42.2	52,306
82	Jamnagar	Okhamandal	377.9	190.6	45.8	-	4,633
83	Junagadh	Bhesan	277.3	148.9	76.7	-	640
84	Junagadh	Junagadh	364.4	157.9	72.0	4.2	2,087
85	Junagadh	Keshod	407.8	200.7	84.0	0.3	993
86	Junagadh	Kodinar	518.8	202.4	72.2	13.3	4,887
87	Junagadh	Malia	415.9	191.2	65.1	0.7	1,607
88	Junagadh	Manavadar	288.2	183.7	81.7	0.2	896
89	Junagadh	Mangrol	370.9	220.7	73.4	0.0	1,329
90	Junagadh	Mendarda	258.2	113.6	50.6	1.3	511
91	Junagadh	Patan-Veraval	101.8	50.3	9.1	13.9	3,642
92	Junagadh	Sutrapada	138.3	59.6	7.2	-	1,912
93	Junagadh	Talala	349.7	165.0	76.0	2.8	954
94	Junagadh	Una	280.3	165.9	81.2	4.4	1,719
95	Junagadh	Vanthali	238.3	134.9	47.2	2.6	956
96	Junagadh	Visavadar	467.9	284.1	240.4	1.3	1,188
97	Kachchh	Abdasa	236.9	163.3	116.0	2.0	1,178
98	Kachchh	Anjar	258.2	174.2	86.3	0.2	912
99	Kachchh	Bhachau	489.7	350.8	274.4	-	1,284
100	Kachchh	Bhuj	707.0	429.0	341.9	1.0	1,976
101	Kachchh	Gandhidham	124.6	57.4	17.4	-	5,669
102	Kachchh	Lakhpat	147.5	138.0	86.6	1.1	454
103	Kachchh	Mandvi	412.5	305.3	138.9	0.1	874
104	Kachchh	Mundra	245.8	144.2	69.5	0.8	822
105	Kachchh	Nakhatrana	557.3	343.1	304.5	1.7	1,053
106	Kachchh	Rapar	475.6	320.0	191.0	0.8	741
107	Kheda	Balasinor	104.2	54.6	33.0	-	454
108	Kheda	Kapadvanj	280.3	146.8	81.9	0.9	1,231
109	Kheda	Kathlal	149.1	78.8	44.2	0.5	671
110	Kheda	Kheda	19.6	10.3	5.2	7.9	891
111	Kheda	Mahudha	19.2	10.9	5.1	1.0	632
112	Kheda	Matar	24.2	9.9	5.0	7.6	1,670
113	Kheda	Mehmedabad	43.4	23.0	10.6	3.0	1,149
114	Kheda	Nadiad	32.8	18.2	8.5	7.0	3,147

GUJARAT COMPOSITE RISK ZONATION: COMPOSITE GVA RISK DUE TO DROUGHT & FLOOD

(Rs. MILLION 2001 PRICES) Table No. COMT - 03 of 04

GSDMA

Sr. No	District	Taluka	Drought			Flood	Total GVA
			Extreme	Severe	Moderate		
115	Kheda	Thasra	89.0	51.7	28.8	13.5	1,029
116	Kheda	Virpur	102.1	51.3	30.2	4.0	385
117	Mahesana	Becharaji	136.1	75.3	41.6	-	476
118	Mahesana	Kadi	183.7	100.5	65.8	-	3,979
119	Mahesana	Kheralu	137.1	74.1	24.9	-	917
120	Mahesana	Mahesana	416.0	194.9	114.5	0.3	6,232
121	Mahesana	Satlasana	111.0	63.4	22.9	-	450
122	Mahesana	Unjha	103.4	66.3	30.2	0.1	859
123	Mahesana	Vadnagar	118.6	66.4	23.3	-	641
124	Mahesana	Vijapur	165.0	109.1	79.2	-	1,716
125	Mahesana	Visnagar	153.3	95.3	63.8	-	1,601
126	Narmada	Dediapada	41.8	17.4	9.3	-	461
127	Narmada	Nandod	119.4	46.9	22.5	6.3	1,490
128	Narmada	Sagbara	85.1	40.6	24.0	-	459
129	Narmada	Tilakwada	57.5	30.0	15.2	0.5	435
130	Navsari	Bansda	2.8	1.5	0.8	41.5	786
131	Navsari	Chikhli	2.7	0.8	0.2	31.8	1,681
132	Navsari	Gandevi	2.4	1.0	0.3	24.1	1,665
133	Navsari	Jalalpore	1.0	0.4	0.2	4.5	1,094
134	Navsari	Navsari	0.7	0.2	0.1	9.5	2,355
135	Panch Mahals	Ghoghamba	124.0	80.7	51.5	2.0	539
136	Panch Mahals	Godhra	137.4	83.8	50.2	2.1	1,777
137	Panch Mahals	Halol	75.1	56.1	35.3	3.2	6,320
138	Panch Mahals	Jambughoda	14.0	11.0	6.7	0.1	206
139	Panch Mahals	Kadana	66.9	48.1	36.2	3.1	362
140	Panch Mahals	Kalol	54.7	38.6	26.2	0.2	1,194
141	Panch Mahals	Khanpur	42.9	28.0	18.8	4.3	502
142	Panch Mahals	Lunawada	84.7	55.5	37.3	13.2	1,195
143	Panch Mahals	Morwa (Hadaf)	53.7	34.2	21.1	4.3	317
144	Panch Mahals	Santrampur	95.2	67.3	50.1	0.7	538
145	Panch Mahals	Shehera	82.4	49.5	29.5	6.5	625
146	Patan	Chanasma	155.6	85.5	47.0	-	765
147	Patan	Harij	204.4	102.1	47.6	-	491
148	Patan	Patan	272.5	163.7	83.9	1.1	1,867
149	Patan	Radhanpur	230.3	131.3	76.2	9.0	543
150	Patan	Sami	455.2	257.8	107.5	6.0	920
151	Patan	Santalpur	244.9	181.0	85.2	3.9	393
152	Patan	Sidhpur	128.0	80.6	35.8	0.1	1,116
153	Patan	Vagdod	92.6	56.0	28.9	-	437
154	Porbandar	Kutiyana	101.2	90.4	20.9	2.0	326
155	Porbandar	Porbandar	564.0	344.6	173.2	4.8	4,162
156	Porbandar	Ranavav	130.0	61.3	18.9	2.3	1,108
157	Rajkot	Dhoraji	262.5	155.8	77.2	0.6	1,276
158	Rajkot	Gondal	586.1	354.6	252.7	6.1	2,130
159	Rajkot	Jamkandorna	277.4	139.6	93.7	0.4	741
160	Rajkot	Jasdan	417.8	242.6	186.5	0.9	1,413
161	Rajkot	Jetpur	493.6	236.7	111.8	5.5	3,038
162	Rajkot	Kotda Sangani	246.9	148.6	98.1	2.3	1,566
163	Rajkot	Lodhika	190.5	113.0	72.4	0.8	805
164	Rajkot	Maliya	244.9	178.9	92.8	4.6	695
165	Rajkot	Morvi	401.3	306.1	174.6	9.1	2,853
166	Rajkot	Paddhari	295.0	171.9	95.4	6.3	1,010
167	Rajkot	Rajkot	561.5	310.5	183.0	9.0	8,820
168	Rajkot	Tankara	236.9	183.1	106.9	4.8	1,044
169	Rajkot	Upleta	381.0	234.2	158.7	5.0	1,185
170	Rajkot	Wankaner	371.0	220.8	128.7	2.7	1,638
171	Sabar Kantha	Bayad	328.6	206.8	141.7	1.4	1,188
172	Sabar Kantha	Bhiloda	326.7	212.6	133.8	1.4	1,265
173	Sabar Kantha	Dhansura	178.1	116.2	80.7	1.8	703
174	Sabar Kantha	Himatnagar	377.1	236.0	140.2	2.0	2,420
175	Sabar Kantha	Idar	422.7	240.7	126.4	-	2,153
176	Sabar Kantha	Khedbrahma	321.5	180.3	74.6	0.1	1,037
177	Sabar Kantha	Malpur	123.7	73.8	54.1	0.4	545
178	Sabar Kantha	Meghraj	222.9	143.3	102.5	2.8	736
179	Sabar Kantha	Modasa	312.9	207.4	145.1	3.7	1,195
180	Sabar Kantha	Prantij	199.2	130.4	73.2	-	1,636
181	Sabar Kantha	Talod	199.3	134.2	76.1	-	916
182	Sabar Kantha	Vadali	160.6	92.2	48.6	-	639
183	Sabar Kantha	Vijaynagar	122.1	78.2	44.5	0.4	419
184	Surat	Bardoli	0.4	0.2	0.1	5.7	1,736
185	Surat	Chorasi	108.8	16.5	0.9	226.1	55,767
186	Surat	Kamrej	1.1	0.4	0.1	10.2	1,155
187	Surat	Mahuva	0.6	0.3	0.2	4.3	969
188	Surat	Mandvi	30.4	12.6	5.5	13.3	2,068
189	Surat	Mangrol	51.0	23.0	9.9	1.4	3,683
190	Surat	Nizar	34.8	13.6	5.4	-	549
191	Surat	Olpad	5.4	2.3	1.1	18.4	2,373
192	Surat	Palsana	0.1	-	-	2.2	1,929
193	Surat	Songadh	35.3	17.4	6.8	2.4	1,305
194	Surat	Surat City	20.2	2.8	0.3	54.0	15,319
195	Surat	Uchchhal	6.9	2.4	0.5	1.0	504
196	Surat	Umarpada	35.5	16.3	7.1	-	365
197	Surat	Valod	2.7	1.4	0.7	0.7	462
198	Surat	Vyara	9.1	5.0	1.9	1.3	1,359
199	Surendranagar	Chotila	363.0	161.8	111.8	1.1	1,102
200	Surendranagar	Chuda	96.9	59.0	31.3	0.6	290
201	Surendranagar	Dasada	272.9	140.6	55.0	-	753
202	Surendranagar	Dhrangadhra	518.5	189.1	124.8	1.0	1,370
203	Surendranagar	Halvad	627.7	361.6	156.8	4.1	1,116
204	Surendranagar	Lakhtar	112.0	57.8	42.1	-	350
205	Surendranagar	Limbdi	251.0	141.4	70.2	0.2	987
206	Surendranagar	Muli	378.1	231.0	134.9	1.5	780
207	Surendranagar	Sayla	429.2	171.4	105.7	2.5	2,975
208	Surendranagar	Wadhwan	248.5	103.7	75.3	1.9	2,255
209	The Dangs	The Dangs	100.5	56.3	20.1	0.2	620
210	Vadodara	Chhota Udaipur	132.2	70.7	41.8	0.8	785
211	Vadodara	Dabhoi	101.7	62.9	35.4	1.6	970
212	Vadodara	Jetpur Pavi	90.8	56.0	33.1	3.6	835
213	Vadodara	Karjan	66.2	34.6	18.9	4.7	5,042
214	Vadodara	Kavant	99.2	54.0	32.3	1.1	376
215	Vadodara	Nasvadi	91.4	45.0	23.6	-	443
216	Vadodara	Padra	139.8	67.7	30.4	6.7	3,652
217	Vadodara	Sankheda	150.8	100.7	58.1	-	966
218	Vadodara	Savli	251.7	116.2	54.9	9.0	4,331
219	Vadodara	Sinor	28.0	14.8	7.9	0.8	468
220	Vadodara	Vadodara	557.2	153.2	22.4	47.3	36,783
221	Vadodara	Vaghodia	143.0	90.4	47.9	2.3	2,753
222	Valsad	Dharampur	-	-	-	1.5	783
223	Valsad	Kaprada	-	-	-	1.9	460
224	Valsad	Pardi	-	-	-	39.1	8,454
225	Valsad	Umbergaon	0.9	0.2	-	35.5	3,547
226	Valsad	Valsad	-	-	-	42.4	5,640

GUJARAT COMPOSITE RISK ZONATION: COMPOSITE GVA RISK DUE TO EARTHQUAKE AND CYCLONE & STORM SURGE
(50 & 100 YEAR RETURN PERIOD) (Rs. MILLION 2001 PRICES) Table No. COMT - 04 of 04

GSDMA

Sr. No	District	Taluka	EQ. (50 year return)	Cyc. & Surge (50 year return)	EQ. (100 year return)	Cyc. & Surge (100 year return)	Total GVA
1	Ahmadabad	Ahmadabad City	1.5	9.4	1,077.9	12.5	38,134
2	Ahmadabad	Barwala	2.9	1.0	4.9	19.4	254
3	Ahmadabad	Bavla	0.8	5.3	16.8	6.9	1,152
4	Ahmadabad	Daskroi	17.5	11.1	132.0	14.7	4,863
5	Ahmadabad	Detroj-Rampura	-	1.3	3.5	1.9	259
6	Ahmadabad	Dhandhuka	0.3	10.4	12.0	82.8	1,179
7	Ahmadabad	Dholka	12.5	8.6	80.3	30.7	3,018
8	Ahmadabad	Mandal	-	1.0	5.0	1.2	383
9	Ahmadabad	Ranpur	3.3	1.2	6.7	2.0	257
10	Ahmadabad	Sanand	-	10.7	120.2	13.1	5,631
11	Ahmadabad	Viramgam	-	4.9	58.0	6.9	2,921
12	Amreli	Amreli	9.6	10.1	46.1	14.7	1,303
13	Amreli	Babra	-	3.7	19.7	6.0	707
14	Amreli	Bagasara	0.2	2.5	10.1	12.4	572
15	Amreli	Dhari	0.5	6.0	12.0	18.6	1,106
16	Amreli	Jafrabad	0.3	31.5	6.4	127.7	1,470
17	Amreli	Khambha	-	1.6	7.3	7.5	454
18	Amreli	Kunkavav Vadia	-	2.6	4.3	7.6	764
19	Amreli	Lathi	-	2.6	10.3	4.1	817
20	Amreli	Lilia	-	1.1	2.6	1.7	380
21	Amreli	Rajula	-	8.7	45.7	151.5	4,194
22	Amreli	Savar Kundla		5.7	10.8	9.5	1,476
23	Anand	Anand	-	25.6	211.9	37.5	5,974
24	Anand	Anklav	4.3	2.5	16.7	3.6	684
25	Anand	Borsad	8.6	5.0	47.7	15.0	1,143
26	Anand	Khambhat	7.7	17.3	50.4	53.4	1,460
27	Anand	Petlad	9.6	5.5	49.8	8.5	1,322
28	Anand	Sojitra	-	1.5	5.0	2.1	390
29	Anand	Tarapur	-	1.4	4.1	3.6	459
30	Anand	Umreth	.	2.6	22.1	3.8	901
31	Banas Kantha	Amirgadh	0.2	0.8	5.2	1.5	653
32	Banas Kantha	Bhabhar	2.4	0.8	4.8	1.2	502
33	Banas Kantha	Danta	0.3	1.2	8.2	2.3	861
34	Banas Kantha	Dantiwada	0.3	1.2	2.8	2.1	521
35	Banas Kantha	Deesa	12.0	5.3	64.0	8.9	2,310
36	Banas Kantha	Deodar	0.4	2.2	4.9	3.4	672
37	Banas Kantha	Dhanera	0.5	1.8	6.3	3.3	946
38	Banas Kantha	Kankrej	4.3	2.2	17.0	3.5	902
39	Banas Kantha	Palanpur	11.8	5.3	99.9	8.8	2,627
40	Banas Kantha	Tharad	0.3	1.3	9.4	2.3	999
41	Banas Kantha	Vadgam	1.1	5.0	10.7	8.2	1,387
42	Banas Kantha	Vav	1.8	0.3	12.4	0.5	548
43	Bharuch	Amod	5.0	3.9	19.9	26.2	745
44	Bharuch	Anklesvar	162.4	24.9	322.8	183.4	9,645
45	Bharuch	Bharuch	164.9	26.2	407.5	151.5	12,592
46	Bharuch	Hansot	0.7	2.4	15.1	44.8	1,523
47	Bharuch	Jambusar	5.6	11.8	35.8	112.4	2,113
48	Bharuch	Jhagadia	4.0	5.0	172.0	7.7	16,221
49	Bharuch	Vagra	4.9	38.5	46.3	252.9	3,502
50	Bharuch	Valia	2.6	1.0	27.2	2.0	2,389
51	Bhavnagar	Bhavnagar	5.1	36.3	210.8	116.4	7,006
52	Bhavnagar	Botad	11.4	5.9	20.6	10.0	941
53	Bhavnagar	Gadhada	0.4	3.7	12.9	5.9	794
54	Bhavnagar	Gariadhar	-	2.4	6.9	4.0	651
55	Bhavnagar	Ghogha	0.3	2.5	8.3	15.1	731
56	Bhavnagar	Mahuva	-	7.4	18.3	26.8	2,232
57	Bhavnagar	Palitana	.	4.2	23.1	7.3	899
58	Bhavnagar	Sihor	9.7	7.2	40.3	14.4	1,362
59	Bhavnagar	Talaja	6.2	7.2	26.2	32.6	1,035
60	Bhavnagar	Umrala	0.1	1.1	6.4	2.0	431
61	Bhavnagar	Vallabhipur	4.5	1.2	9.9	4.8	325
62	Dohad	Devgadbaria	-	0.9	2.1	1.7	606
63	Dohad	Dhanpur	-	0.3	-	0.6	511
64	Dohad	Dohad	-	2.3	6.2	4.9	1,008
65	Dohad	Fatepura	-	0.4	-	0.6	259
66	Dohad	Garbada	-	0.3	-	0.6	297
67	Dohad	Jhalod	-	1.7	3.8	3.0	884
68	Dohad	Limkheda	-	0.7	1.6	1.3	408
69	Gandhinagar	Dehgam	-	5.2	13.9	7.2	1,547
70	Gandhinagar	Gandhinagar	-	8.9	187.2	13.0	6,192
71	Gandhinagar	Kalol	-	15.3	185.1	22.4	7,718
72	Gandhinagar	Mansa	9.5	5.5	44.0	7.5	1,155
73	Jamnagar	Bhanvad	2.7	3.2	11.4	8.9	712
74	Jamnagar	Dhrol	18.6	1.6	28.2	3.2	1,073
75	Jamnagar	Jamjodhpur	0.5	5.6	12.2	20.9	1,083
76	Jamnagar	Jamnagar	80.1	141.9	229.3	204.8	8,622
77	Jamnagar	Jodiya	10.4	3.1	21.1	28.2	815
78	Jamnagar	Kalavad	0.4	3.8	15.1	13.8	1,250
79	Jamnagar	Kalyanpur	0.3	4.7	6.4	22.4	1,074
80	Jamnagar	Khambhalia	0.6	9.0	17.2	31.5	1,172
81	Jamnagar	Lalpur	0.3	313.2	3,353.4	1,311.7	52,306
82	Jamnagar	Okhamandal	0.6	48.2	94.8	226.1	4,633
83	Junagadh	Bhesan	-	3.3	6.4	10.3	640
84	Junagadh	Junagadh	-	27.7	35.2	80.2	2,087
85	Junagadh	Keshod	-	7.3	24.5	22.5	993
86	Junagadh	Kodinar	-	31.8	47.9	131.0	4,887
87	Junagadh	Malia	-	6.7	66.1	91.3	1,607
88	Junagadh	Manavadar	-	5.8	21.0	20.0	896
89	Junagadh	Mangrol	-	20.1	10.2	85.7	1,329
90	Junagadh	Mendarda	-	2.9	4.9	9.6	511
91	Junagadh	Patan-Veraval	-	70.9	23.2	309.6	3,642
92	Junagadh	Sutrapada	-	14.3	20.7	59.3	1,912
93	Junagadh	Talala	-	5.7	11.3	26.0	954
94	Junagadh	Una	-	31.8	7.8	134.7	1,719
95	Junagadh	Vanthali	-	4.7	48.9	49.8	956
96	Junagadh	Visavadar	-	6.1	32.6	25.6	1,188
97	Kachchh	Abdasa	5.1	22.9	12.8	107.9	1,178
98	Kachchh	Anjar	18.8	11.2	28.1	18.4	912
99	Kachchh	Bhachau	43.2	8.1	46.5	24.3	1,284
100	Kachchh	Bhuj	92.2	15.0	145.6	23.6	1,976
101	Kachchh	Gandhidham	115.8	52.2	316.8	264.4	5,669
102	Kachchh	Lakhpat	23.1	0.6	19.3	9.2	454
103	Kachchh	Mandvi	20.7	9.5	46.2	34.6	874
104	Kachchh	Mundra	17.0	1.8	33.5	37.1	822
105	Kachchh	Nakhatrana	16.4	8.8	21.4	14.1	1,053
106	Kachchh	Rapar	8.5	6.1	17.1	8.7	741
107	Kheda	Balasinor	-	1.3	6.0	1.9	454
108	Kheda	Kapadvanj		3.6	30.1	5.3	1,231
109	Kheda	Kathlal	-	1.6	16.0	2.4	671
110	Kheda	Kheda	2.0	1.3	20.2	1.7	891
111	Kheda	Mahudha	-	1.5	23.2	2.1	632
112	Kheda	Matar	4.0	2.5	55.5	3.6	1,670
113	Kheda	Mehmedabad	8.0	4.6	38.0	6.8	1,149
114	Kheda	Nadiad	25.2	14.5	122.4	21.3	3,147

GUJARAT COMPOSITE RISK ZONATION: COMPOSITE GVA RISK DUE TO EARTHQUAKE AND CYCLONE & STORM SURGE (50 & 100 YEAR RETURN PERIOD) (Rs. MILLION 2001 PRICES) Table No. COMT - 04 of 04

GSDMA

Sr. No	District	Taluka	EQ. (50 year return)	Cyc. & Surge (50 year return)	EQ. (100 year return)	Cyc. & Surge (100 year return)	Total GVA
115	Kheda	Thasra	-	3.1	21.5	4.5	1,029
116	Kheda	Virpur	-	0.4	2.0	0.7	385
117	Mahesana	Becharaji	0 4	2.1	8.8	3.0	476
118	Mahesana	Kadı	-	12.7	92.4	16 8	3,979
119	Mahesana	Kheralu	4.6	2.0	27.4	3.4	917
120	Mahesana	Mahesana	3.0	17.4	128.5	24.0	6,232
121	Mahesana	Satlasana	0.3	1.3	4.4	2.1	450
122	Mahesana	Unjha	8.5	4.4	35.0	6.3	859
123	Mahesana	Vadnagar	3.0	1.5	11.9	2.2	641
124	Mahesana	Vijapur	12.6	6.5	54.0	9.3	1,716
125	Mahesana	Visnagar	1.1	5.5	43.9	8.0	1,601
126	Narmada	Dediapada	-	0.4	1.0	0.7	461
127	Narmada	Nandod	-	1.0	2.3	1.7	1,490
128	Narmada	Sagbara	-	0.2	0.8	0.5	459
129	Narmada	Tilakwada	-	0.6	9.9	1.1	435
130	Navsari	Bansda	-	1.6	4.3	3.4	786
131	Navsari	Chikhli	-	3.9	27.0	7.9	1,681
132	Navsari	Gandevi	-	41.7	54.8	104.5	1,665
133	Navsari	Jalalpore	-	25.9	32.4	49.4	1,094
134	Navsari	Navsari	-	13.0	90.9	24.1	2,355
135	Panch Mahals	Ghoghamba	-	0.9	1.7	1.3	539
136	Panch Mahals	Godhra	-	5.2	10.1	8.0	1,777
137	Panch Mahals	Halol	-	5.0	9.7	8.2	6,320
138	Panch Mahals	Jambughoda	-	0 3	-	0 5	206
139	Panch Mahals	Kadana	-	0.7	-	1.2	362
140	Panch Mahals	Kalol	-	3.0	10.1	4.9	1,194
141	Panch Mahals	Khanpur	-	1.0	2.2	1.7	502
142	Panch Mahals	Lunawada	-	2.8	5.4	4.3	1,195
143	Panch Mahals	Morwa (Hadaf)	-	1.0	-	1.7	317
144	Panch Mahals	Santrampur	-	1.4	-	2.5	538
145	Panch Mahals	Shehera	-	0.7	1.4	1.1	625
146	Patan	Chanasma	0.6	3.3	12.2	4.7	765
147	Patan	Harij	0.3	1.5	9.3	2.3	491
148	Patan	Patan	1.0	5.3	42.2	7.6	1,867
149	Patan	Radhanpur	5 0	0.3	16.9	0.4	543
150	Patan	Sami	0.3	1.5	29.0	2.1	920
151	Patan	Santalpur	1.3	0.2	10.7	0 2	393
152	Patan	Sidhpur	10.6	5.4	53.1	7.8	1,116
153	Patan	Vagdod	0.4	2.2	3.3	3.2	437
154	Porbandar	Kutiyana	-	2.9	6 8	11.6	326
155	Porbandar	Porbandar	0.1	70.5	107.8	335.1	4,162
156	Porbandar	Ranavav	-	7.5	28.2	38.8	1,108
157	Rajkot	Dhoraji	-	13.9	22.6	42.2	1,276
158	Rajkot	Gondal	14.8	14.0	70.7	49.3	2,130
159	Rajkot	Jamkandorna	0.3	3.3	16.9	19.8	741
160	Rajkot	Jasdan	10.3	8.3	41.4	13.1	1,413
161	Rajkot	Jetpur	-	14.5	31.9	51.1	3,038
162	Rajkot	Kotda Sangani	0.2	1.4	42.9	9.8	1,566
163	Rajkot	Lodhika	0.5	4.6	29.6	9.5	805
164	Rajkot	Maliya	1.2	0 5	5.2	9.4	695
165	Rajkot	Morvi	28.9	29.3	90.5	46.0	2,853
166	Rajkot	Paddhari	5.3	4.7	52.7	8.7	1,010
167	Rajkot	Rajkot	12.7	113.2	249.3	192.4	8,820
168	Rajkot	Tankara	7.4	1.0	41.5	4.7	1,044
169	Rajkot	Upleta	-	12.9	19.4	39.0	1,185
170	Rajkot	Wankaner	0.1	0 6	35 3	2.7	1,638
171	Sabar Kantha	Bayad		2.4	6.1	3.6	1,188
172	Sabar Kantha	Bhiloda	-	1.1	3.1	2.0	1,265
173	Sabar Kantha	Dhansura	-	1 3	4.2	2 0	703
174	Sabar Kantha	Himatnagar	-	6.1	28.0	8.8	2,420
175	Sabar Kantha	Idar	8.1	3.6	41.9	5.6	2,153
176	Sabar Kantha	Khedbrahma	1.7	0.6	9.8	1.2	1,037
177	Sabar Kantha	Malpur	-	0.7	2.6	1.2	545
178	Sabar Kantha	Meghraj	-	1.0	3 0	1.7	736
179	Sabar Kantha	Modasa	-	2.0	12.0	3.3	1,195
180	Sabar Kantha	Prantij	-	3 8	13.0	5.5	1,636
181	Sabar Kantha	Talod	-	2.3	18.0	3 6	916
182	Sabar Kantha	Vadali	0.5	0.6	3.0	1.2	639
183	Sabar Kantha	Vijaynagar	-	0.5	0.2	0.9	419
184	Surat	Bardolı	-	3.3	24.0	6.2	1,736
185	Surat	Chorasi	317.3	458.9	1,452.7	2,977 0	55,767
186	Surat	Kamrej	-	18.3	113.4	31.9	1,155
187	Surat	Mahuva	-	1.1	8.6	2.1	969
188	Surat	Mandvi	-	6.3	16.9	14 1	2,068
189	Surat	Mangrol	42.4	18.9	171.5	35.8	3,683
190	Surat	Nizar	-	0.5	1.6	0.9	549
191	Surat	Olpad	9 9	11.6	52 1	141 1	2,373
192	Surat	Palsana	-	9 6	72.7	16.6	1,929
193	Surat	Songadh	-	0.4	1.3	1.0	1,305
194	Surat	Surat City	65.4	-	5.5	119.1	15,319
195	Surat	Uchchhal	-	0.1	0.4	0.3	504
196	Surat	Umarpada	-	0.1	-	0.3	365
197	Surat	Valod	-	0.8	4 0	1.7	462
198	Surat	Vyara	-	1.5	4.5	3.0	1,359
199	Surendranagar	Chotila	0.3	2.6	25 1	6.7	1,102
200	Surendranagar	Chuda	4.1	1.3	7.5	2.2	290
201	Surendranagar	Dasada	-	1.4	7.6	1.9	753
202	Surendranagar	Dhrangadhra	6.3	4.4	53.9	6.0	1,370
203	Surendranagar	Halvad	0.7	5.5	22.4	8.2	1,116
204	Surendranagar	Lakhtar	0.3	2.0	5.8	2.7	350
205	Surendranagar	Limbdi	1.8	1.3	16.7	2.5	987
206	Surendranagar	Muli	0 4	2.9	16.1	5.1	780
207	Surendranagar	Sayla	0.7	5.2	68.4	22.5	2,975
208	Surendranagar	Wadhwan	1.0	6.9	65.3	15.5	2,255
209	The Dangs	The Dangs	-	1 1	3 7	2.5	620
210	Vadodara	Chhota Udaipur	-	1.0	2.3	1.7	785
211	Vadodara	Dabhoi	-	2 8	5 4	4.6	970
212	Vadodara	Jetpur Pavi	-	0 8	1.7	1.3	835
213	Vadodara	Karjan	-	2.4	60 3	4.0	5,042
214	Vadodara	Kavant	-	0.5	1.1	0.8	376
215	Vadodara	Nasvadı	-	0.9	2.1	1.5	443
216	Vadodara	Padra	7.4	4.5	59.1	10 4	3,652
217	Vadodara	Sankheda	-	2.6	5 2	4 0	966
218	Vadodara	Savli	-	5.1	52.2	7.4	4,331
219	Vadodara	Sinor	-	2.0	6 0	3.2	468
220	Vadodara	Vadodara	-	96.3	958.9	141 1	36,783
221	Vadodara	Vaghodia	-	2.6	4 4	3.7	2,753
222	Valsad	Dharampur	-	1.8	4 0	3.4	783
223	Valsad	Kaprada	-	0.7	1 3	1 1	460
224	Valsad	Pardi	-	22.6	214.1	43.3	8,454
225	Valsad	Umbergaon	-	17.5	104.1	32 0	3,547
226	Valsad	Valsad	-	38.6	85.3	72.3	5,640

ANNUALISED COMPOSITE RISK & RISK INDEX

ANNUALISED COMPOSITE RISK AND VULNERABILITY ASSESSMENT

Annualised risk is estimated from the summation of the series of probabilistic risk estimates for 10, 25, 50 and 100-year return period events.

ANNUALISED COMPOSITE RISK

The Annualised composite capital risk is highest for earthquakes estimated at Rs. 3,839 million (60 percent) followed by cyclone and storm surge accounting for Rs. 1,692 million (26 percent) and flood accounting for Rs. 801 million (12 percent) and lowest for drought accounting for Rs. 88 million (1 percent) of the total annual capital risk respectively. The GVA risk is highest for drought at Rs. 9,759 million (95 percent of the total annual GVA risk) followed by earthquake, cyclone & storm surge and floods.

Table (3.1): Annualised Composite Risk Estimates for Gujarat (Rs. Million - 2001 Prices)

Hazard	Capital Risk		GVA Risk	
	Amount (Rs. Million)	% to Total Risk	Amount (Rs.Million)	% to Total Risk
Drought	88	1%	9,759	95%
Flood	801	12%	135	1%
Earthquake	3,839	60%	183	2%
Cyclone & Storm Surge	1,692	26%	157	2%
All Hazards	6,420	100%	10,235	100%

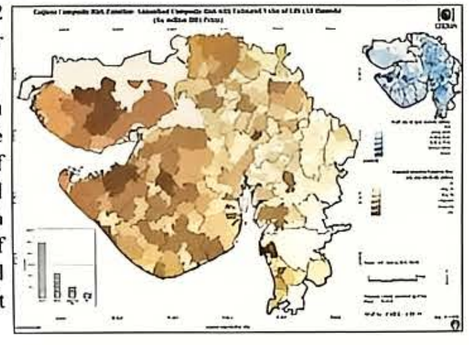
Source: TARU Analysis, 2005

Table (3.2): Estimated Annualised Composite Risk (With Value of Loss of Life) (Rs. Million - 2001 Prices)

Hazard	Composite Risk		Composite Risk with Value of Life	
	Amount (Rs.Million)	% to Total Risk	Amount (Rs.Million)	% to Total Risk
Drought	9,847	59%	9,847	57%
Flood	936	6%	952	6%
Earthquake	4,022	24%	4,431	26%
Cyclone & Storm Surge	1,849	11%	2,052	12%
All Hazards	16,655	100%	17,282	100%

Source: TARU Analysis, 2005

The Annualised Average Loss (AAL) was computed across all hazard categories including loss of life. The Annualised Composite Risk is highest for drought accounting for Rs. 9,847 million (59 percent) followed by earthquake accounting for Rs. 4,022 million (24 percent), cyclone and storm surge accounting for Rs. 1,849 million (11 percent), and flood accounting for Rs. 936 million (5 percent of the total annual composite risk respectively). The overall risk trends do not change significantly with the addition of loss of life value estimates except for an increase to an estimated Rs. 17,282 million from Rs. 16,655 million for the composite risk.



Annualised Composite Risk with estimated value of loss of life suggests higher risk to talukas of Saurashtra and Kachchh, coastal Gujarat and some talukas of north Gujarat. However, most parts of south Gujarat (except coastal areas) and the eastern tribal belt have lower risk exposure.

ANNUALISED COMPOSITE VULNERABILITY

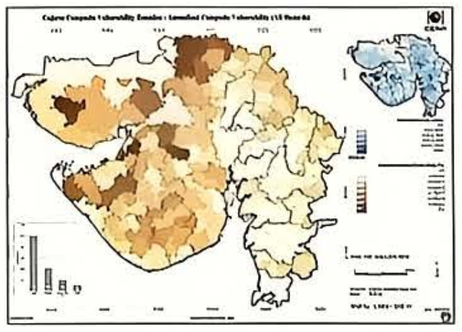
Composite Capital Vulnerability is estimated at 0.20 percent of total capital stock and is highest for earthquake (0.12 percent) followed by cyclone and surge (0.05 percent), flood (0.02 percent) and drought (0.01 percent). The Annualised Composite GVA Vulnerability is estimated at 1.77 percent of the total GVA of which 1.69 percent is accounted for by drought.

Table (3.3): Composite Vulnerability

Hazard	Capital Vulnerability	GVA Vulnerability
Drought	0.01%	1.69%
Flood	0.02%	0.02%
Earthquake	0.12%	0.03%
Cyclone & Storm Surge	0.05%	0.03%
All Hazards	0.20%	1.77%

Source: TARU Analysis, 2005

Annualised Composite Vulnerability based on capital and GVA risk suggests higher vulnerability of most talukas of Saurashtra and Kachchh apart from Banaskantha and Patan districts as presented in the adjoining figure.



GUJARAT COMPOSITE RISK INDEX

An overall Composite Risk Index for Gujarat on a taluka-wise basis was developed estimated to prioritize overall investments and disaster mitigation and related development interventions. The Risk Index has been computed by stratifying annualised risk estimates by two quintile classes to generate a five-point Risk scale (Very High, High, Moderate, Low and Very Low).

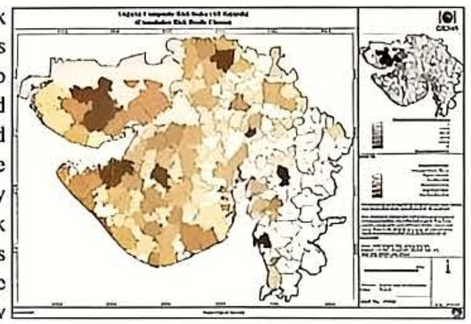


Table (4.1): All Hazards Taluka-wise Gujarat Risk Index Classification (No. of Talukas)

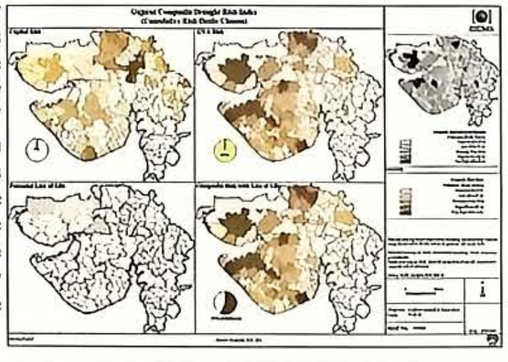
Risk Decile Class	Composite Risk	Composite Capital Risk	Composite GVA Risk	Potential Risk of Loss of Life
Very High (IX to X Decile)	9	4	12	4
High (VII to VIII Decile)	23	13	21	6
Moderate (V to VI Decile)	34	31	29	14
Low (III to IV Decile)	49	54	42	35
Very Low (I to II Decile)	111	124	122	167

Source: TARU Analysis, 2005

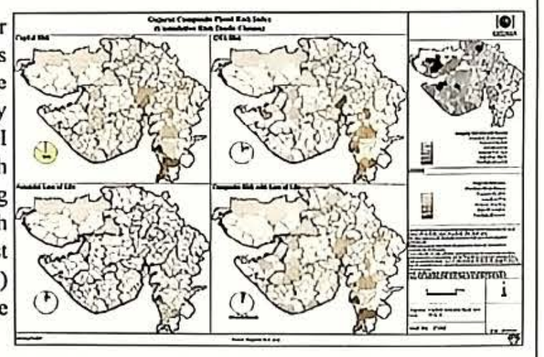
Composite Risk Index for Gujarat suggest nine talukas as most vulnerable, falling in the V quintile class followed by 23 talukas falling in the IV Risk quintile class with high vulnerability, 34 talukas falling in III Risk quintile class with moderate vulnerability and the remaining 160 talukas in low (II) and very low (I) Risk quintile vulnerability.

The potential risk of loss of life contributes 4 percent to the Composite Risk Index while 37 percent is contributed by Capital Risk and 59 percent by GVA Risk.

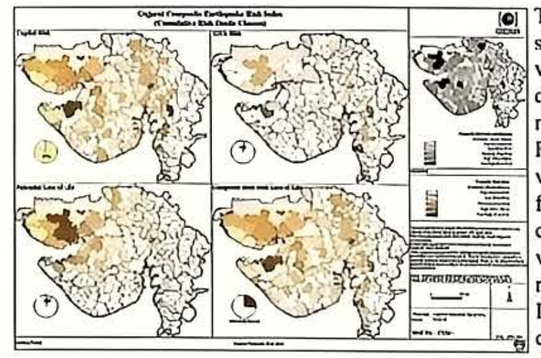
The Drought Risk Index for Gujarat has 12 talukas as most vulnerable falling in the V quintile class, followed by 21 talukas falling in the IV Risk quintile class with high vulnerability, 28 talukas falling in III Risk quintile class with moderate vulnerability and the remaining 165 talukas in low (II and very low Risk quintile class) vulnerability.



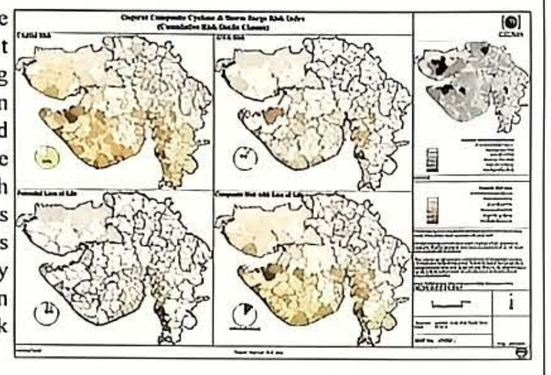
The Flood Risk Index for Gujarat suggests three talukas as most vulnerable falling in the V quintile class followed by five talukas falling in the III Risk quintile class with high vulnerability, 11 talukas falling in III Risk quintile class with moderate vulnerability and rest of the 207 talukas in low (II) and very low (I Risk quintile class) vulnerability.



The Earthquake Risk Index suggests four talukas as most vulnerable falling in the V quintile class followed by nine talukas falling in the IV Risk quintile class with high vulnerability, 27 talukas falling in III Risk quintile class with moderate vulnerability and the remaining 186 talukas in low II and very low (I Risk quintile class) vulnerability.



The Cyclone and Storm Surge Risk Index for Gujarat suggests two talukas as being the most vulnerable falling in the V quintile class, followed by eight talukas falling in the IV Risk quintile class with high vulnerability, 20 talukas falling in III Risk quintile class with moderate vulnerability and rest of the 196 talukas in low II and very low (I Risk quintile class) vulnerability.



CONCLUSIONS

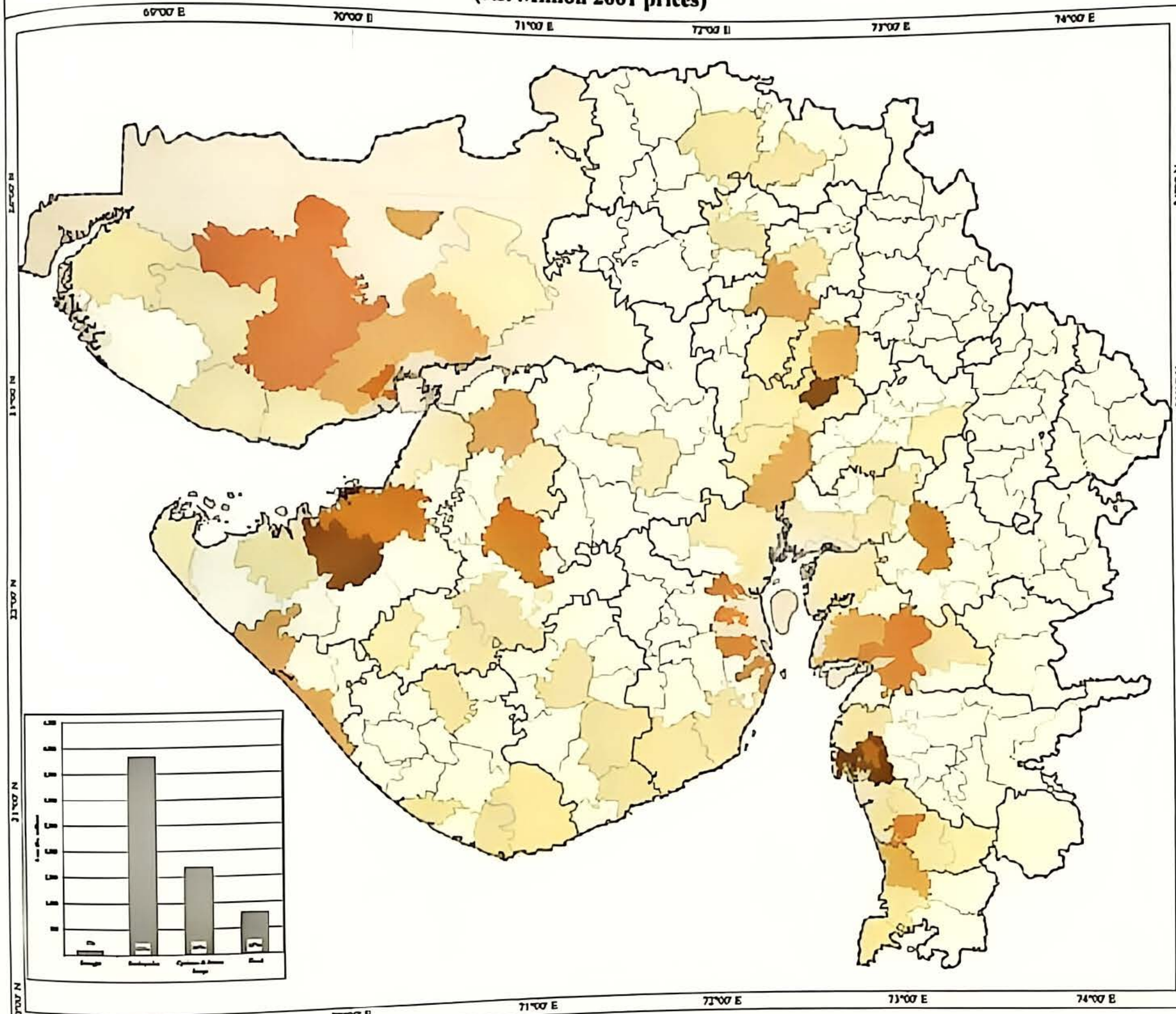
A rank ordering for Composite Capital Risk suggests that 100-year earthquake event has the highest risk followed by 100-year cyclone and surge, 50-year earthquake, 50-year cyclone and surge event; flood and drought.

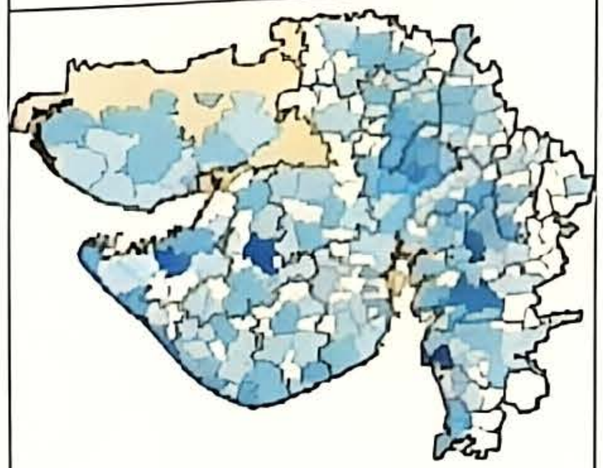
A rank ordering for Composite GVA Risk suggests extreme drought, followed by severe and moderate drought, and 100-year return earthquake event as the highest risk followed by 100-year cyclone and surge event, 50-year cyclone and surge event, 50-year earthquake event and flood.

Drought is the most important hazard with a composite annualised risk of Rs. 9,847 million (56 percent of the total annualised risk) followed by earthquakes accounting for Rs. 4,022 million (26 percent of the total annualised risk), cyclone and storm surge accounting for Rs.1,849 million (12 percent of the total annualised risk) and flood accounting for Rs. 936 million (6 percent of the total annualised risk).

Gujarat Composite Risk Zonation : Annualised Composite Capital Risk (All Hazards)
(Rs. Million 2001 prices)

GSDMA





Total Value of Capital Assets (Rs. Million)
- < 5000
- > 5000 to 10000
- > 10000 to 20000
- > 20000 to 50000
- > 50000 to 100000
- > 100000

LEGEND

Estimated Annualised Capital Risk (Rs. Million)
- < 25
- > 25 to 50
- > 50 to 75
- > 75 to 100
- > 100 to 250
- > 250

Source: TARU Analysis, 2004, BISAG, GoG

0 100 km

N

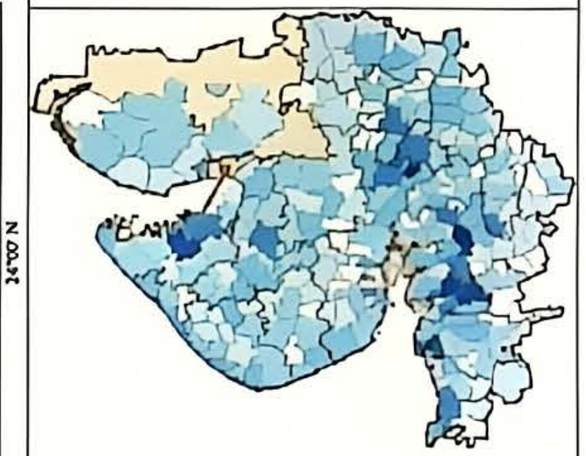
Projection : Lambert Azimuthal Equal Area
Datum : WGS 84

MAP No. : CARM - 01 OF 04

Date : 24/6/2005

Gujarat Composite Risk Zonation : Annualised Composite GVA Risk (All Hazards)
(Rs. Million 2001 prices)

GSDMA



LEGEND

Estimated Annualised GVA Risk (Rs. Million)
< 25
> 25 to 50
> 50 to 75
> 75 to 100
> 100 to 250
> 250

Source: TARU Analysis, 2004; BISAG, GoG

0 100 km

N

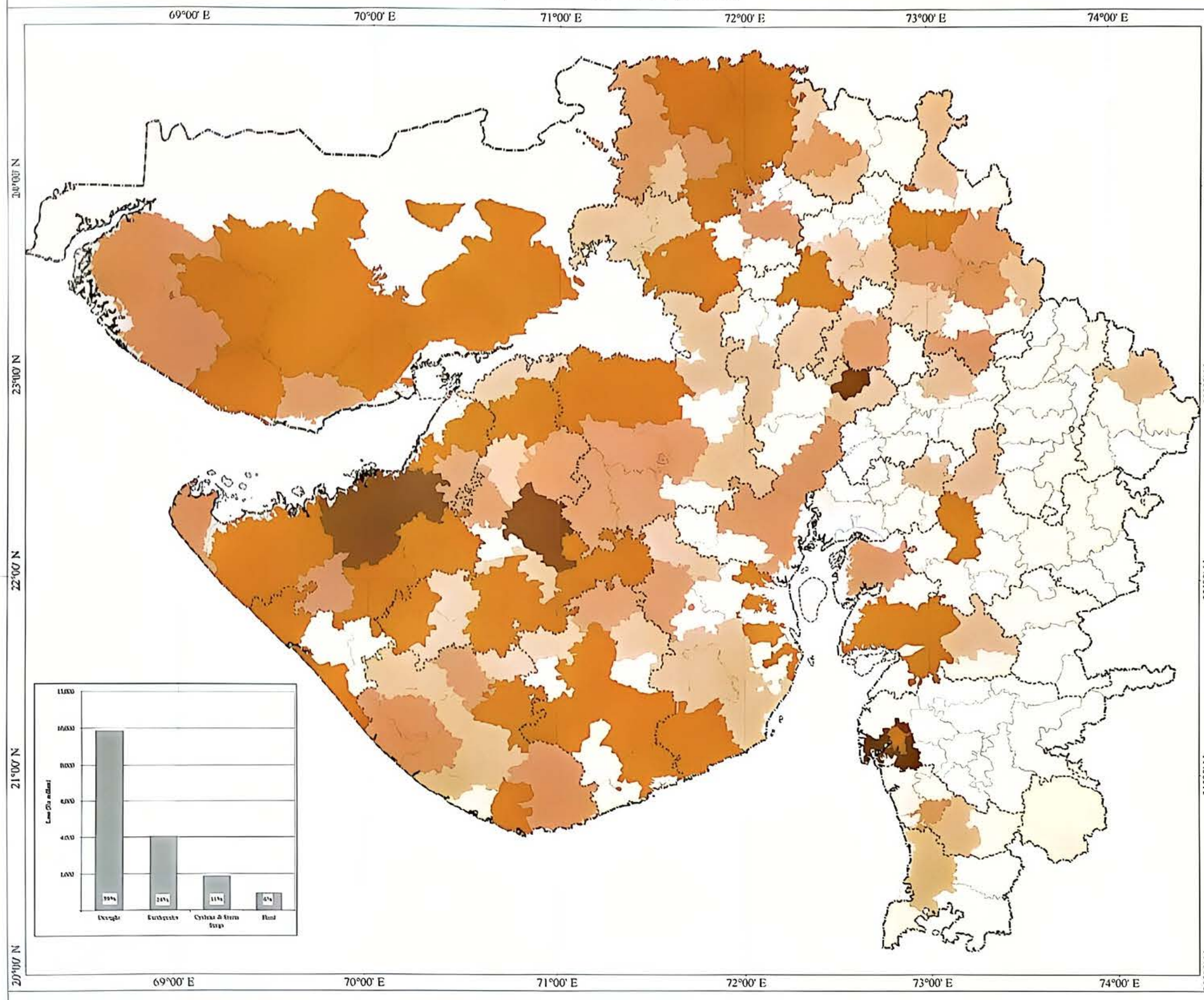
Projection : Lambert Azimuthal Equal Area
Datum : WGS 84

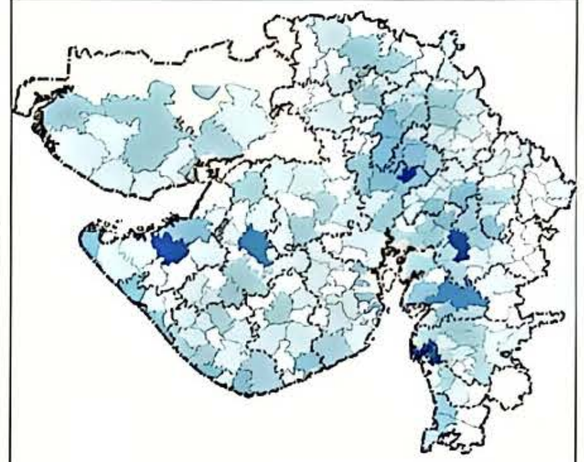
MAP No. : CARM - 02 OF 04

Date : 24/6/2005

Gujarat Composite Risk Zonation : Annualised Composite Risk (All Hazards)
(Rs. Million 2001 prices)

GSDMA





Total Capital Asset (Rs. Million)

- < 5000
- > 5000 to 10000
- > 10000 to 20000
- > 20000 to 50000
- > 50000 to 100000
- > 100000

LEGEND

Estimated Annualised Composite Risk (Rs. Million)

- < 25
- > 25 to 50
- > 50 to 75
- > 75 to 100
- > 100 to 250
- > 250

Source: TARU Analysis, 2004; BISAG, GoG.

0 100 km

N

Projection : Lambert Azimuthal Equal Area
Datum : WGS 84

MAP No. : CARM - 03 OF 04

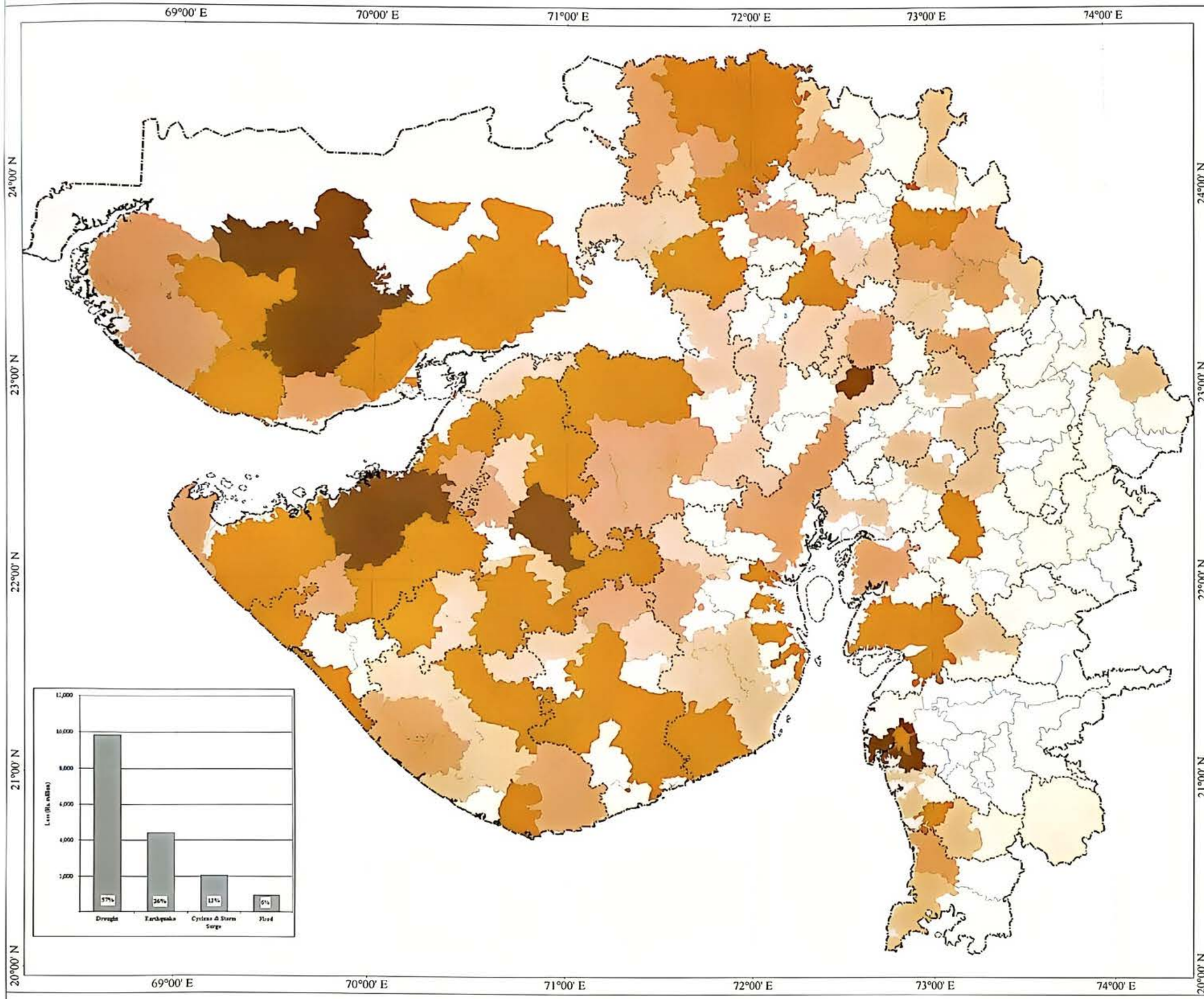
Date : 24/6/2005

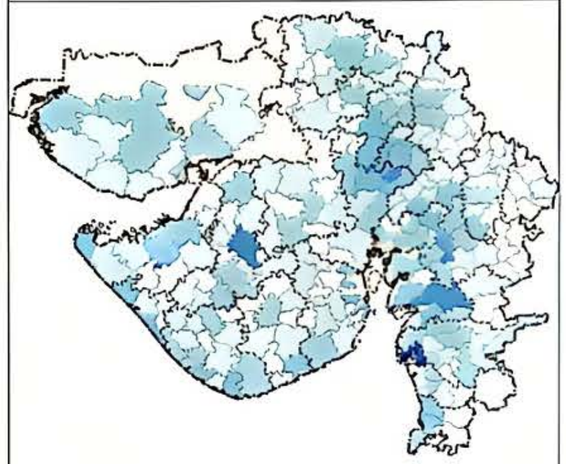
Gujarat Composite Risk Zonation: Annualised Composite Risk with Estimated Value of Life (All Hazards)
(Rs. Million 2001 prices)

GSDMA

69°00' E 70°00' E 71°00' E 72°00' E 73°00' E 74°00' E

24°00' N 23°00' N 22°00' N 21°00' N 20°00' N





Total Value of Capital Assets (Rs. Million)

- < 5000
- > 5000 to 10000
- > 10000 to 20000
- > 20000 to 50000
- > 50000 to 100000
- > 100000

LEGEND

Estimated Annualised Composite Risk with value of Life (Rs. Million)

- < 25
- > 25 to 50
- > 50 to 75
- > 75 to 100
- > 100 to 250
- > 250

Source: TARU Analysis, 2004; BISAG, GoG.

0 100 km

N

Projection : Lambert Azimuthal Equal Area
Datum : WGS 84

MAP No. : CARM - 04 OF 04

Date : 24/6/2005

GUJARAT COMPOSITE RISK ZONATION : ANNUALISED COMPOSITE CAPITAL & GVA RISK (ALL HAZARDS)
(Rs. MILLION 2001 PRICES) Table No. CART - 01 of 02

GSDMA

Sr. No	District	Taluka	Composite Capital Risk	Composite GVA Risk	Total Composite Risk	Total GVA	Total Capital Assets
1	Ahmadabad	Ahmadabad City	417.8	22.3	440.2	38,134	281,507
2	Ahmadabad	Barwala	9.0	18.4	27.5	254	2,115
3	Ahmadabad	Bavla	27.3	16.3	43.6	1,152	7,679
4	Ahmadabad	Daskroi	49.9	18.9	68.7	4,863	27,551
5	Ahmadabad	Detroj-Rampura	6.8	16.7	23.5	259	2,378
6	Ahmadabad	Dhandhuka	30.1	61.0	91.1	1,179	6,274
7	Ahmadabad	Dholka	57.5	26.7	84.2	3,018	13,092
8	Ahmadabad	Mandal	7.2	23.9	31.1	383	2,664
9	Ahmadabad	Ranpur	8.9	16.7	25.6	257	2,169
10	Ahmadabad	Sanand	29.8	14.7	44.5	5,631	20,041
11	Ahmadabad	Viramgam	20.3	53.2	73.5	2,921	13,487
12	Amreli	Amreli	34.4	99.5	134.0	1,303	11,493
13	Amreli	Babra	13.0	73.7	86.6	707	4,256
14	Amreli	Bagasara	10.8	38.2	48.9	572	3,548
15	Amreli	Dhari	20.3	97.0	117.4	1,106	5,756
16	Amreli	Jafrabad	15.7	31.2	46.9	1,470	8,651
17	Amreli	Khambha	10.4	30.9	41.3	454	3,064
18	Amreli	Kunkavav Vadia	11.9	61.8	73.7	764	3,827
19	Amreli	Lathi	12.7	59.9	72.5	817	5,462
20	Amreli	Lilia	9.7	32.9	42.6	380	2,389
21	Amreli	Rajula	35.4	102.3	137.6	4,194	21,417
22	Amreli	Savar Kundla	27.2	106.5	133.7	1,476	9,157
23	Anand	Anand	47.7	10.4	58.1	5,974	35,652
24	Anand	Anklav	16.9	8.8	25.7	684	5,244
25	Anand	Borsad	33.2	3.9	37.0	1,143	11,834
26	Anand	Khambhat	36.8	9.7	46.5	1,460	13,880
27	Anand	Petlad	23.2	5.4	28.6	1,322	10,402
28	Anand	Sojitra	8.7	2.4	11.1	390	3,412
29	Anand	Tarapur	12.2	4.0	16.3	459	3,112
30	Anand	Umreth	10.3	2.5	12.8	901	6,037
31	Banas Kantha	Amirgadh	5.7	34.9	40.5	653	2,764
32	Banas Kantha	Bhabhar	6.3	62.7	69.0	502	2,707
33	Banas Kantha	Danta	8.4	37.7	46.0	861	4,574
34	Banas Kantha	Dantiwada	6.3	53.3	59.6	521	2,398
35	Banas Kantha	Deesa	34.8	203.6	238.4	2,310	13,820
36	Banas Kantha	Deodar	10.1	80.5	90.6	672	3,719
37	Banas Kantha	Dhanera	11.7	106.0	117.6	946	4,801
38	Banas Kantha	Kankrej	19.5	99.5	119.0	902	5,140
39	Banas Kantha	Palanpur	32.2	52.8	84.9	2,627	18,845
40	Banas Kantha	Tharad	13.5	141.1	154.6	999	5,628
41	Banas Kantha	Vadgam	14.8	43.1	57.9	1,387	6,498
42	Banas Kantha	Vav	10.1	82.8	93.0	548	3,503
43	Bharuch	Amod	13.3	12.6	25.9	745	4,354
44	Bharuch	Anklesvar	86.2	23.0	109.2	9,645	44,240
45	Bharuch	Bharuch	83.9	48.4	132.3	12,592	51,831
46	Bharuch	Hansot	13.2	2.7	15.8	1,523	8,047
47	Bharuch	Jambusar	33.1	51.9	85.0	2,113	11,728
48	Bharuch	Jhagadia	31.8	22.8	54.5	16,221	64,393
49	Bharuch	Vagra	58.2	44.2	102.4	3,502	22,189
50	Bharuch	Valia	24.8	11.7	36.5	2,389	11,046
51	Bhavnagar	Bhavnagar	75.4	64.7	140.1	7,006	45,365
52	Bhavnagar	Botad	19.5	53.4	72.9	941	9,047
53	Bhavnagar	Gadhada	14.7	64.7	79.4	794	5,975
54	Bhavnagar	Gariadhar	9.1	58.4	67.5	651	3,640
55	Bhavnagar	Ghogha	8.6	32.3	40.8	731	4,143
56	Bhavnagar	Mahuva	30.9	128.3	159.2	2,232	12,041
57	Bhavnagar	Palitana	16.3	49.0	65.3	899	6,847
58	Bhavnagar	Sihor	16.9	41.1	58.0	1,362	8,117
59	Bhavnagar	Talaja	26.0	43.5	69.5	1,035	9,099
60	Bhavnagar	Umrala	8.5	24.7	33.3	431	3,073
61	Bhavnagar	Vallabhipur	8.8	19.9	28.7	325	3,129
62	Dohad	Devgadbaria	8.6	28.1	36.7	606	4,691
63	Dohad	Dhanpur	4.7	19.5	24.2	511	3,739
64	Dohad	Dohad	9.7	35.9	45.5	1,008	7,133
65	Dohad	Fatepura	5.4	11.4	16.8	259	2,062
66	Dohad	Garbada	4.6	15.3	19.9	297	1,965
67	Dohad	Jhalod	12.4	45.6	58.0	884	4,716
68	Dohad	Limkheda	10.5	23.0	33.4	408	3,376
69	Gandhinagar	Dehgam	18.7	22.4	41.1	1,547	10,753
70	Gandhinagar	Gandhinagar	50.4	32.7	83.1	6,192	45,766
71	Gandhinagar	Kalol	31.1	30.1	61.2	7,718	42,412
72	Gandhinagar	Mansa	17.5	23.1	40.6	1,155	9,262
73	Jamnagar	Bhanvad	15.9	60.8	76.7	712	3,673
74	Jamnagar	Dhrol	22.3	69.8	92.1	1,073	5,268
75	Jamnagar	Jamjodhpur	17.3	100.5	117.8	1,083	4,959
76	Jamnagar	Jamnagar	169.7	153.9	323.6	8,622	43,205
77	Jamnagar	Jodiya	26.5	83.9	110.4	815	4,440
78	Jamnagar	Kalavad	22.9	132.6	155.5	1,250	6,792
79	Jamnagar	Kalyanpur	21.4	132.8	154.2	1,074	6,306
80	Jamnagar	Khambhalia	27.9	114.0	141.9	1,172	9,667
81	Jamnagar	Lalpur	381.3	581.9	963.2	52,306	206,986
82	Jamnagar	Okhamandal	29.2	65.6	94.9	4,633	29,583
83	Junagadh	Bhesan	8.5	50.5	59.0	640	2,834
84	Junagadh	Junagadh	37.4	61.6	99.0	2,087	14,708
85	Junagadh	Keshod	21.7	69.9	91.6	993	7,728
86	Junagadh	Kodinar	40.8	83.1	123.9	4,887	26,598
87	Junagadh	Malia	16.4	69.0	85.4	1,607	12,278
88	Junagadh	Manavadar	17.3	55.9	73.2	896	5,662
89	Junagadh	Mangrol	23.8	67.9	91.7	1,329	10,306
90	Junagadh	Mendarda	8.6	42.6	51.2	511	2,548
91	Junagadh	Patan-Veraval	40.3	22.2	62.5	3,642	26,193
92	Junagadh	Sutrapada	14.5	21.6	36.1	1,912	9,979
93	Junagadh	Talala	14.0	59.8	73.8	954	5,133
94	Junagadh	Una	38.8	55.2	94.1	1,719	13,455
95	Junagadh	Vanthali	19.3	43.4	62.7	956	8,047
96	Junagadh	Visavadar	20.1	100.1	120.2	1,188	6,600
97	Kachchh	Abdasa	23.0	53.6	76.6	1,178	7,621
98	Kachchh	Anjar	65.7	53.0	118.7	912	7,801
99	Kachchh	Bhachau	52.4	113.2	165.7	1,284	10,052
100	Kachchh	Bhuj	92.1	151.7	243.9	1,976	17,129
101	Kachchh	Gandhidham	118.6	29.1	147.7	5,669	13,793
102	Kachchh	Lakhpat	40.0	38.1	78.1	454	12,069
103	Kachchh	Mandvi	26.5	87.1	113.6	874	8,810
104	Kachchh	Mundra	29.6	47.1	76.7	822	6,014
105	Kachchh	Nakhatrana	35.9	121.5	157.4	1,053	6,352
106	Kachchh	Rapar	29.0	99.3	128.2	741	6,172
107	Kheda	Balasinor	6.2	19.3	25.5	454	4,690
108	Kheda	Kapadvanj	16.7	51.4	68.1	1,231	8,918
109	Kheda	Kathlal	12.1	27.5	39.6	671	5,818
110	Kheda	Kheda	17.0	4.6	21.5	891	5,975
111	Kheda	Mahudha	8.6	3.9	12.5	632	5,319
112	Kheda	Matar	19.5	5.4	24 9	1,670	8,674
113	Kheda	Mehmedabad	19.2	8.7	27.9	1,149	7,101
114	Kheda	Nadiad	39.4	8.9	48.3	3,147	21,110

GUJARAT COMPOSITE RISK ZONATION : ANNUALISED COMPOSITE CAPITAL & GVA RISK (ALL HAZARDS)

(Rs. MILLION 2001 PRICES) Table No. CART - 01 of 02

GSDMA

Sr. No	District	Taluka	Composite Capital Risk	Composite GVA Risk	Total Composite Risk	Total GVA	Total Capital Assets
115	Kheda	Thasra	31.2	18.6	49.9	1,029	21,785
116	Kheda	Virpur	4.9	18.8	23.7	385	2,279
117	Mahesana	Becharaji	9.6	25.5	35.1	476	4,181
118	Mahesana	Kadi	32.8	36.3	69.1	3,979	25,513
119	Mahesana	Kheralu	15.5	24.0	39.6	917	7,659
120	Mahesana	Mahesana	50.4	74.5	125.0	6,232	37,178
121	Mahesana	Satlasana	7.6	19.8	27.4	450	3,850
122	Mahesana	Unjha	16.2	20.7	36.9	859	8,631
123	Mahesana	Vadnagar	12.3	21.1	33.3	641	5,542
124	Mahesana	Vijapur	24.1	36.3	60.4	1,716	13,686
125	Mahesana	Visnagar	29.4	31.9	61.3	1,601	17,499
126	Narmada	Dediapada	8.1	6.9	15.0	461	3,174
127	Narmada	Nandod	15.2	19.6	34.8	1,490	9,367
128	Narmada	Sagbara	3.6	15.0	18.6	459	1,955
129	Narmada	Tilakwada	2.5	10.5	13.0	435	2,596
130	Navsari	Bansda	33.0	4.8	37.8	786	4,114
131	Navsari	Chikhli	46.2	4.0	50.2	1,681	9,206
132	Navsari	Gandevi	93.2	5.2	98.4	1,665	11,774
133	Navsari	Jalalpore	36.4	1.9	38.3	1,094	9,268
134	Navsari	Navsari	30.3	2.5	32.7	2,355	16,319
135	Panch Mahals	Ghoghamba	7.0	25.9	32.9	539	3,372
136	Panch Mahals	Godhra	17.3	27.6	45.0	1,777	14,948
137	Panch Mahals	Halol	9.1	17.2	26.3	6,320	22,727
138	Panch Mahals	Jambughoda	1.3	3.2	4.5	206	1,135
139	Panch Mahals	Kadana	6.1	15.5	21.6	362	2,883
140	Panch Mahals	Kalol	7.8	12.2	20.0	1,194	7,485
141	Panch Mahals	Khanpur	6.6	9.5	16.1	502	3,525
142	Panch Mahals	Lunawada	21.4	19.2	40.6	1,195	8,531
143	Panch Mahals	Morwa (Hadaf)	9.3	11.4	20.7	317	2,290
144	Panch Mahals	Santrampur	10.5	21.4	31.9	538	7,680
145	Panch Mahals	Shehera	14.4	16.8	31.3	625	4,662
146	Patan	Chanasma	11.4	29.1	40.4	765	5,379
147	Patan	Harij	7.8	35.6	43.4	491	3,556
148	Patan	Patan	29.2	52.7	81.9	1,867	14,916
149	Patan	Radhanpur	15.2	45.0	60.1	543	4,306
150	Patan	Sami	20.0	83.0	103.0	920	6,213
151	Patan	Santalpur	15.1	51.6	66.8	393	3,371
152	Patan	Sidhpur	16.4	25.4	41.8	1,116	8,192
153	Patan	Vagdod	6.2	17.9	24.0	437	2,445
154	Porbandar	Kutiyana	10.6	21.7	32.3	326	3,414
155	Porbandar	Porbandar	62.9	114.5	177.4	4,162	26,151
156	Porbandar	Ranavav	15.8	22.1	37.8	1,108	7,516
157	Rajkot	Dhoraji	22.5	50.5	73.1	1,276	7,658
158	Rajkot	Gondal	36.7	121.7	158.5	2,130	13,004
159	Rajkot	Jamkandorna	11.6	51.6	63.1	741	4,124
160	Rajkot	Jasdan	24.6	85.7	110.3	1,413	9,564
161	Rajkot	Jetpur	33.4	85.9	119.3	3,038	12,095
162	Rajkot	Kotda Sangani	13.7	50.2	63.9	1,566	6,840
163	Rajkot	Lodhika	10.6	38.2	48.7	805	3,546
164	Rajkot	Maliya	15.4	52.3	67.7	695	3,294
165	Rajkot	Morvi	58.7	91.7	150.4	2,853	18,624
166	Rajkot	Paddhari	20.9	57.7	78.6	1,010	5,039
167	Rajkot	Rajkot	140.1	113.3	253.4	8,820	72,014
168	Rajkot	Tankara	15.2	53.8	69.0	1,044	4,109
169	Rajkot	Upleta	28.5	78.7	107.3	1,185	8,611
170	Rajkot	Wankaner	25.6	72.7	98.3	1,638	8,236
171	Sabar Kantha	Bayad	12.8	68.0	80.8	1,188	6,032
172	Sabar Kantha	Bhiloda	11.2	67.5	78.8	1,265	6,558
173	Sabar Kantha	Dhansura	7.2	37.8	44.9	703	3,311
174	Sabar Kantha	Himatnagar	22.4	76.0	98.4	2,420	14,291
175	Sabar Kantha	Idar	23.5	79.7	103.2	2,153	11,304
176	Sabar Kantha	Khedbrahma	12.6	57.8	70.4	1,037	5,967
177	Sabar Kantha	Malpur	4.9	25.3	30.2	545	3,179
178	Sabar Kantha	Meghraj	9.2	47.2	56.4	736	4,282
179	Sabar Kantha	Modasa	16.9	67.1	84.0	1,195	8,166
180	Sabar Kantha	Prantij	10.5	40.5	51.0	1,636	7,754
181	Sabar Kantha	Talod	9.2	41.2	50.4	916	5,262
182	Sabar Kantha	Vadali	9.1	30.2	39.3	639	2,722
183	Sabar Kantha	Vijaynagar	5.9	24.5	30.5	419	2,811
184	Surat	Bardoli	13.7	1.0	14.7	1,736	9,919
185	Surat	Chorasi	400.7	95.1	495.7	55,767	223,042
186	Surat	Kamrej	20.4	3.0	23.4	1,155	6,918
187	Surat	Mahuva	8.8	0.7	9.4	969	4,259
188	Surat	Mandvi	16.3	6.6	22.9	2,068	10,777
189	Surat	Mangrol	11.9	11.8	23.8	3,683	13,631
190	Surat	Nizar	4.3	5.4	9.7	549	5,067
191	Surat	Olpad	35.4	5.1	40.4	2,373	13,296
192	Surat	Palsana	9.6	1.3	11.0	1,929	10,432
193	Surat	Songadh	11.3	6.2	17.5	1,305	8,109
194	Surat	Surat City	153.3	10.3	163.6	15,319	146,921
195	Surat	Uchchhal	3.1	1.1	4.2	504	5,333
196	Surat	Umarpada	3.6	5.9	9.5	365	1,450
197	Surat	Valod	5.9	0.6	6.6	462	2,349
198	Surat	Vyara	14.1	1.8	15.9	1,359	10,302
199	Surendranagar	Chotila	15.1	64.1	79.2	1,102	6,317
200	Surendranagar	Chuda	10.5	19.0	29.4	290	2,587
201	Surendranagar	Dasada	10.3	47.0	57.2	753	4,311
202	Surendranagar	Dhrangadhra	21.4	84.2	105.5	1,370	8,221
203	Surendranagar	Halvad	21.2	115.5	136.7	1,116	5,666
204	Surendranagar	Lakhtar	5.5	21.3	26.8	350	2,266
205	Surendranagar	Limbdi	19.5	46.5	66.1	987	7,724
206	Surendranagar	Muli	8.8	74.8	83.6	780	2,770
207	Surendranagar	Sayla	13.3	71.9	85.2	2,975	11,774
208	Surendranagar	Wadhwan	36.9	43.9	80.8	2,255	15,916
209	The Dangs	The Dangs	12.2	17.8	30.0	620	3,811
210	Vadodara	Chhota Udaipur	6.6	24.6	31.2	785	4,878
211	Vadodara	Dabhoi	7.8	20.3	28.1	970	6,946
212	Vadodara	Jetpur Pavi	7.1	18.4	25.5	835	3,934
213	Vadodara	Karjan	13.1	13.1	26.3	5,042	18,113
214	Vadodara	Kavant	4.7	18.7	23.4	376	2,389
215	Vadodara	Nasvadi	5.0	16.0	21.0	443	2,294
216	Vadodara	Padra	21.4	25.4	46.8	3,652	17,491
217	Vadodara	Sankheda	7.1	31.1	38.2	966	6,135
218	Vadodara	Savli	15.0	43.9	58.8	4,331	18,219
219	Vadodara	Sinor	2.8	5.3	8.1	468	2,400
220	Vadodara	Vadodara	139.0	90.9	230.0	36,783	197,554
221	Vadodara	Vaghodia	6.3	28.5	34.8	2,753	10,260
222	Valsad	Dharampur	9.3	0.3	9.6	783	3,719
223	Valsad	Kaprada	10.2	0.2	10.4	460	3,087
224	Valsad	Pardi	48.6	6.9	55.6	8,454	38,382
225	Valsad	Umbergaon	42.0	5.4	47.4	3,547	15,614
226	Valsad	Valsad	61.7	6.6	68.3	5,640	29,541

GUJARAT COMPOSITE RISK ZONATION : ANNUALISED COMPOSITE CAPITAL & GVA VULNERABILITY
(ALL HAZARDS) (Rs. MILLION 2001 PRICES) Table No. CART - 02 of 02

GSDMA

Sr. No	District	Taluka	Composite Capital Vulnerability	Composite GVA Vulnerability	Composite Vulnerability	Total GVA	Total Capital Assets
1	Ahmadabad	Ahmadabad City	0.1%	0.1%	0.1%	38,134	281,507
2	Ahmadabad	Barwala	0.4%	7.2%	1.2%	254	2,115
3	Ahmadabad	Bavla	0.4%	1.4%	0.5%	1,152	7,679
4	Ahmadabad	Daskroi	0.2%	0.4%	0.2%	4,863	27,551
5	Ahmadabad	Detroj-Rampura	0.3%	6.5%	0.9%	259	2,378
6	Ahmadabad	Dhandhuka	0.5%	5.2%	1.2%	1,179	6,274
7	Ahmadabad	Dholka	0.4%	0.9%	0.5%	3,018	13,092
8	Ahmadabad	Mandal	0.3%	6.2%	1.0%	383	2,664
9	Ahmadabad	Ranpur	0.4%	6.5%	1.1%	257	2,169
10	Ahmadabad	Sanand	0.1%	0.3%	0.2%	5,631	20,041
11	Ahmadabad	Viramgam	0.2%	1.8%	0.4%	2,921	13,487
12	Amreli	Amreli	0.3%	7.6%	1.0%	1,303	11,493
13	Amreli	Babra	0.3%	10.4%	1.7%	707	4,256
14	Amreli	Bagasara	0.3%	6.7%	1.2%	572	3,548
15	Amreli	Dhari	0.4%	8.8%	1.7%	1,106	5,756
16	Amreli	Jafrabad	0.2%	2.1%	0.5%	1,470	8,651
17	Amreli	Khambha	0.3%	6.8%	1.2%	454	3,064
18	Amreli	Kunkavav Vadia	0.3%	8.1%	1.6%	764	3,827
19	Amreli	Lathi	0.2%	7.3%	1.2%	817	5,462
20	Amreli	Lilia	0.4%	8.6%	1.5%	380	2,389
21	Amreli	Rajula	0.2%	2.4%	0.5%	4,194	21,417
22	Amreli	Savar Kundla	0.3%	7.2%	1.3%	1,476	9,157
23	Anand	Anand	0.1%	0.2%	0.1%	5,974	35,652
24	Anand	Anklav	0.3%	1.3%	0.4%	684	5,244
25	Anand	Borsad	0.3%	0.3%	0.3%	1,143	11,834
26	Anand	Khambhat	0.3%	0.7%	0.3%	1,460	13,880
27	Anand	Petlad	0.2%	0.4%	0.2%	1,322	10,402
28	Anand	Sojitra	0.3%	0.6%	0.3%	390	3,412
29	Anand	Tarapur	0.4%	0.9%	0.5%	459	3,112
30	Anand	Umreth	0.2%	0.3%	0.2%	901	6,037
31	Banas Kantha	Amirgadh	0.2%	5.3%	1.2%	653	2,764
32	Banas Kantha	Bhabhar	0.2%	12.5%	2.2%	502	2,707
33	Banas Kantha	Danta	0.2%	4.4%	0.8%	861	4,574
34	Banas Kantha	Dantiwada	0.3%	10.2%	2.0%	521	2,398
35	Banas Kantha	Deesa	0.3%	8.8%	1.5%	2,310	13,820
36	Banas Kantha	Deodar	0.3%	12.0%	2.1%	672	3,719
37	Banas Kantha	Dhanera	0.2%	11.2%	2.0%	946	4,801
38	Banas Kantha	Kankrej	0.4%	11.0%	2.0%	902	5,140
39	Banas Kantha	Palanpur	0.2%	2.0%	0.4%	2,627	18,845
40	Banas Kantha	Tharad	0.2%	14.1%	2.3%	999	5,628
41	Banas Kantha	Vadgam	0.2%	3.1%	0.7%	1,387	6,498
42	Banas Kantha	Vav	0.3%	15.1%	2.3%	548	3,503
43	Bharuch	Amod	0.3%	1.7%	0.5%	745	4,354
44	Bharuch	Anklesvar	0.2%	0.2%	0.2%	9,645	44,240
45	Bharuch	Bharuch	0.2%	0.4%	0.2%	12,592	51,831
46	Bharuch	Hansot	0.2%	0.2%	0.2%	1,523	8,047
47	Bharuch	Jambusar	0.3%	2.5%	0.6%	2,113	11,728
48	Bharuch	Jhagadia	0.0%	0.1%	0.1%	16,221	64,393
49	Bharuch	Vagra	0.3%	1.3%	0.4%	3,502	22,189
50	Bharuch	Valia	0.2%	0.5%	0.3%	2,389	11,046
51	Bhavnagar	Bhavnagar	0.2%	0.9%	0.3%	7,006	45,365
52	Bhavnagar	Botad	0.2%	5.7%	0.7%	941	9,047
53	Bhavnagar	Gadhada	0.2%	8.1%	1.2%	794	5,975
54	Bhavnagar	Gariadhar	0.3%	9.0%	1.6%	651	3,640
55	Bhavnagar	Ghogha	0.2%	4.4%	0.8%	731	4,143
56	Bhavnagar	Mahuva	0.3%	5.7%	1.1%	2,232	12,041
57	Bhavnagar	Palitana	0.2%	5.5%	0.8%	899	6,847
58	Bhavnagar	Sihor	0.2%	3.0%	0.6%	1,362	8,117
59	Bhavnagar	Talaja	0.3%	4.2%	0.7%	1,035	9,099
60	Bhavnagar	Umrala	0.3%	5.7%	0.9%	431	3,073
61	Bhavnagar	Vallabhipur	0.3%	6.1%	0.8%	325	3,129
62	Dohad	Devgadbaria	0.2%	4.6%	0.7%	606	4,691
63	Dohad	Dhanpur	0.1%	3.8%	0.6%	511	3,739
64	Dohad	Dohad	0.1%	3.6%	0.6%	1,008	7,133
65	Dohad	Fatepura	0.3%	4.4%	0.7%	259	2,062
66	Dohad	Garbada	0.2%	5.2%	0.9%	297	1,965
67	Dohad	Jhalod	0.3%	5.2%	1.0%	884	4,716
68	Dohad	Limkheda	0.3%	5.6%	0.9%	408	3,376
69	Gandhinagar	Dehgam	0.2%	1.5%	0.3%	1,547	10,753
70	Gandhinagar	Gandhinagar	0.1%	0.5%	0.2%	6,192	45,766
71	Gandhinagar	Kalol	0.1%	0.4%	0.1%	7,718	42,412
72	Gandhinagar	Mansa	0.2%	2.0%	0.4%	1,155	9,262
73	Jamnagar	Bhanvad	0.4%	8.5%	1.7%	712	3,673
74	Jamnagar	Dhrol	0.4%	6.5%	1.5%	1,073	5,268
75	Jamnagar	Jamjodhpur	0.3%	9.3%	2.0%	1,083	4,959
76	Jamnagar	Jamnagar	0.4%	1.8%	0.6%	8,622	43,205
77	Jamnagar	Jodiya	0.6%	10.3%	2.1%	815	4,440
78	Jamnagar	Kalavad	0.3%	10.6%	1.9%	1,250	6,792
79	Jamnagar	Kalyanpur	0.3%	12.4%	2.1%	1,074	6,306
80	Jamnagar	Khambhalia	0.3%	9.7%	1.3%	1,172	9,667
81	Jamnagar	Lalpur	0.2%	1.1%	0.4%	52,306	206,986
82	Jamnagar	Okhamandal	0.1%	1.4%	0.3%	4,633	29,583
83	Junagadh	Bhesan	0.3%	7.9%	1.7%	640	2,834
84	Junagadh	Junagadh	0.3%	2.9%	0.6%	2,087	14,708
85	Junagadh	Keshod	0.3%	7.0%	1.1%	993	7,728
86	Junagadh	Kodinar	0.2%	1.7%	0.4%	4,887	26,598
87	Junagadh	Malia	0.1%	4.3%	0.6%	1,607	12,278
88	Junagadh	Manavadar	0.3%	6.2%	1.1%	896	5,662
89	Junagadh	Mangrol	0.2%	5.1%	0.8%	1,329	10,306
90	Junagadh	Mendarda	0.3%	8.3%	1.7%	511	2,548
91	Junagadh	Patan-Veraval	0.2%	0.6%	0.2%	3,642	26,193
92	Junagadh	Sutrapada	0.1%	1.1%	0.3%	1,912	9,979
93	Junagadh	Talala	0.3%	6.3%	1.2%	954	5,133
94	Junagadh	Una	0.3%	3.2%	0.6%	1,719	13,455
95	Junagadh	Vanthali	0.2%	4.5%	0.7%	956	8,047
96	Junagadh	Visavadar	0.3%	8.4%	1.5%	1,188	6,600
97	Kachchh	Abdasa	0.3%	4.5%	0.9%	1,178	7,621
98	Kachchh	Anjar	0.8%	5.8%	1.4%	912	7,801
99	Kachchh	Bhachau	0.5%	8.8%	1.5%	1,284	10,052
100	Kachchh	Bhuj	0.5%	7.7%	1.3%	1,976	17,129
101	Kachchh	Gandhidham	0.9%	0.5%	0.8%	5,669	13,793
102	Kachchh	Lakhpat	0.3%	8.4%	0.6%	454	12,069
103	Kachchh	Mandvi	0.3%	10.0%	1.2%	874	8,810
104	Kachchh	Mundra	0.5%	5.7%	1.1%	822	6,014
105	Kachchh	Nakhatrana	0.6%	11.5%	2.1%	1,053	6,352
106	Kachchh	Rapar	0.5%	13.4%	1.9%	741	6,172
107	Kheda	Balasinor	0.1%	4.2%	0.5%	454	4,690
108	Kheda	Kapadvanj	0.2%	4.2%	0.7%	1,231	8,918
109	Kheda	Kathlal	0.2%	4.1%	0.6%	671	5,818
110	Kheda	Kheda	0.3%	0.5%	0.3%	891	5,975
111	Kheda	Mahudha	0.2%	0.6%	0.2%	632	5,319
112	Kheda	Matar	0.2%	0.3%	0.2%	1,670	8,674
113	Kheda	Mehmedabad	0.3%	0.8%	0.3%	1,149	7,101
114	Kheda	Nadiad	0.2%	0.3%	0.2%	3,147	21,110

GUJARAT COMPOSITE RISK ZONATION : ANNUALISED COMPOSITE CAPITAL & GVA VULNERABILITY
(ALL HAZARDS) (Rs. MILLION 2001 PRICES) Table No. CART - 02 of 02

GSDMA

Sr. No	District	Taluka	Composite Capital Vulnerability	Composite GVA Vulnerability	Composite Vulnerability	Total GVA	Total Capital Assets
115	Kheda	Thasra	0.1%	1.8%	0.2%	1,029	21,785
116	Kheda	Virpur	0.2%	4.9%	0.9%	385	2,279
117	Mahesana	Becharaji	0.2%	5.4%	0.8%	476	4,181
118	Mahesana	Kadi	0.1%	0.9%	0.2%	3,979	25,513
119	Mahesana	Kheralu	0.2%	2.6%	0.5%	917	7,659
120	Mahesana	Mahesana	0.1%	1.2%	0.3%	6,232	37,178
121	Mahesana	Satlasana	0.2%	4.4%	0.6%	450	3,850
122	Mahesana	Unjha	0.2%	2.4%	0.4%	859	8,631
123	Mahesana	Vadnagar	0.2%	3.3%	0.5%	641	5,542
124	Mahesana	Vijapur	0.2%	2.1%	0.4%	1,716	13,686
125	Mahesana	Visnagar	0.2%	2.0%	0.3%	1,601	17,499
126	Narmada	Dediapada	0.3%	1.5%	0.4%	461	3,174
127	Narmada	Nandod	0.2%	1.3%	0.3%	1,490	9,367
128	Narmada	Sagbara	0.2%	3.3%	0.8%	459	1,955
129	Narmada	Tilakwada	0.1%	2.4%	0.4%	435	2,596
130	Navsari	Bansda	0.8%	0.6%	0.8%	786	4,114
131	Navsari	Chikhli	0.5%	0.2%	0.5%	1,681	9,206
132	Navsari	Gandevi	0.8%	0.3%	0.7%	1,665	11,774
133	Navsari	Jalalpore	0.4%	0.2%	0.4%	1,094	9,268
134	Navsari	Navsari	0.2%	0.1%	0.2%	2,355	16,319
135	Panch Mahals	Ghoghamba	0.2%	4.8%	0.8%	539	3,372
136	Panch Mahals	Godhra	0.1%	1.6%	0.3%	1,777	14,948
137	Panch Mahals	Halol	0.0%	0.3%	0.1%	6,320	22,727
138	Panch Mahals	Jambughoda	0.1%	1.5%	0.3%	206	1,135
139	Panch Mahals	Kadana	0.2%	4.3%	0.7%	362	2,883
140	Panch Mahals	Kalol	0.1%	1.0%	0.2%	1,194	7,485
141	Panch Mahals	Khanpur	0.2%	1.9%	0.4%	502	3,525
142	Panch Mahals	Lunawada	0.3%	1.6%	0.4%	1,195	8,531
143	Panch Mahals	Morwa (Hadaf)	0.4%	3.6%	0.8%	317	2,290
144	Panch Mahals	Santrampur	0.1%	4.0%	0.4%	538	7,680
145	Panch Mahals	Shehera	0.3%	2.7%	0.6%	625	4,662
146	Patan	Chanasma	0.2%	3.8%	0.7%	765	5,379
147	Patan	Harij	0.2%	7.2%	1.1%	491	3,556
148	Patan	Patan	0.2%	2.8%	0.5%	1,867	14,916
149	Patan	Radhanpur	0.4%	8.3%	1.2%	543	4,306
150	Patan	Sami	0.3%	9.0%	1.4%	920	6,213
151	Patan	Santalpur	0.4%	13.2%	1.8%	393	3,371
152	Patan	Sidhpur	0.2%	2.3%	0.4%	1,116	8,192
153	Patan	Vagdod	0.3%	4.1%	0.8%	437	2,445
154	Porbandar	Kutiyana	0.3%	6.6%	0.9%	326	3,414
155	Porbandar	Porbandar	0.2%	2.8%	0.6%	4,162	26,151
156	Porbandar	Ranavav	0.2%	2.0%	0.4%	1,108	7,516
157	Rajkot	Dhoraji	0.3%	4.0%	0.8%	1,276	7,658
158	Rajkot	Gondal	0.3%	5.7%	1.0%	2,130	13,004
159	Rajkot	Jamkandorna	0.3%	7.0%	1.3%	741	4,124
160	Rajkot	Jasdan	0.3%	6.1%	1.0%	1,413	9,564
161	Rajkot	Jetpur	0.3%	2.8%	0.8%	3,038	12,095
162	Rajkot	Kotda Sangani	0.2%	3.2%	0.8%	1,566	6,840
163	Rajkot	Lodhika	0.3%	4.7%	1.1%	805	3,546
164	Rajkot	Maliya	0.5%	7.5%	1.7%	695	3,294
165	Rajkot	Morvi	0.3%	3.2%	0.7%	2,853	18,624
166	Rajkot	Paddhari	0.4%	5.7%	1.3%	1,010	5,039
167	Rajkot	Rajkot	0.2%	1.3%	0.3%	8,820	72,014
168	Rajkot	Tankara	0.4%	5.2%	1.3%	1,044	4,109
169	Rajkot	Upleta	0.3%	6.6%	1.1%	1,185	8,611
170	Rajkot	Wankaner	0.3%	4.4%	1.0%	1,638	8,236
171	Sabar Kantha	Bayad	0.2%	5.7%	1.1%	1,188	6,032
172	Sabar Kantha	Bhiloda	0.2%	5.3%	1.0%	1,265	6,558
173	Sabar Kantha	Dhansura	0.2%	5.4%	1.1%	703	3,311
174	Sabar Kantha	Himatnagar	0.2%	3.1%	0.6%	2,420	14,291
175	Sabar Kantha	Idar	0.2%	3.7%	0.8%	2,153	11,304
176	Sabar Kantha	Khedbrahma	0.2%	5.6%	1.0%	1,037	5,967
177	Sabar Kantha	Malpur	0.2%	4.6%	0.8%	545	3,179
178	Sabar Kantha	Meghraj	0.2%	6.4%	1.1%	736	4,282
179	Sabar Kantha	Modasa	0.2%	5.6%	0.9%	1,195	8,166
180	Sabar Kantha	Prantij	0.1%	2.5%	0.5%	1,636	7,754
181	Sabar Kantha	Talod	0.2%	4.5%	0.8%	916	5,262
182	Sabar Kantha	Vadali	0.3%	4.7%	1.2%	639	2,722
183	Sabar Kantha	Vijaynagar	0.2%	5.9%	0.9%	419	2,811
184	Surat	Bardoli	0.1%	0.1%	0.1%	1,736	9,919
185	Surat	Chorasi	0.2%	0.2%	0.2%	55,767	223,042
186	Surat	Kamrej	0.3%	0.3%	0.3%	1,155	6,918
187	Surat	Mahuva	0.2%	0.1%	0.2%	969	4,259
188	Surat	Mandvi	0.2%	0.3%	0.2%	2,068	10,777
189	Surat	Mangrol	0.1%	0.3%	0.1%	3,683	13,631
190	Surat	Nizar	0.1%	1.0%	0.2%	549	5,067
191	Surat	Olpad	0.3%	0.2%	0.3%	2,373	13,296
192	Surat	Palsana	0.1%	0.1%	0.1%	1,929	10,432
193	Surat	Songadh	0.1%	0.5%	0.2%	1,305	8,109
194	Surat	Surat City	0.1%	0.1%	0.1%	15,319	146,921
195	Surat	Uchchhal	0.1%	0.2%	0.1%	504	5,333
196	Surat	Umarpada	0.3%	1.6%	0.5%	365	1,450
197	Surat	Valod	0.3%	0.1%	0.2%	462	2,349
198	Surat	Vyara	0.1%	0.1%	0.1%	1,359	10,302
199	Surendranagar	Chotila	0.2%	5.8%	1.1%	1,102	6,317
200	Surendranagar	Chuda	0.4%	6.6%	1.0%	290	2,587
201	Surendranagar	Dasada	0.2%	6.2%	1.1%	753	4,311
202	Surendranagar	Dhrangadhra	0.3%	6.1%	1.1%	1,370	8,221
203	Surendranagar	Halvad	0.4%	10.3%	2.0%	1,116	5,666
204	Surendranagar	Lakhtar	0.2%	6.1%	1.0%	350	2,266
205	Surendranagar	Limbdi	0.3%	4.7%	0.8%	987	7,724
206	Surendranagar	Muli	0.3%	9.6%	2.4%	780	2,770
207	Surendranagar	Sayla	0.1%	2.4%	0.6%	2,975	11,774
208	Surendranagar	Wadhwan	0.2%	1.9%	0.4%	2,255	15,916
209	The Dangs	The Dangs	0.3%	2.9%	0.7%	620	3,811
210	Vadodara	Chhota Udaipur	0.1%	3.1%	0.6%	785	4,878
211	Vadodara	Dabhoi	0.1%	2.1%	0.4%	970	6,946
212	Vadodara	Jetpur Pavi	0.2%	2.2%	0.5%	835	3,934
213	Vadodara	Karjan	0.1%	0.3%	0.1%	5,042	18,113
214	Vadodara	Kavant	0.2%	5.0%	0.8%	376	2,389
215	Vadodara	Nasvadi	0.2%	3.6%	0.8%	443	2,294
216	Vadodara	Padra	0.1%	0.7%	0.2%	3,652	17,491
217	Vadodara	Sankheda	0.1%	3.2%	0.5%	966	6,135
218	Vadodara	Savli	0.1%	1.0%	0.3%	4,331	18,219
219	Vadodara	Sinor	0.1%	1.1%	0.3%	468	2,400
220	Vadodara	Vadodara	0.1%	0.2%	0.1%	36,783	197,554
221	Vadodara	Vaghodia	0.1%	1.0%	0.3%	2,753	10,260
222	Valsad	Dharampur	0.2%	0.0%	0.2%	783	3,719
223	Valsad	Kaprada	0.3%	0.0%	0.3%	460	3,087
224	Valsad	Pardi	0.1%	0.1%	0.1%	8,454	38,382
225	Valsad	Umbergaon	0.3%	0.2%	0.2%	3,547	15,614
226	Valsad	Valsad	0.2%	0.1%	0.2%	5,640	29,541

GUJARAT COMPOSITE RISK ZONATION : ANNUALISED COMPOSITE CAPITAL & GVA VULNERABILITY
(ALL HAZARDS) (Rs. MILLION 2001 PRICES) Table No. CART - 02 of 02

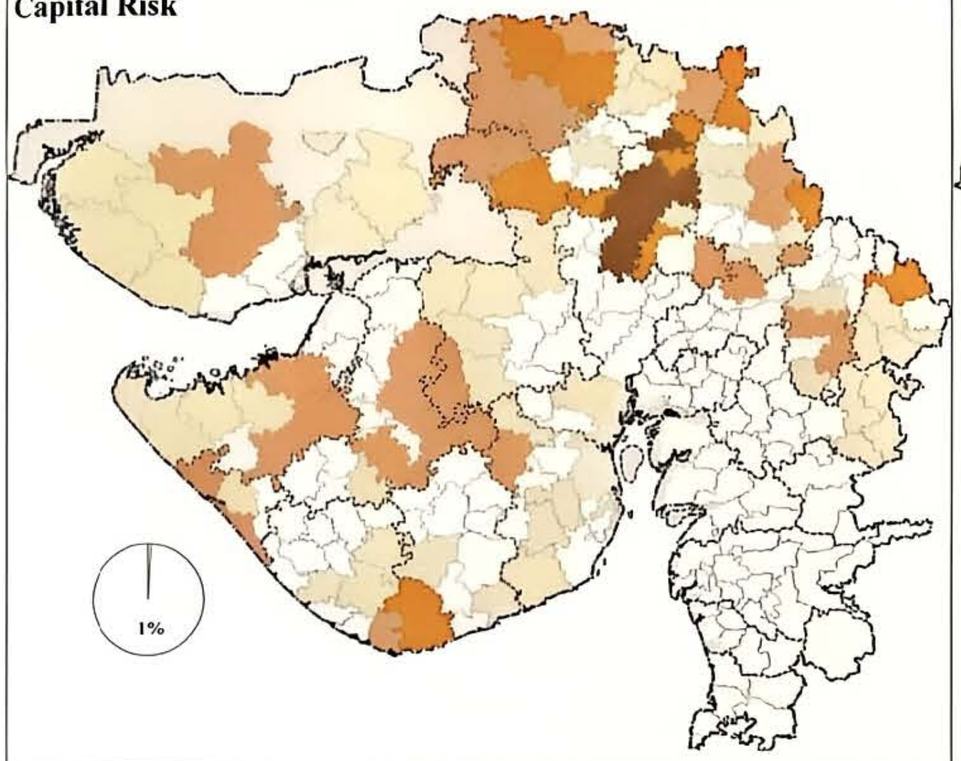
GSDMA

Sr. No	District	Taluka	Composite Capital Vulnerability	Composite GVA Vulnerability	Composite Vulnerability	Total GVA	Total Capital Assets
115	Kheda	Thasra	0.1%	1.8%	0.2%	1,029	21,785
116	Kheda	Virpur	0.2%	4.9%	0.9%	385	2,279
117	Mahesana	Becharaji	0.2%	5.4%	0.8%	476	4,181
118	Mahesana	Kadi	0.1%	0.9%	0.2%	3,979	25,513
119	Mahesana	Kheralu	0.2%	2.6%	0.5%	917	7,659
120	Mahesana	Mahesana	0.1%	1.2%	0.3%	6,232	37,178
121	Mahesana	Satlasana	0.2%	4.4%	0.6%	450	3,850
122	Mahesana	Unjha	0.2%	2.4%	0.4%	859	8,631
123	Mahesana	Vadnagar	0.2%	3.3%	0.5%	641	5,542
124	Mahesana	Vijapur	0.2%	2.1%	0.4%	1,716	13,686
125	Mahesana	Visnagar	0.2%	2.0%	0.3%	1,601	17,499
126	Narmada	Dediapada	0.3%	1.5%	0.4%	461	3,174
127	Narmada	Nandod	0.2%	1.3%	0.3%	1,490	9,367
128	Narmada	Sagbara	0.2%	3.3%	0.8%	459	1,955
129	Narmada	Tilakwada	0.1%	2.4%	0.4%	435	2,596
130	Navsari	Bansda	0.8%	0.6%	0.8%	786	4,114
131	Navsari	Chikhli	0.5%	0.2%	0.5%	1,681	9,206
132	Navsari	Gandevi	0.8%	0.3%	0.7%	1,665	11,774
133	Navsari	Jalalpore	0.4%	0.2%	0.4%	1,094	9,268
134	Navsari	Navsari	0.2%	0.1%	0.2%	2,355	16,319
135	Panch Mahals	Ghoghamba	0.2%	4.8%	0.8%	539	3,372
136	Panch Mahals	Godhra	0.1%	1.6%	0.3%	1,777	14,948
137	Panch Mahals	Halol	0.0%	0.3%	0.1%	6,320	22,727
138	Panch Mahals	Jambughoda	0.1%	1.5%	0.3%	206	1,135
139	Panch Mahals	Kadana	0.2%	4.3%	0.7%	362	2,883
140	Panch Mahals	Kalol	0.1%	1.0%	0.2%	1,194	7,485
141	Panch Mahals	Khanpur	0.2%	1.9%	0.4%	502	3,525
142	Panch Mahals	Lunawada	0.3%	1.6%	0.4%	1,195	8,531
143	Panch Mahals	Morwa (Hadaf)	0.4%	3.6%	0.8%	317	2,290
144	Panch Mahals	Santrampur	0.1%	4.0%	0.4%	538	7,680
145	Panch Mahals	Shehera	0.3%	2.7%	0.6%	625	4,662
146	Patan	Chanasma	0.2%	3.8%	0.7%	765	5,379
147	Patan	Harij	0.2%	7.2%	1.1%	491	3,556
148	Patan	Patan	0.2%	2.8%	0.5%	1,867	14,916
149	Patan	Radhanpur	0.4%	8.3%	1.2%	543	4,306
150	Patan	Sami	0.3%	9.0%	1.4%	920	6,213
151	Patan	Santalpur	0.4%	13.2%	1.8%	393	3,371
152	Patan	Sidhpur	0.2%	2.3%	0.4%	1,116	8,192
153	Patan	Vagdod	0.3%	4.1%	0.8%	437	2,445
154	Porbandar	Kutiyana	0.3%	6.6%	0.9%	326	3,414
155	Porbandar	Porbandar	0.2%	2.8%	0.6%	4,162	26,151
156	Porbandar	Ranavav	0.2%	2.0%	0.4%	1,108	7,516
157	Rajkot	Dhoraji	0.3%	4.0%	0.8%	1,276	7,658
158	Rajkot	Gondal	0.3%	5.7%	1.0%	2,130	13,004
159	Rajkot	Jamkandorna	0.3%	7.0%	1.3%	741	4,124
160	Rajkot	Jasdan	0.3%	6.1%	1.0%	1,413	9,564
161	Rajkot	Jetpur	0.3%	2.8%	0.8%	3,038	12,095
162	Rajkot	Kotda Sangani	0.2%	3.2%	0.8%	1,566	6,840
163	Rajkot	Lodhika	0.3%	4.7%	1.1%	805	3,546
164	Rajkot	Maliya	0.5%	7.5%	1.7%	695	3,294
165	Rajkot	Morvi	0.3%	3.2%	0.7%	2,853	18,624
166	Rajkot	Paddhari	0.4%	5.7%	1.3%	1,010	5,039
167	Rajkot	Rajkot	0.2%	1.3%	0.3%	8,820	72,014
168	Rajkot	Tankara	0.4%	5.2%	1.3%	1,044	4,109
169	Rajkot	Upleta	0.3%	6.6%	1.1%	1,185	8,611
170	Rajkot	Wankaner	0.3%	4.4%	1.0%	1,638	8,236
171	Sabar Kantha	Bayad	0.2%	5.7%	1.1%	1,188	6,032
172	Sabar Kantha	Bhiloda	0.2%	5.3%	1.0%	1,265	6,558
173	Sabar Kantha	Dhansura	0.2%	5.4%	1.1%	703	3,311
174	Sabar Kantha	Himatnagar	0.2%	3.1%	0.6%	2,420	14,291
175	Sabar Kantha	Idar	0.2%	3.7%	0.8%	2,153	11,304
176	Sabar Kantha	Khedbrahma	0.2%	5.6%	1.0%	1,037	5,967
177	Sabar Kantha	Malpur	0.2%	4.6%	0.8%	545	3,179
178	Sabar Kantha	Meghraj	0.2%	6.4%	1.1%	736	4,282
179	Sabar Kantha	Modasa	0.2%	5.6%	0.9%	1,195	8,166
180	Sabar Kantha	Prantij	0.1%	2.5%	0.5%	1,636	7,754
181	Sabar Kantha	Talod	0.2%	4.5%	0.8%	916	5,262
182	Sabar Kantha	Vadali	0.3%	4.7%	1.2%	639	2,722
183	Sabar Kantha	Vijaynagar	0.2%	5.9%	0.9%	419	2,811
184	Surat	Bardoli	0.1%	0.1%	0.1%	1,736	9,919
185	Surat	Chorasi	0.2%	0.2%	0.2%	55,767	223,042
186	Surat	Kamrej	0.3%	0.3%	0.3%	1,155	6,918
187	Surat	Mahuva	0.2%	0.1%	0.2%	969	4,259
188	Surat	Mandvi	0.2%	0.3%	0.2%	2,068	10,777
189	Surat	Mangrol	0.1%	0.3%	0.1%	3,683	13,631
190	Surat	Nizar	0.1%	1.0%	0.2%	549	5,067
191	Surat	Olpad	0.3%	0.2%	0.3%	2,373	13,296
192	Surat	Palsana	0.1%	0.1%	0.1%	1,929	10,432
193	Surat	Songadh	0.1%	0.5%	0.2%	1,305	8,109
194	Surat	Surat City	0.1%	0.1%	0.1%	15,319	146,921
195	Surat	Uchchhal	0.1%	0.2%	0.1%	504	5,333
196	Surat	Umarpada	0.3%	1.6%	0.5%	365	1,450
197	Surat	Valod	0.3%	0.1%	0.2%	462	2,349
198	Surat	Vyara	0.1%	0.1%	0.1%	1,359	10,302
199	Surendranagar	Chotila	0.2%	5.8%	1.1%	1,102	6,317
200	Surendranagar	Chuda	0.4%	6.6%	1.0%	290	2,587
201	Surendranagar	Dasada	0.2%	6.2%	1.1%	753	4,311
202	Surendranagar	Dhrangadhra	0.3%	6.1%	1.1%	1,370	8,221
203	Surendranagar	Halvad	0.4%	10.3%	2.0%	1,116	5,666
204	Surendranagar	Lakhtar	0.2%	6.1%	1.0%	350	2,266
205	Surendranagar	Limbdi	0.3%	4.7%	0.8%	987	7,724
206	Surendranagar	Muli	0.3%	9.6%	2.4%	780	2,770
207	Surendranagar	Sayla	0.1%	2.4%	0.6%	2,975	11,774
208	Surendranagar	Wadhwan	0.2%	1.9%	0.4%	2,255	15,916
209	The Dangs	The Dangs	0.3%	2.9%	0.7%	620	3,811
210	Vadodara	Chhota Udaipur	0.1%	3.1%	0.6%	785	4,878
211	Vadodara	Dabhoi	0.1%	2.1%	0.4%	970	6,946
212	Vadodara	Jetpur Pavi	0.2%	2.2%	0.5%	835	3,934
213	Vadodara	Karjan	0.1%	0.3%	0.1%	5,042	18,113
214	Vadodara	Kavant	0.2%	5.0%	0.8%	376	2,389
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225	Valsad	Umbergaon	0.3%	0.2%	0.2%	3,547	15,614
226	Valsad	Valsad	0.2%	0.1%	0.2%	5,640	29,541

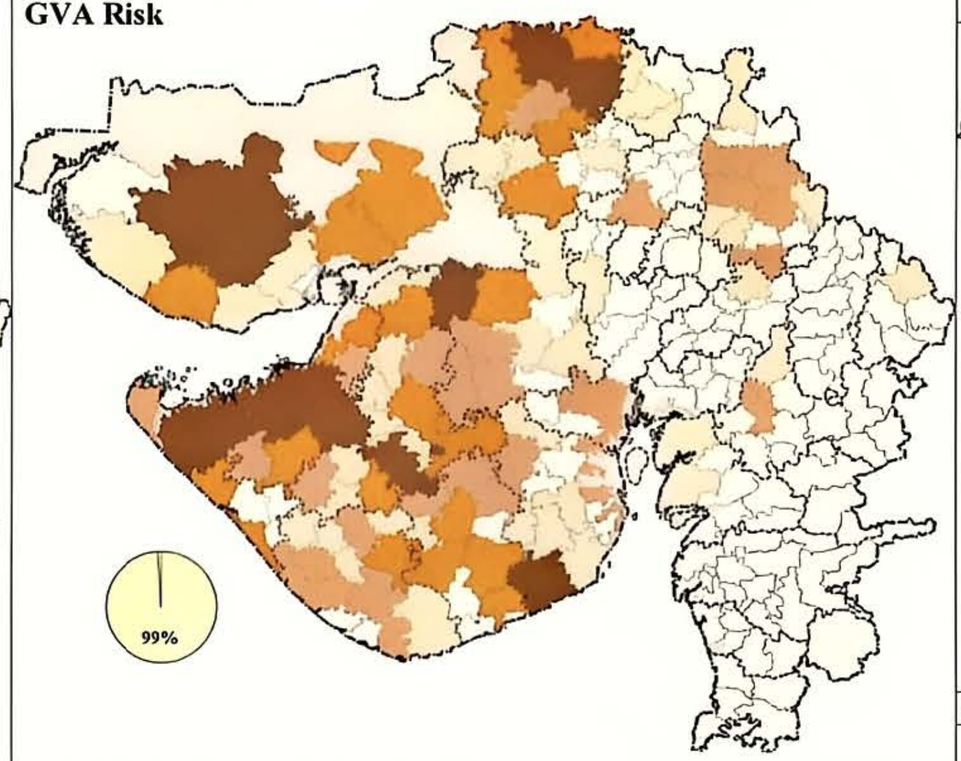
Gujarat Composite Drought Risk Index
(Cumulative Risk Decile Classes)

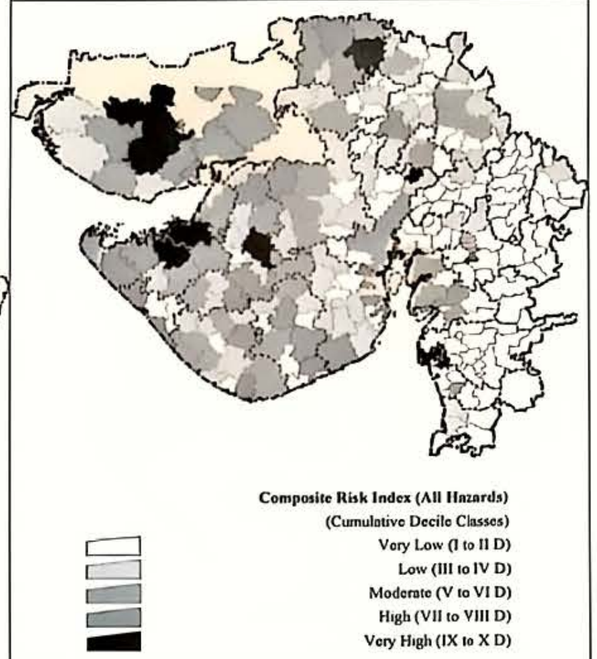
GSDMA

Capital Risk

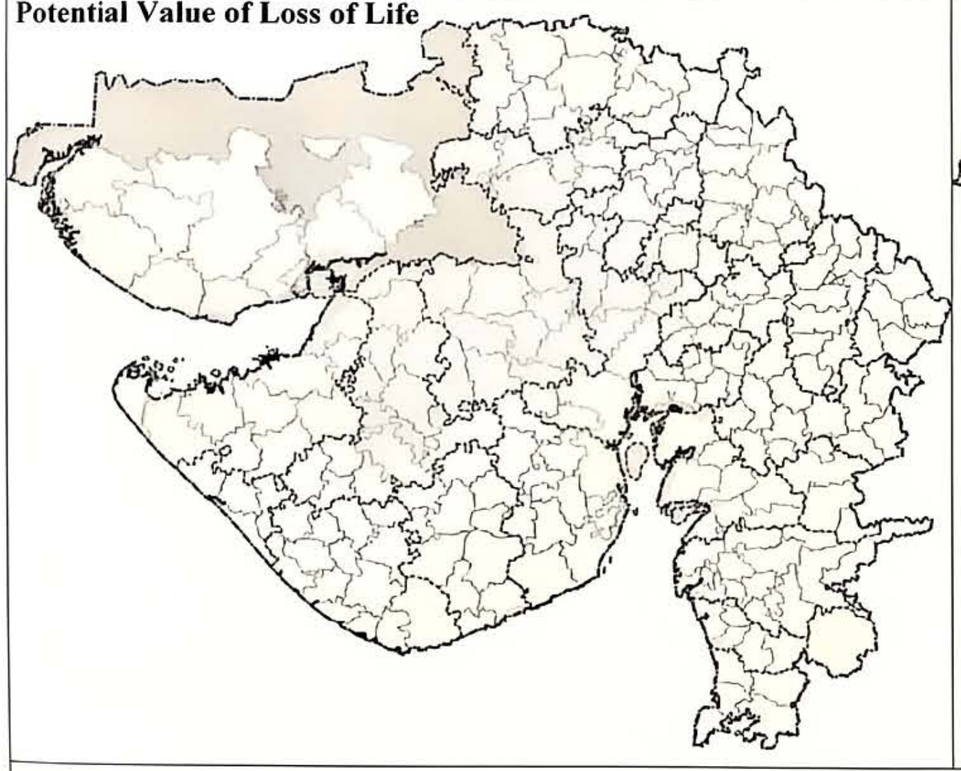


GVA Risk

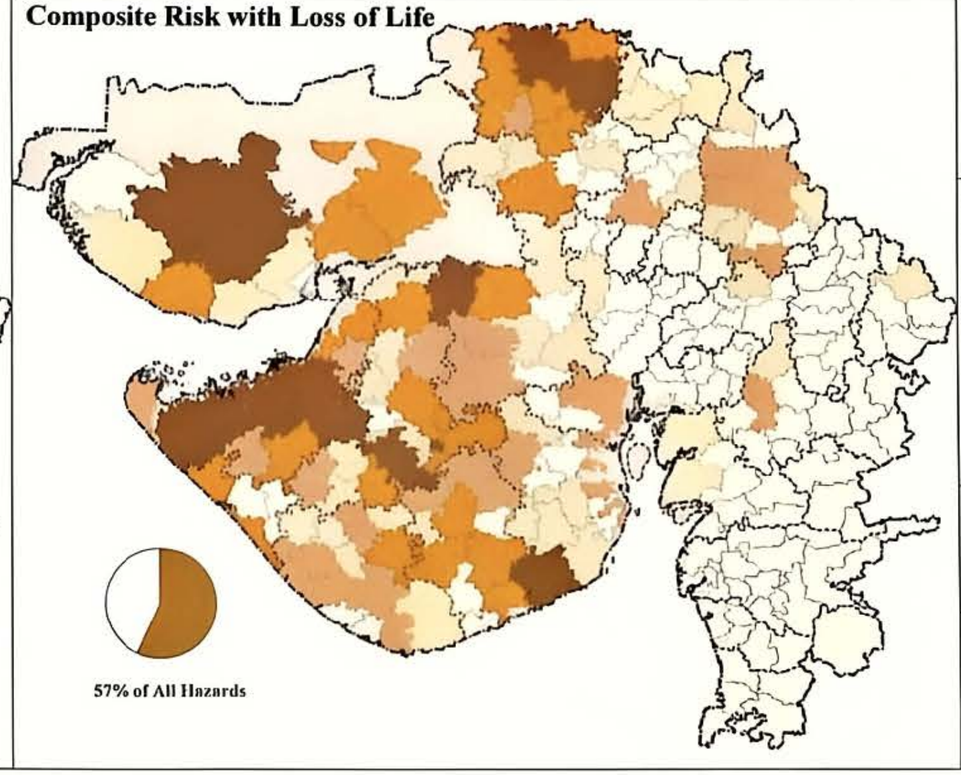




Potential Value of Loss of Life



Composite Risk with Loss of Life



LEGEND

Composite Risk Index
(Cumulative Decile Classes)
Very Low (I to II D)
Low (III to IV D)
Moderate (V to VI D)
High (VII to VIII D)
Very High (IX to X D)

This Risk Index has been computed by stratifying annualised risk estimates using clusters of two deciles classes to generate a five point index. The first two main map pie charts show relative weightage of risk component in overall index. The fourth main map pie chart shows the proportion of specific hazard risk to composite risk of all hazards. These estimates are only indicative and are based on specific hazard risk exceedance probabilities over a defined return period. They do not purport to correspond to a particular historical, future event or other hazards. Please see the detailed technical paper for methods used to estimate the potential loss of life based on hazard intensity and historical data.

Source: TARU Analysis, 2004; BISAG, GoG.

0 100 km

N

Projection : Lambert Azimuthal Equal Area
Datum : WGS 84

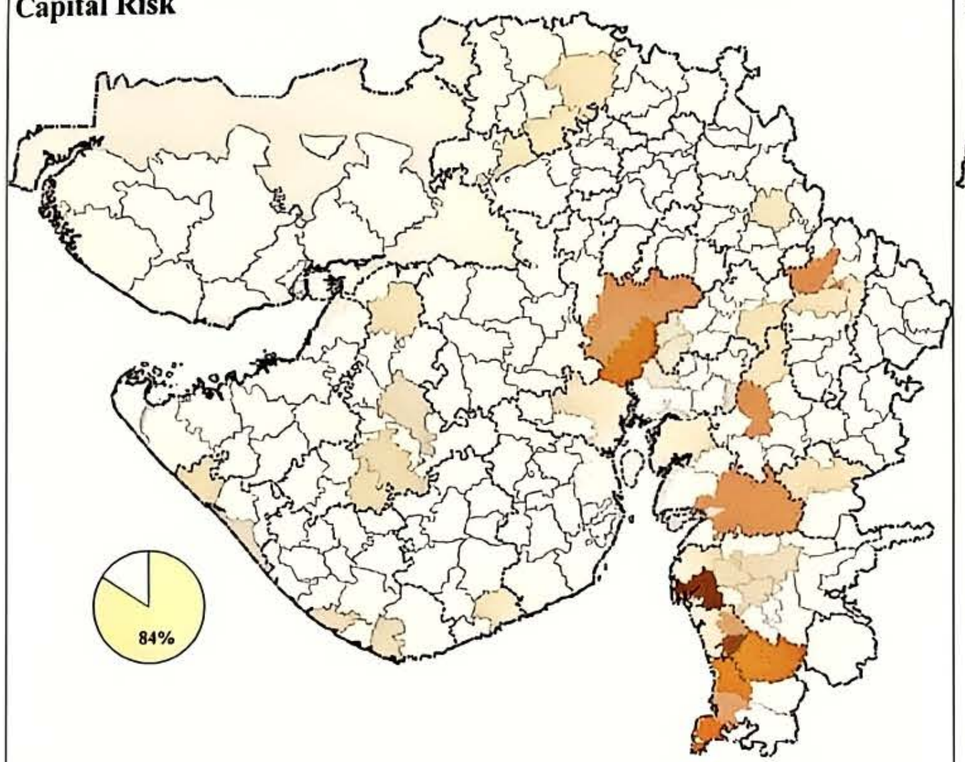
MAP No. : CRIM - 01 OF 09

Date : 18/6/2005

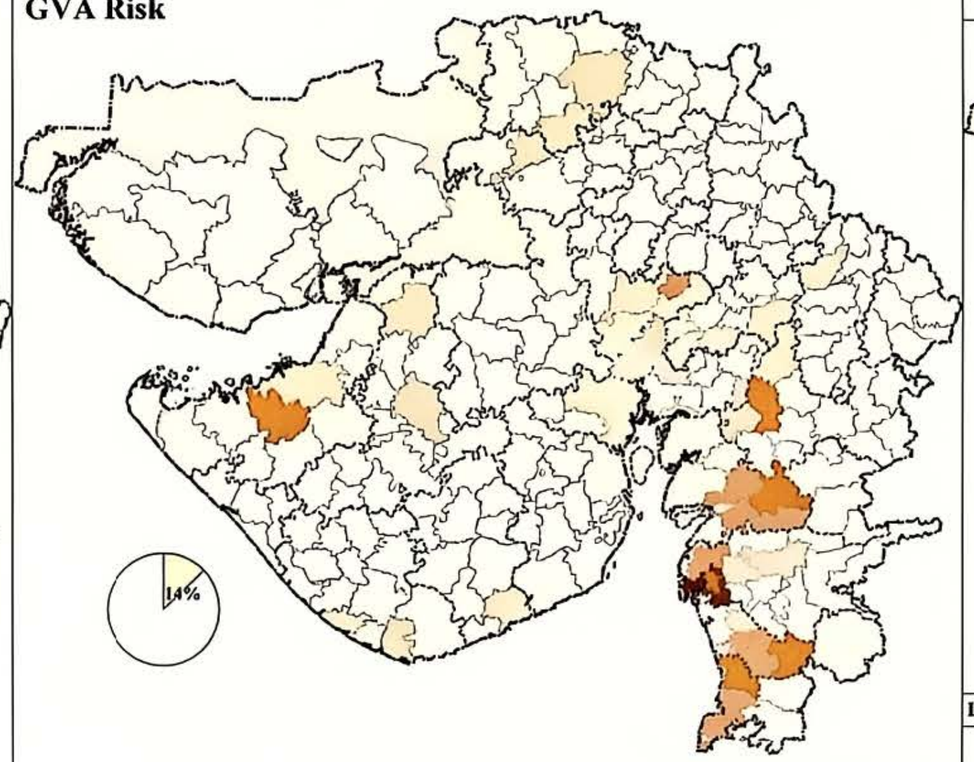
Gujarat Composite Flood Risk Index
(Cumulative Risk Decile Classes)

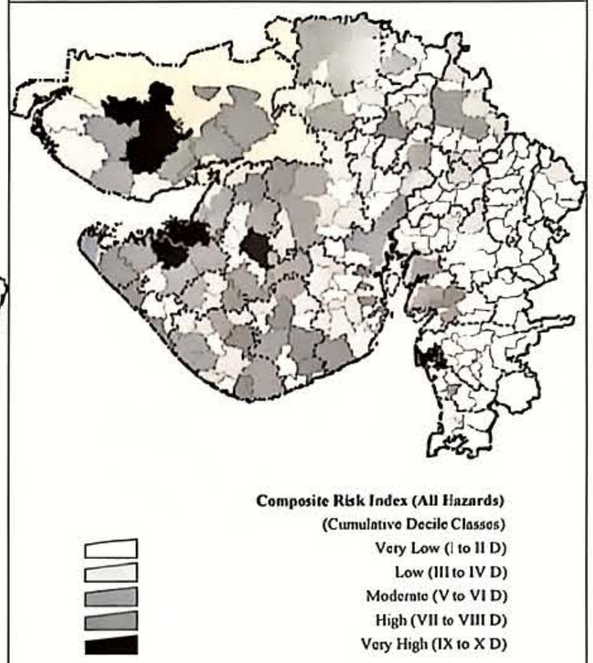
GSDMA

Capital Risk



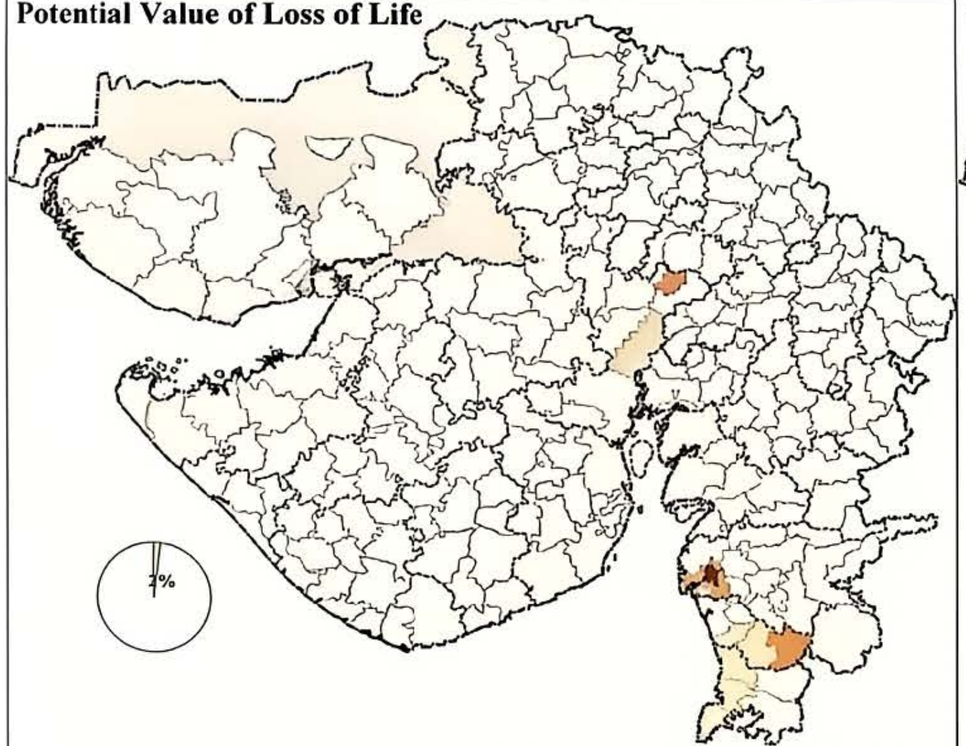
GVA Risk



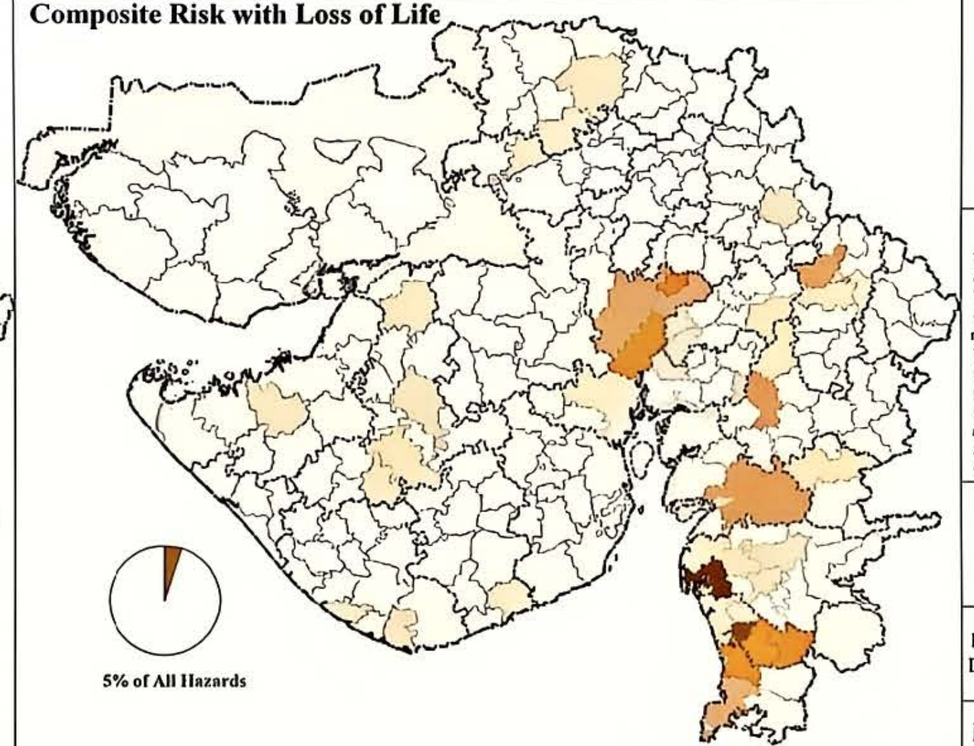


LEGEND

Potential Value of Loss of Life



Composite Risk with Loss of Life



Composite Risk Index
(Cumulative Decile Classes)
Very Low (I to II D)
Low (III to IV D)
Moderate (V to VI D)
High (VII to VIII D)
Very High (IX to X D)

This Risk Index has been computed by stratifying annualised risk estimates using clusters of two deciles classes to generate a five point index.
The first three main map pie charts show relative weightage of risk component in overall index. The fourth main map pie chart shows the proportion of specific hazard risk to composite risk of all hazards.
These estimates are only indicative and based on specific hazard risk exceedance probabilities over a defined return period. They do not purport to correspond to a particular historical, future event or other hazards. Please see the detailed technical paper for methods used to estimate the potential loss of life based on hazard intensity and historical data.
Source: TARU Analysis, 2004; Jonkman et al., 2003; Nathwani et al., 1997; Gujarat SDP, 2000-2001, DSE, GoG; CRED, 2002; BMTPC, 2000, BISAG, GoG

0 100 km

N

Projection : Lambert Azimuthal Equal Area
Datum : WGS 84

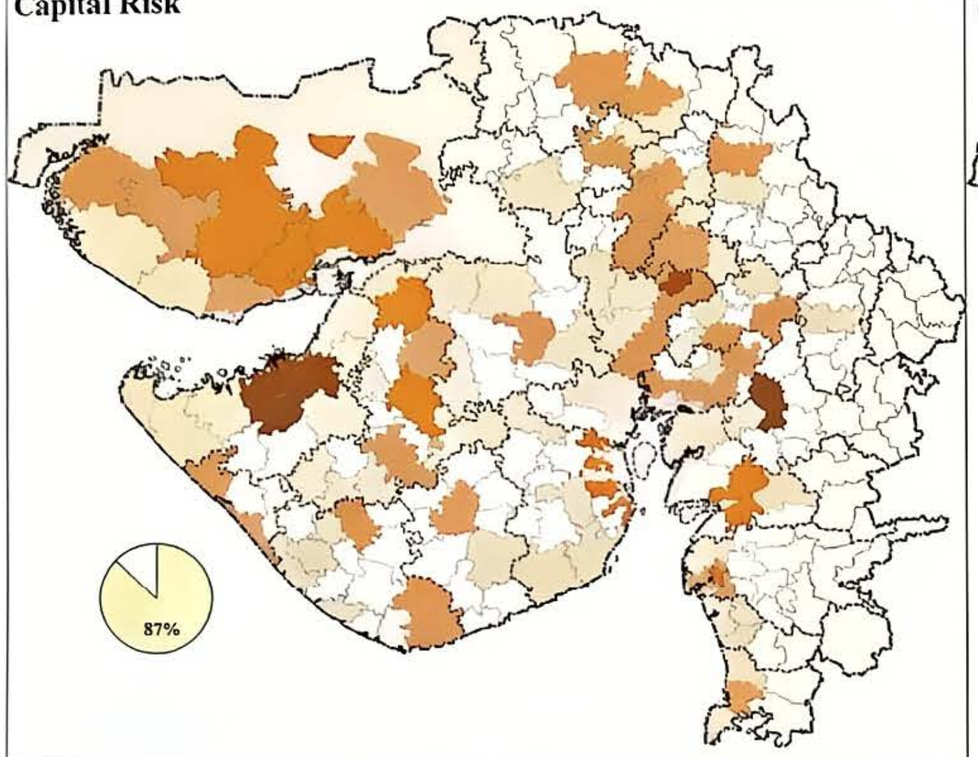
MAP No. : CRIM - 02 OF 09

Date : 18/6/2005

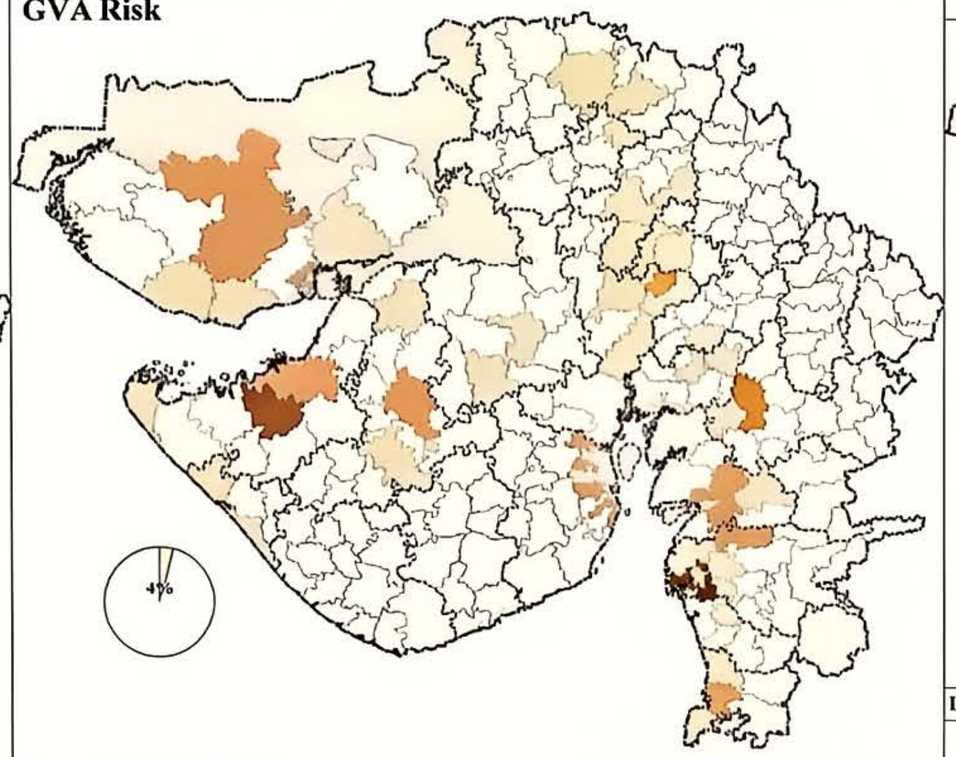
Gujarat Composite Earthquake Risk Index
(Cumulative Risk Decile Classes)

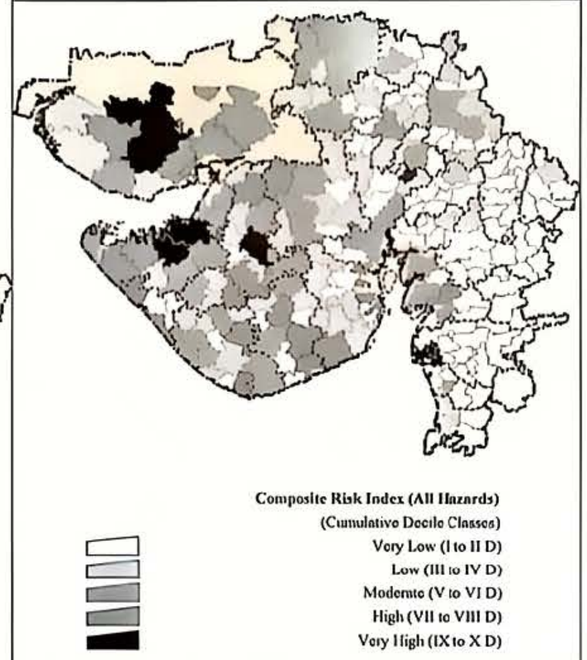
GSDMA

Capital Risk



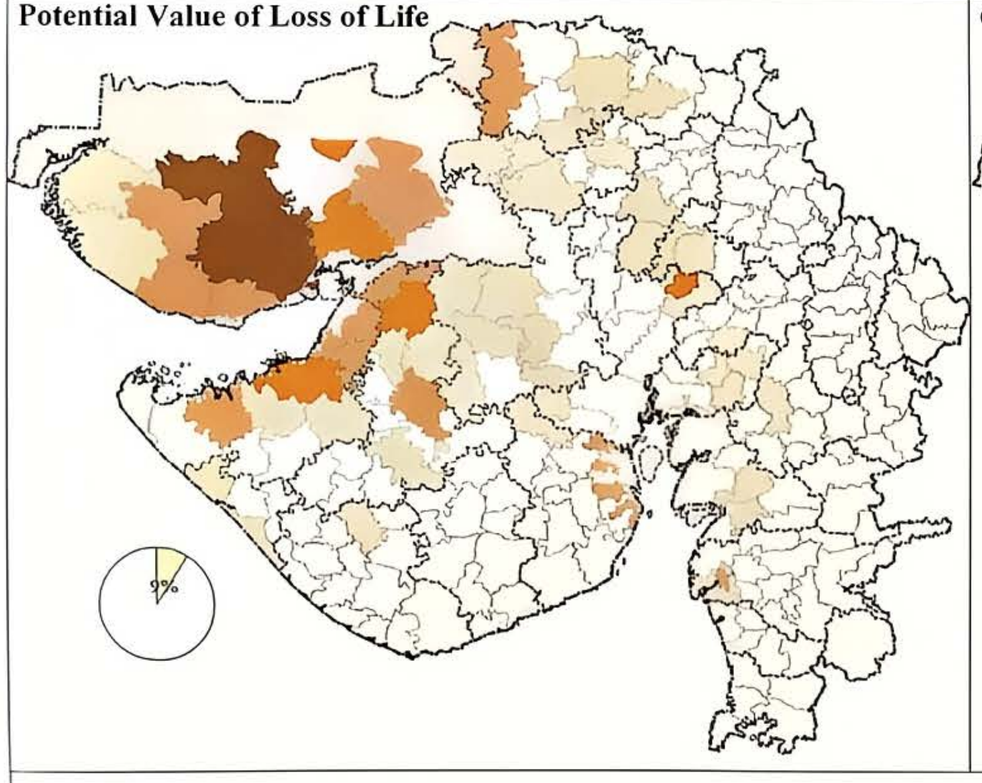
GVA Risk



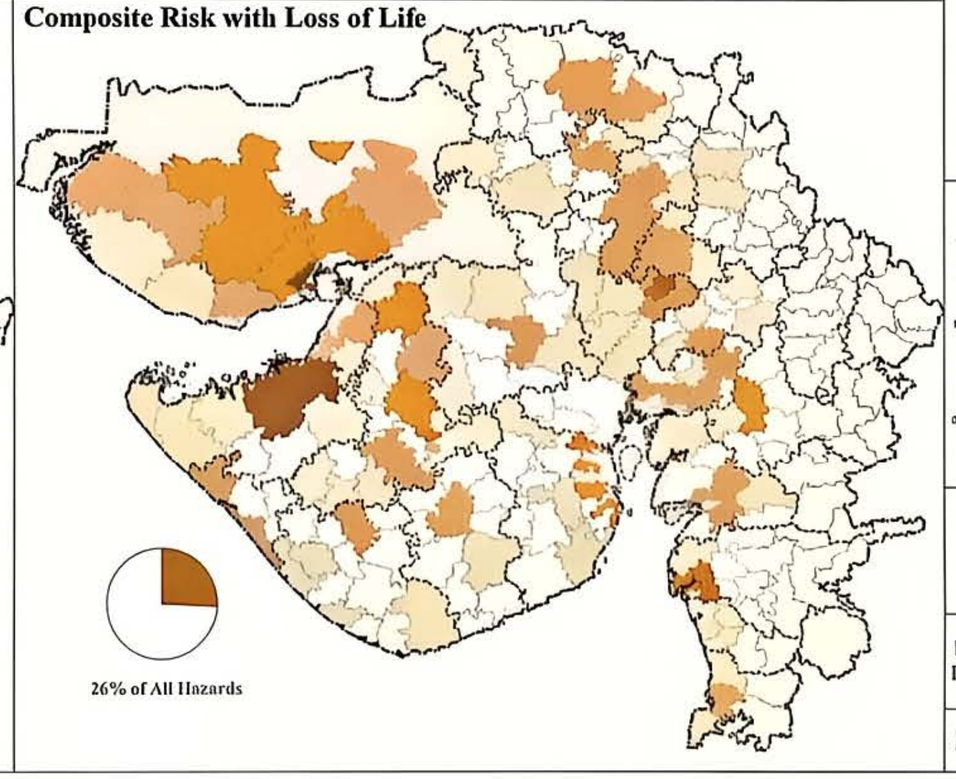


LEGEND

Potential Value of Loss of Life



Composite Risk with Loss of Life



Composite Risk Index
(Cumulative Decile Classes)
Very Low (I to II D)
Low (III to IV D)
Moderate (V to VI D)
High (VII to VIII D)
Very High (IX to X D)

This Risk Index has been computed by stratifying annualised risk estimates using clusters of two deciles classes to generate a five point index.
The first two main map pie charts show relative weightage of risk component in overall index. The fourth main map pie chart shows the proportion of specific hazard risk to composite risk of all hazards.
These estimates are only indicative and are based on specific hazard risk exceedance probabilities over a defined return period. They do not purport to correspond to a particular historical, future event or other hazards. Please see the detailed technical paper for methods used to estimate the potential loss of life based on hazard intensity and historical data.

Source: TARU Analysis, 2004; Jonkman et al., 2003; Nathwani et al., 1997; Gujarat SDP, 2000-2001, DSE, GoG; CRED, 2002; BMTPC, 2000; BISAG, GoG.

0 100 km

N

Projection : Lambert Azimuthal Equal Area
Datum : WGS 84

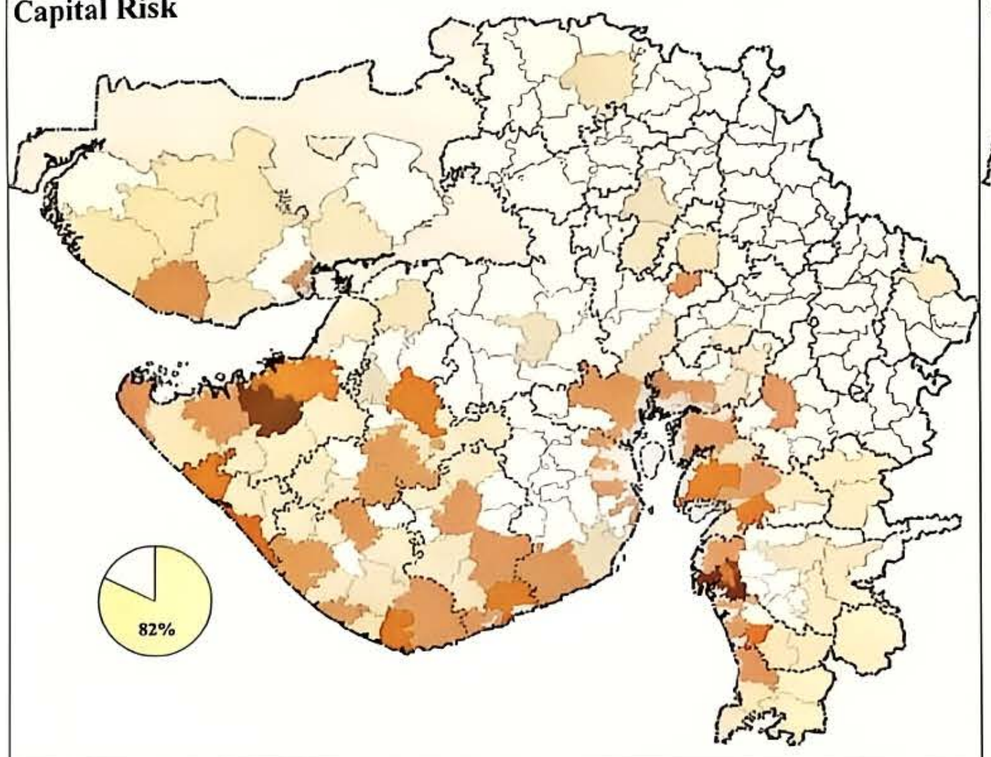
MAP No. : CRIM - 03 OF 09

Date : 18/6/2005

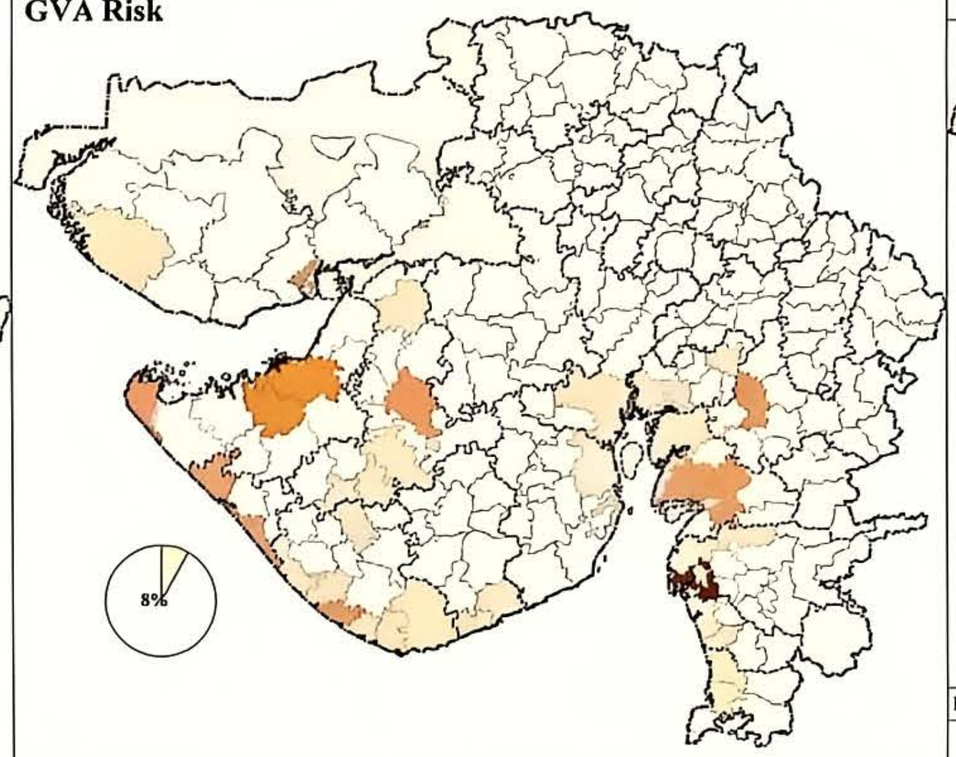
Gujarat Composite Cyclone & Storm Surge Risk Index
(Cumulative Risk Decile Classes)

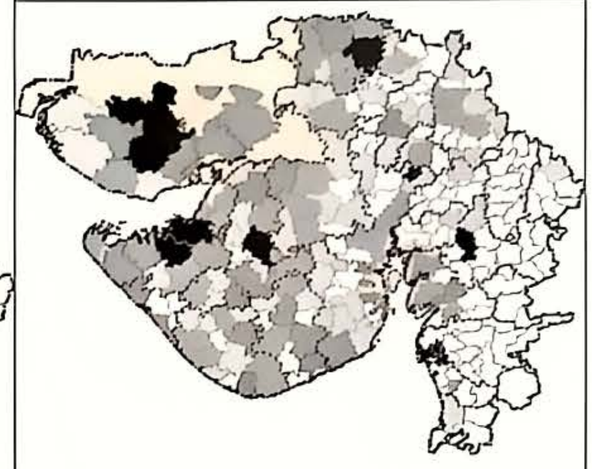
GSDMA

Capital Risk



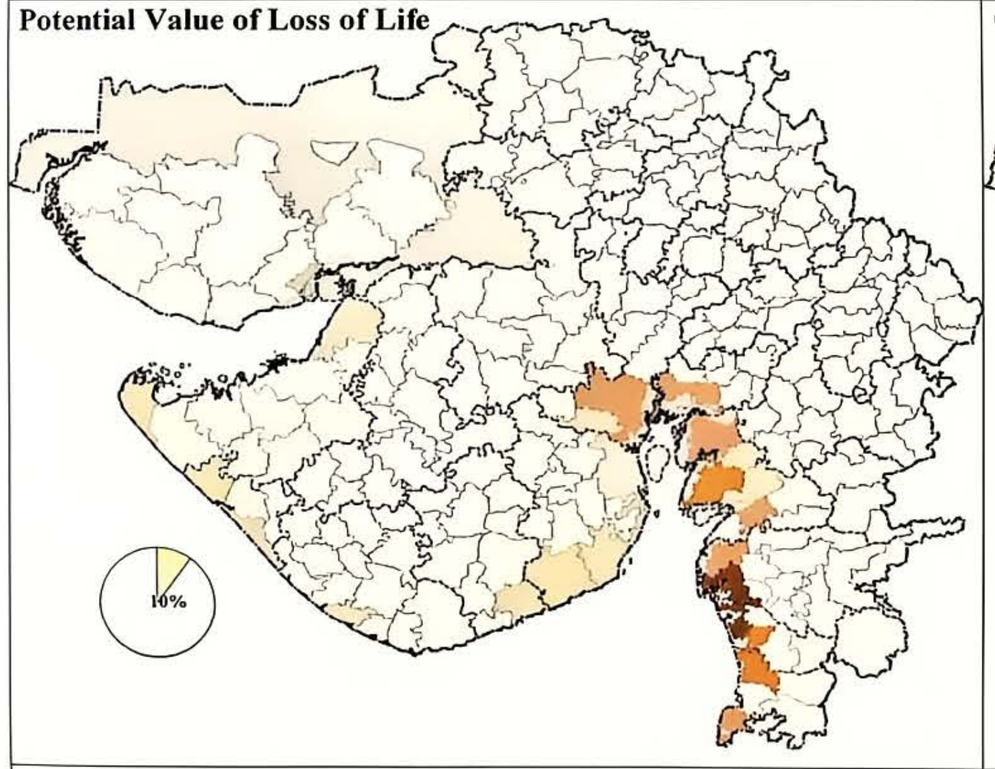
GVA Risk



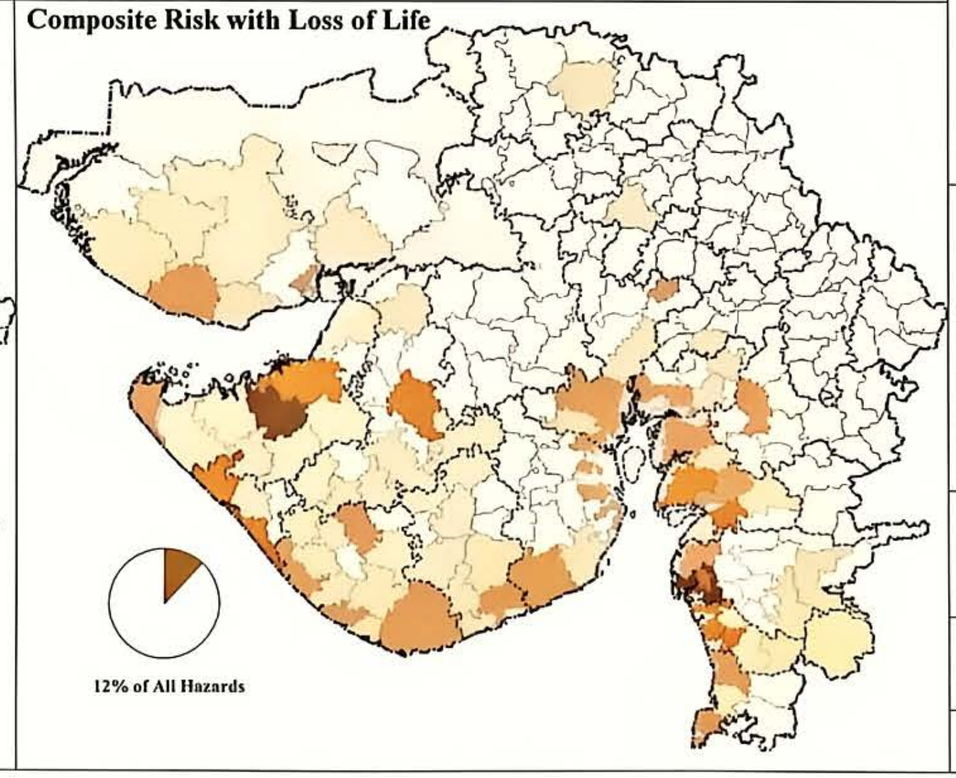


Composite Risk Index (All Hazards)
(Cumulative Decile Classes)
Very Low (I to II D)
Low (III to IV D)
Moderate (V to VI D)
High (VII to VIII D)
Very High (IX to X D)

Potential Value of Loss of Life



Composite Risk with Loss of Life



LEGEND

Composite Risk Index
(Cumulative Decile Classes)
Very Low (I to II D)
Low (III to IV D)
Moderate (V to VI D)
High (VII to VIII D)
Very High (IX to X D)

This Risk Index has been computed by stratifying annualised risk estimates using clusters of two deciles classes to generate a five point index.

The first three main map pie charts show relative weightage of risk component in overall index. The fourth main map pie chart shows the proportion of specific hazard risk to composite risk of all hazards.

These estimates are only indicative and are based on specific hazard risk exceedance probabilities over a defined return period. They do not purport to correspond to a particular historical, future event or other hazards. Please see the detailed technical paper for methods used to estimate the potential loss of life based on hazard intensity and historical data.

Sources: TARU Analysis, 2004; Jonkman et al., 2003, Nathwani et al., 1997; CRED, 2002; BMTPC, 2000; BISAG, GoG

0 100 km

N

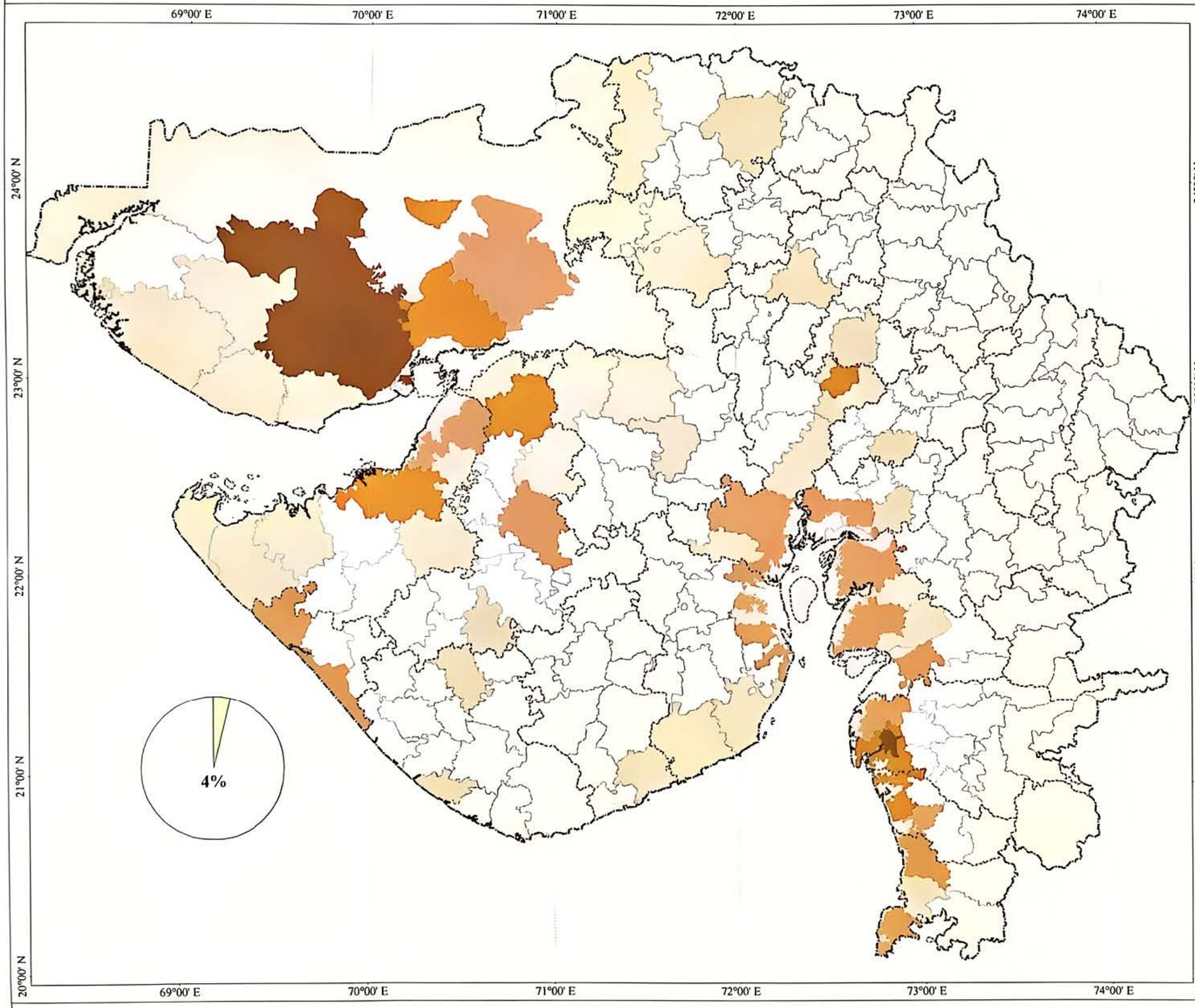
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Datum : WGS 84

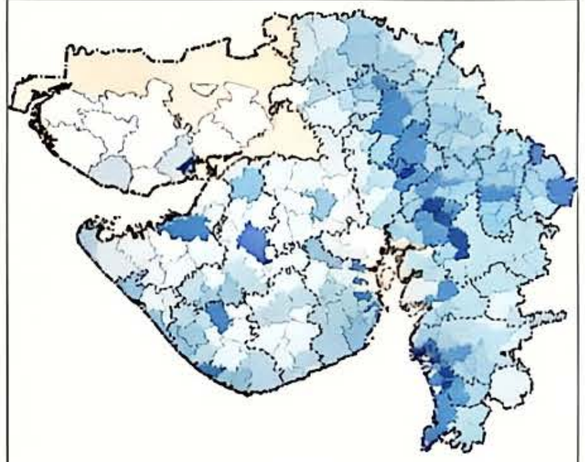
MAP No. : CRIM - 04 OF 09

Date : 18/6/2005

Gujarat Potential Loss of Life Index (All Hazards)
(Cumulative Risk Decile Classes)

GSDMA





Population Density (Person/Sq. Km.)

< 100
> 100 to 200
> 200 to 300
> 300 to 500
> 500 to 1000
> 1000

LEGEND

Composite Risk Index
(Cumulative Decile Classes)
Very Low (I to II D)
Low (III to IV D)
Moderate (V to VI D)
High (VII to VIII D)
Very High (IX to X D)

This Risk Index has been computed by stratifying annualised risk estimates using clusters of two deciles classes to generate a five point index.
The main map pie chart shows relative weightage of risk component in overall index.
These estimates are only indicative and are based on specific hazard risk exceedance probabilities over a defined return period. They do not purport to correspond to a particular historical, future event or other hazards. Please see the detailed Technical paper for methods used to estimate the potential loss of life based on hazard intensity and historical data.
Sources: TARU Analysis, 2004; Jonkman et al., 2003, Nathwani et al., 1997, CRED, 2002; BMTPC, 2000; BISAG, GoG.

0 100 km

N

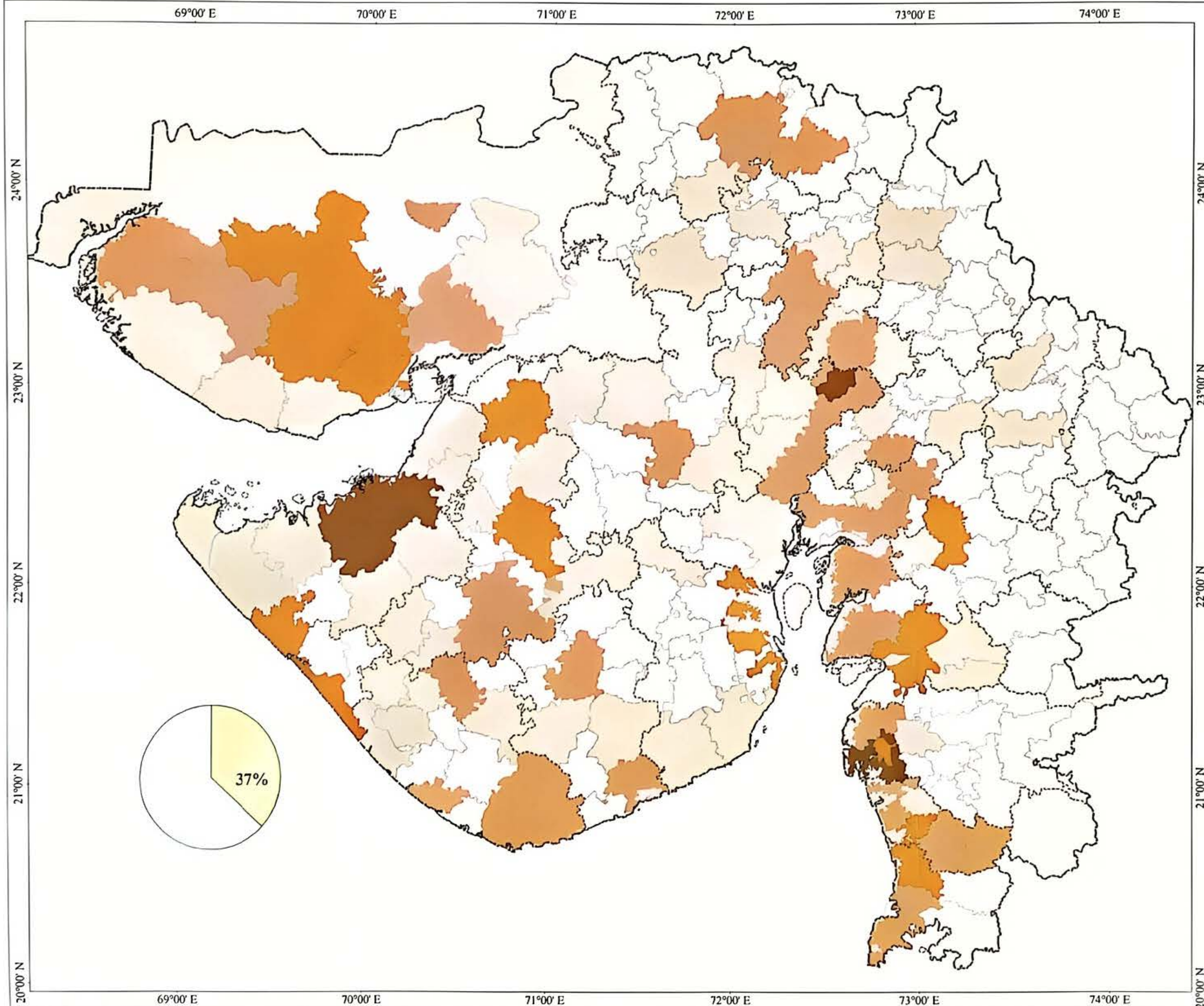
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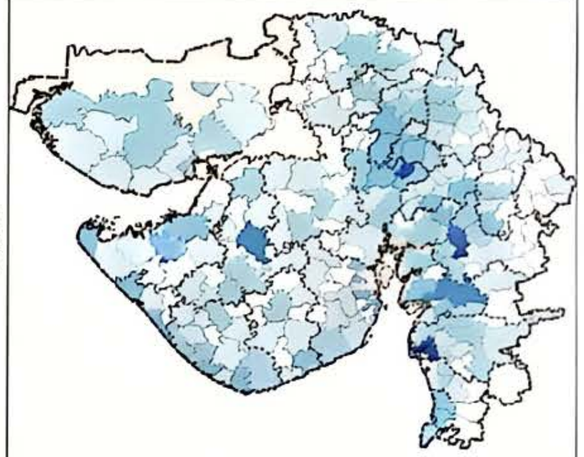
MAP No. : CRIM - 05 OF 09

Date : 18/6/2005

Gujarat Composite Capital Risk Index (All Hazards)
(Cumulative Risk Decile Classes)

GSDMA





Value of Total Capital Assets (Rs. million)

< 5000
> 5000 to 10000
> 10000 to 20000
> 20000 to 50000
> 50000 to 100000
> 100000

LEGEND

Composite Risk Index
(Cumulative Decile Classes)
Very Low (I to II D)
Low (III to IV D)
Moderate (V to VI D)
High (VII to VIII D)
Very High (IX to X D)

This Risk Index has been computed by stratifying annualised risk estimates using clusters of two deciles classes to generate a five point index.

The main map pie chart shows relative weightage of risk component in overall index.

Source TARU Analysis, 2004, BISAG, GoG

0 100 km

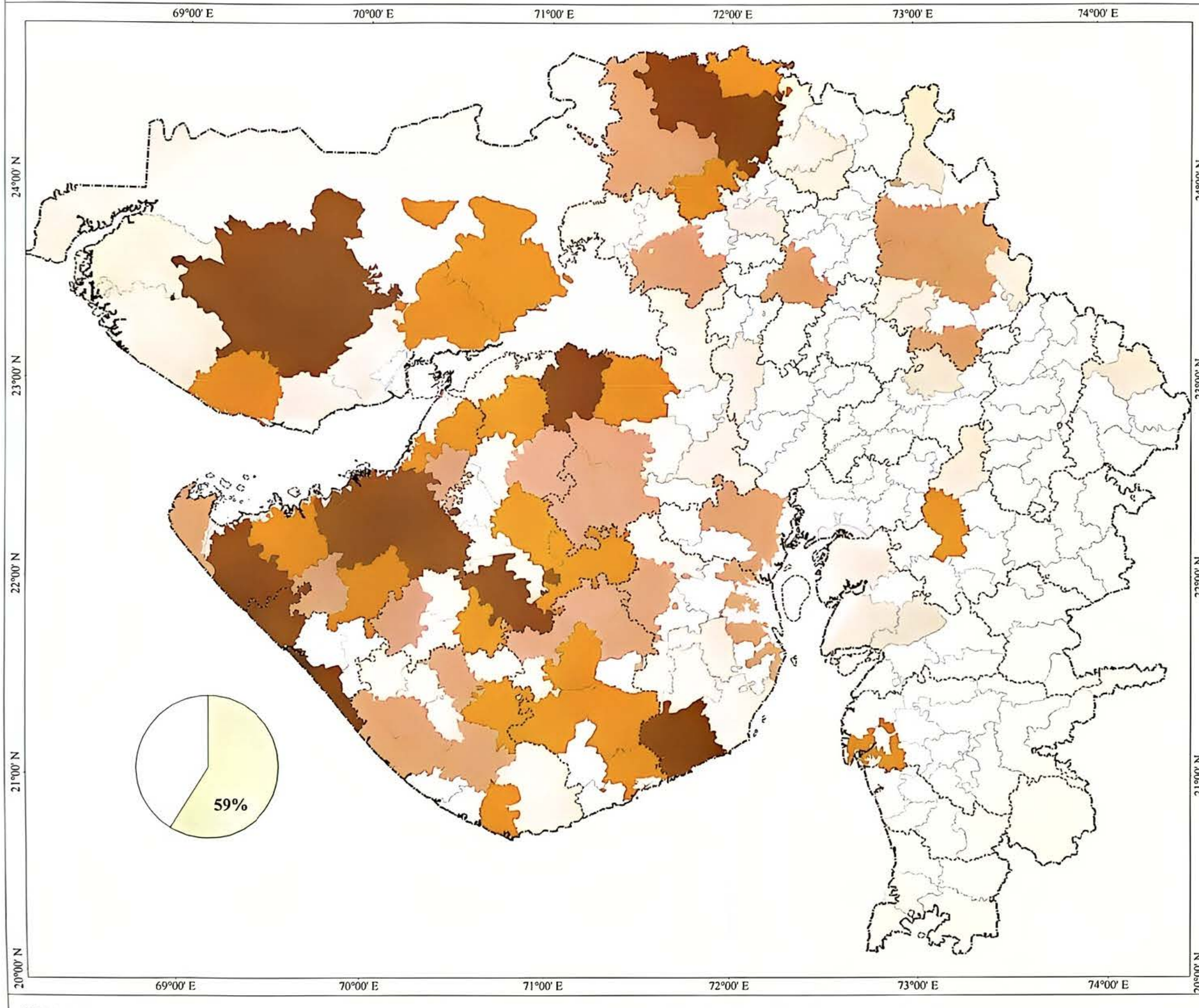
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Projection : Lambert Azimuthal Equal Area
Datum : WGS 84

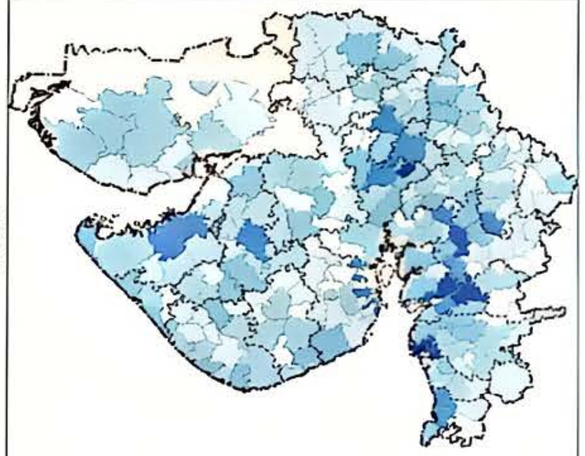
MAP No. : CRIM - 06 OF 09

Date : 24/6/2005

Gujarat Composite GVA Risk Index (All Hazards)
(Cumulative Risk Decile Classes)



GSDMA



Total GVA (Rs. million)
- < 500
- > 500 to 1000
- > 1000 to 2000
- > 2000 to 5000
- > 5000 to 10000
- > 10000

LEGEND

Composite Risk Index
(Cumulative Decile Classes)
- Very Low (I to II D)
- Low (III to IV D)
- Moderate (V to VI D)
- High (VII to VIII D)
- Very High (IX to X D)

This Risk Index has been computed by stratifying annualised risk estimates using clusters of two deciles classes to generate a five point index.

The main map pie chart shows relative weightage of risk component in overall index.

Source: TARU Analysis, 2004, BISAG, GoG.

0 — 100 km

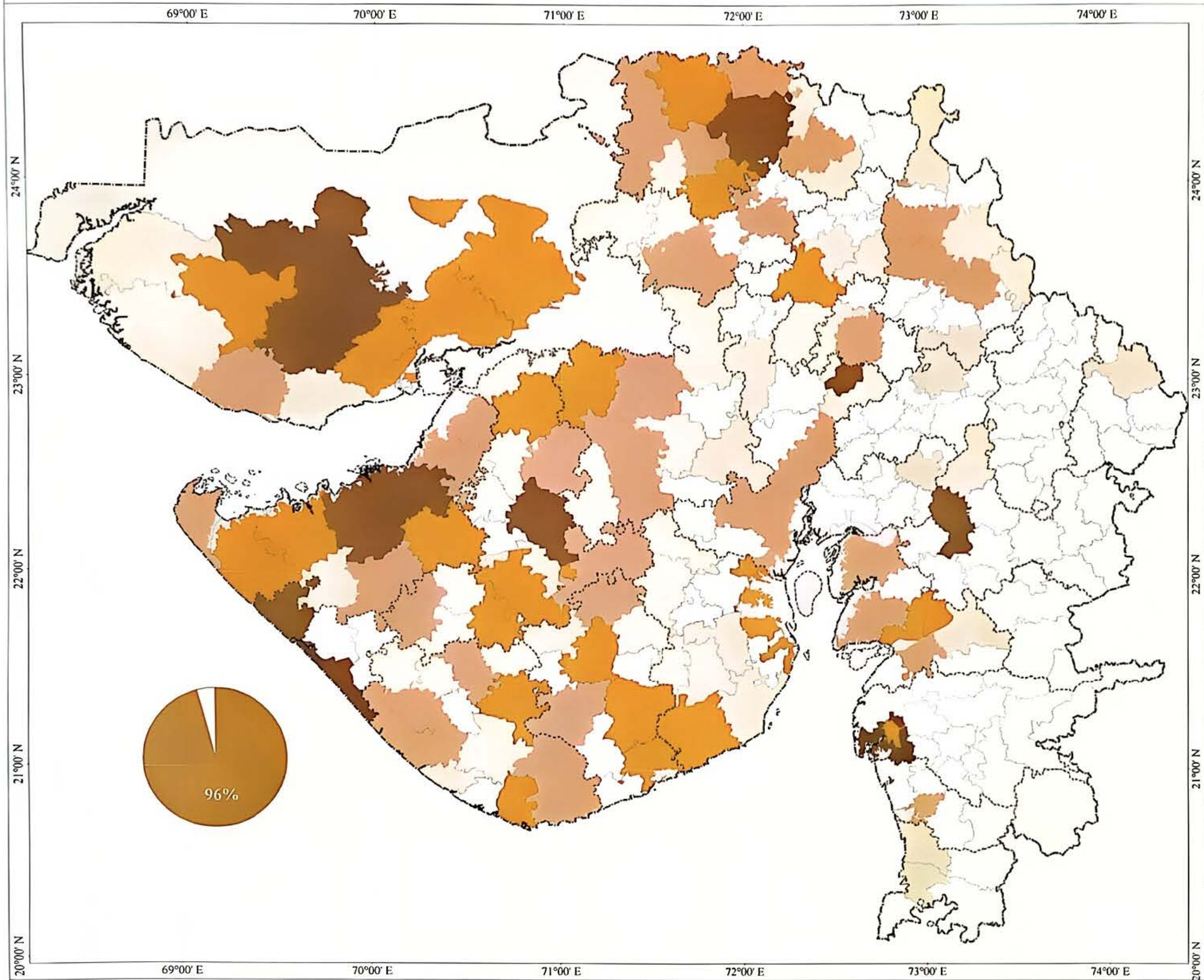
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Projection : Lambert Azimuthal Equal Area
Datum : WGS 84

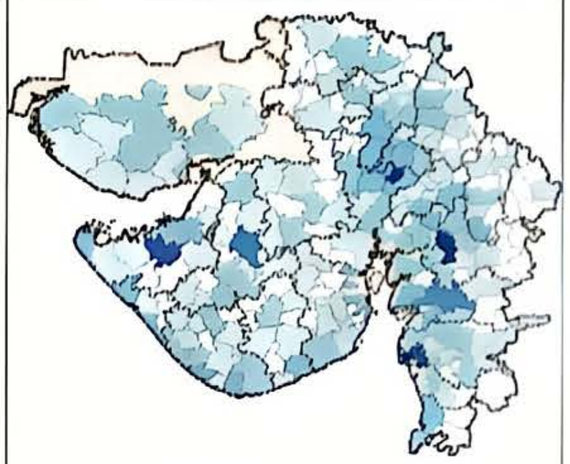
MAP No. : CRIM - 07 OF 09

Date : 18/6/2005

Gujarat Composite Capital & GVA Risk Index (All Hazards)
(Cumulative Risk Decile Classes)



GSDMA



Value of Total Capital Assets (Rs. million)
- < 5000
- > 5000 to 10000
- > 10000 to 20000
- > 20000 to 50000
- > 50000 to 100000
- > 100000

LEGEND

Composite Risk Index
(Cumulative Decile Classes)
- Very Low (I to II D)
- Low (III to IV D)
- Moderate (V to VI D)
- High (VII to VIII D)
- Very High (IX to X D)

This Risk Index has been computed by stratifying annualised risk estimates using clusters of two deciles classes to generate a five point index.

The main map pie chart shows relative weightage of risk component in overall index.

Source: TARU Analysis, 2004; BISAG, GoG

0 — 100 km

N

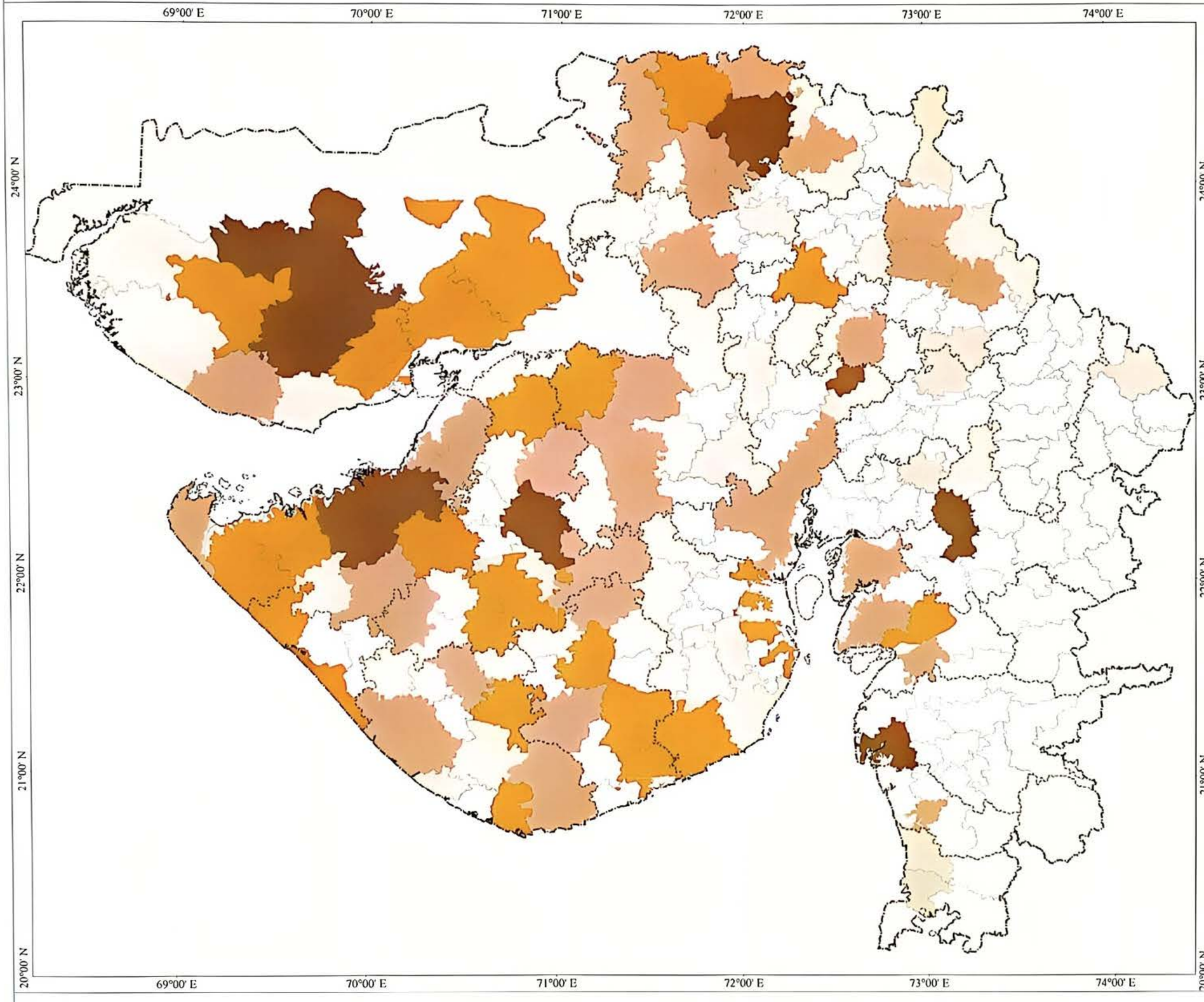
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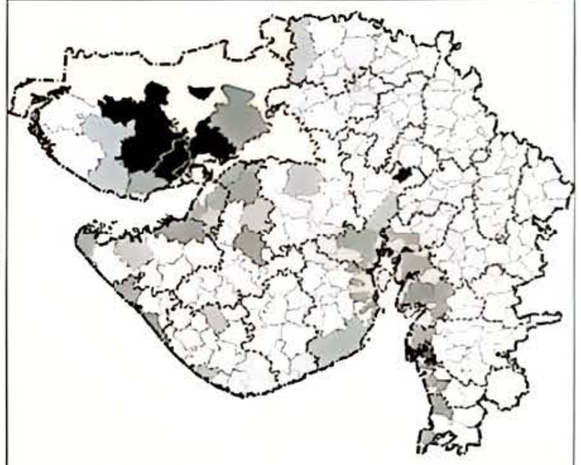
MAP No. : CRIM - 08 OF 09

Date : 18/6/2005

Gujarat Composite Risk Index (All Hazards)
(Cumulative Risk Decile Classes)

GSDMA





Estimated Annualised Loss of Life (in nos.)

- < 5
- > 5 to 10
- > 10 to 15
- > 15 to 30
- > 30 to 60
- > 60

(Exponential class intervals)

LEGEND

Composite Risk Index
(Cumulative Decile Classes)

- Very Low (I to II D)
- Low (III to IV D)
- Moderate (V to VI D)
- High (VII to VIII D)
- Very High (IX to X D)

This Risk Index has been computed by stratifying annualised risk estimates using clusters of two deciles classes to generate a five point index.

These estimates are only indicative and are based on specific hazard risk exceedance probabilities over a defined return period. They do not purport to correspond to a particular historical, future event or other hazards. Please see the detailed technical paper for methods used to estimate the potential loss of life based on hazard intensity and historical data.

Source: TARU Analysis, 2004, Jonkman et al, 2003; Nathwani et al, 1997, Gujarat SDP, 2000-2001, DSE, GoG, CRED, 2002; BMTPC, 2000, BISAG, GoG.

0 — 100 km

N

Projection : Lambert Azimuthal Equal Area
Datum : WGS 84

MAP No. : CRIM - 09 OF 09

Date : 18/6/2005

ACKNOWLEDGEMENTS

The development of the Gujarat Hazard Risk & Vulnerability Atlas is one of the most comprehensive recent disaster and risk assessment initiatives in India. Its assessment of risk to the 50 million people of Gujarat (at the scale of 25 districts and 226 Talukas) of six natural and manmade hazards: drought, earthquake, cyclone, storm surge, flood and chemical accidents; quantification of physical, socio-economic and economic vulnerability and their estimated separate and combined risk to the population, infrastructure, capital assets and economy of a state has never been attempted before.

This has only been possible due to the tremendous commitment and intellectual labour of a large inter-disciplinary team of nearly twenty specialists from TARU who drew from a wide range of fields of knowledge and practice including: seismology, meteorology, hydrology, earth sciences, earthquake, wind and building engineering, industrial safety, remote sensing and GIS, statistics, disaster management and mitigation, vulnerability assessment, social development, economics and finance. This team was provided information by a field research and survey team of over twenty professionals that fanned across Gujarat to enable a systematic multi-dimensional empirical assessment of risk. An experienced logistics and project management team from TARU ably assisted this and other processes.

This Atlas would not been conceived or successfully executed without World Bank GEERP financing and the powerful institutional support of GSDMA. The vision, perseverance and unstinting support of Joint CEO Shri V. Thiruppugazh, the technical guidance of former GSDMA Seismic advisor, Prof. A.S. Arya and the encouragement of the World Bank Task manager, Mr. Shyamal Sarkar were critical in bringing this process to fruition. The GSDMA and PMC support team: Deepty Tiwari, Manish Rege, M. Srikanth & Darpan Jethi worked many hours to facilitate the functioning of this multiply-challenged assignment.

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The most important contribution however, has come from the thousands of households, enterprises and industries, NGOs and researchers in Gujarat who enabled the Atlas team to draw upon their day-to-day experience of responding and coping with multiple hazards, risks and disasters. Their names would fill a full volume on their own.

It has been a great privilege to work with such a talented and committed team of Indian professionals and to have collectively broken so much new ground, in spite of tremendous challenges of data availability and an almost complete lack of precedence of such work in South Asia. We hope that this Atlas can enable a number of concrete steps to make India and vulnerable people across the world more secure.

Aromar Revi
Team Leader

New Delhi, May 2005

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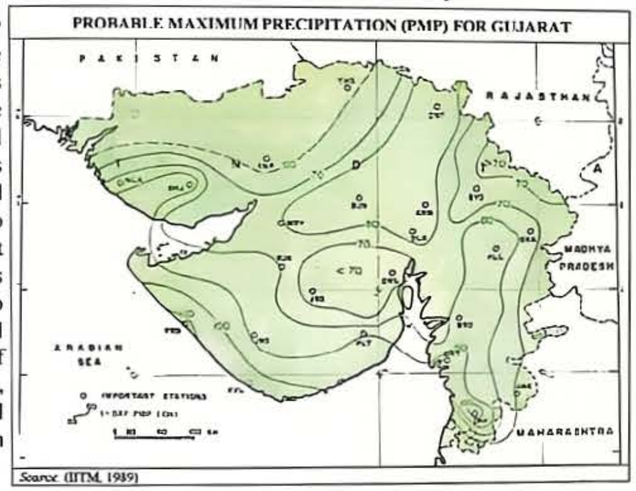
SEVERE RAINSTORM (27th JUNE to 3rd JULY - 2005)

FLOODS IN GUJARAT

Unlike widely believed, Gujarat has seen many damaging floods. Almost all the major rivers in the state pass through a wide stretch of very flat terrain (often more than 50 km) before reaching the sea. These flat lowlands of the lower river basins are prone to flooding due to occasional heavy rainstorms in the middle and upper basins. Fairly impervious catchments (rocky or black cotton soils) and steep sloping upper catchments can concentrate runoff to cause heavy short duration floods which can be devastating in the small river basins of Saurashtra and Kachchh. Single day rainfall of more than 300 mm is not uncommon in these regions and severe rainstorms often last for 2 to 3 days.

During the 1988-98 period, the average flood damage per year was estimated at about Rs. 400 million per year (Flood Control Cell, 2005). The highest damage reported was in 1997 with a total annual damage of Rs. 1,106 million and minimum was during 1991 with a damage of Rs 120 million for the irrigation and dam structures only.

The Gujarat PMP map shows that the one-day PMP is often higher than the average annual rainfall in most parts of Saurashtra and Kachchh. It has to be noted that occasional cyclones and depressions also cause heavy rainfall in large parts of Saurashtra, Kachchh, central and northern Gujarat.



Floods are reported almost every third year across a Saurashtra, Kachchh and Northern Gujarat. Ahmedabad, Surat and Bharuch cities which are located on the flat alluvial plains of large rivers have been ravaged in the past (Bhat, 1999). The heavy floods of 1927 affected large parts of Ahmedabad city and its neighbourhood subsequent to an extraordinary 41 cm rainfall in a single day and a total of over 85 cm over three days (GAU undated). While the 1927 Ahmedabad flood was mostly due to local rainfall, the city has suffered from floods originating in upper basin of the Sabarmati River. Similarly, floods of Tapi River affect Surat and flooding of the Narmada affects Bharuch town. Surat witnessed unprecedented floods in 1822, 1835, 1837, 1843 and 1849. Some of the floods were even named as "Mahajagat" floods.

RAINSTORMS IN GUJARAT

A rainstorm is a spell of heavy rainfall over a large area with average precipitation exceeding a specified threshold value. Gujarat, especially South Gujarat & Saurashtra are prone to short periods of extreme precipitation and rainstorms. The stare has been affected by three severe rainstorms off the fifteen recorded in India over the last 100 years, (IITM Pune, Severe rainstorms of India, 1994). A brief account:

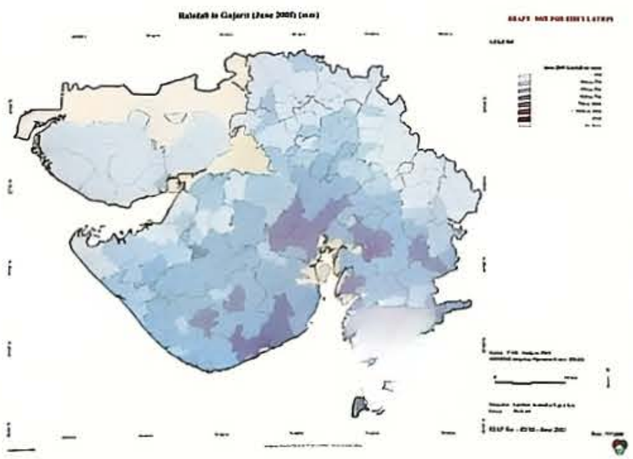
26-28 July, 1927 Rainstorm over Gujarat was caused by a monsoon depression which originated in the Bay of Bengal on the morning 23rd July and traversed the Indian Subcontinent. The depression caused heavy rains by stimulating the activity of the Arabian sea monsoon current bringing moist southwesterly air flow over Gujarat and caused heavy rains in North Gujarat and South Aravali hills. The maximum rain fell over Gujarat on 26th, 27th and the 28th July 1927 with daily rainfall at many stations exceeding 30 cm. Over 54 cm fell on Dakor on 28th, July 1927. The event return period as estimated by IITM at 2000 years. The total rainfall in these three days reached 129 cm in Dakor, 100 cm at Kalol and 83 cm at Ahmedabad, which were 3 to 4 times the normal for the month.

1-3 July, 1941 Rainstorm over South Gujarat-North Konkan was caused by the depression which formed in the head Bay of Bengal on 28th June 1941. The depression caused heavy rainfall along its track, but when it reached close to Baihar the monsoon current from the Arabian sea was strengthened and rainfall over the coastal plains of South Gujarat and the north Konkan was heavy to very heavy on the morning of 2nd July 1941. Dharmpur station, in South Gujarat recorded 99 cm of rainfall – the highest recorded 24-hour rainfall for a plain area station in India. The total rainfall was 99 cm, 126 cm and 145 cm over a 1 , 2 and 3-day respectively. The areal rain-depths obtained from this rainstorm exceeded severe tropical US and Australian rainstorms and is classified as one of the most severe tropical rainstorms ever recorded.

10-12 August, 1979 Rainstorm over Saurashtra and Kachchh was caused by the movement of a depression which developed in the Northeast Bay of Bengal as a low-pressure area on 5th August 1979. Under the influence of this system, the monsoon was strong to vigorous in Saurashtra and Kachchh. The strong monsoon conditions caused heavy to very heavy rainfall over Saurashtra and Kachchh over the 10th to 12th August, 1979 period. Daily rainfall at many stations exceeded 20 cm. The total rainfall over these three days reached 30 cm at Bhuj, 55 cm at Morvi, 56 cm at Rajkot which is almost equal to their mean annual rainfall. Dhrangadhra recorded 70 cm in 3 days, which was 20 cm more than the mean annual rainfall of this station. The maximum 1-day rainfall of 35 cm that fell in Rajkot on 11th August 1979 was estimated at a return period of 100 years (IITM, 1994). This event also caused the breach of Machhu-2 earthen dam.

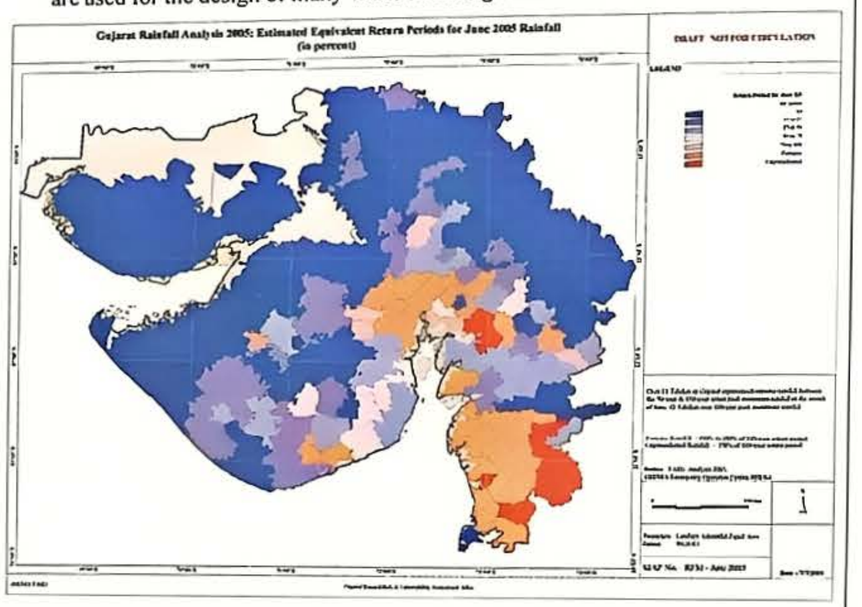
27TH JUNE - 3RD JULY, 2005 SEVERE RAINFALL IN GUJARAT

Unprecedented torrential rain lashed some parts of Gujarat from 27th June to 3rd of July 2005. The rains were continuous, so severe and early in the monsoon season that the scale of the regional flooding in many Talukas caught the state machinery unaware. Flash flooding and regional inundation took place, due to incessant rainfall across many catchments and slow outflows especially in topographically vulnerable areas with poor natural drainage, stretches with poor cross-drainage leading to a rapid rate of rise of floodwater due to concentration,. Many flooded areas remain inaccessible by road, while rail links to other part of the country were severely affected.



Data collated from 198 rain gauge stations across Gujarat and compared with GSDMA's 100-year rainfall database for the month of June (that was used to prepare the GSDMA Gujarat Hazard Risk & Vulnerability Atlas) provides the following snapshot of this extreme rainfall event:

- The rainfall was so severe that 13 Talukas reported an excess of 1000 mm (1 metre) of rain over this 1-week period in late June. Concentration of this rainfall lead to flooding with depths in excess of 1 m in many locations.
- Much of 24 Talukas received more than 80 percent of their mean annual rainfall in this short period.
- Rainfall in 110 of the 226 Talukas in the State exceeded the historical 10-year Return period (i.e. one-in-ten year return) maximum cumulative rainfall. Amongst these 40 Talukas experienced rainfall more than two times the maximum reported over a ten-year return.
- Rainfall in over 50 Talukas was in excess of the 50-year Return period (i.e. one-in-fifty year return) maximum cumulative rainfall. Amongst these 20 Talukas experiencing rainfall more than 150% of the 50-year peak and 4 Talukas received rain in excess of 200% of this peak. It may be noted that 50-year peak flood levels are used for the design of many water-retaining structures.



- Unprecedented rainfall in 42 Talukas exceeding the 100-year Return period (i.e. maximum rainfall in 100 years). Within this set 7 Talukas in South and Central Gujarat and coastal Saurashtra received rainfall in excess of 150% of the 100-year historical peak rainfall for the month of June making this an extreme unprecedented event in the scientific record.

As per normal mitigative practice most water retaining structures and some lifeline infrastructure is designed in response to 50 or 100-year peak flooding. The hazard exposure of some areas of Gujarat in June 2005 was in excess of this. In addition, the modification of the topography and hydrology by an extensive network of dams and water retaining structures to cope with the challenge of drought poses its own challenge in terms of catchment and flood management.

CONCLUSIONS

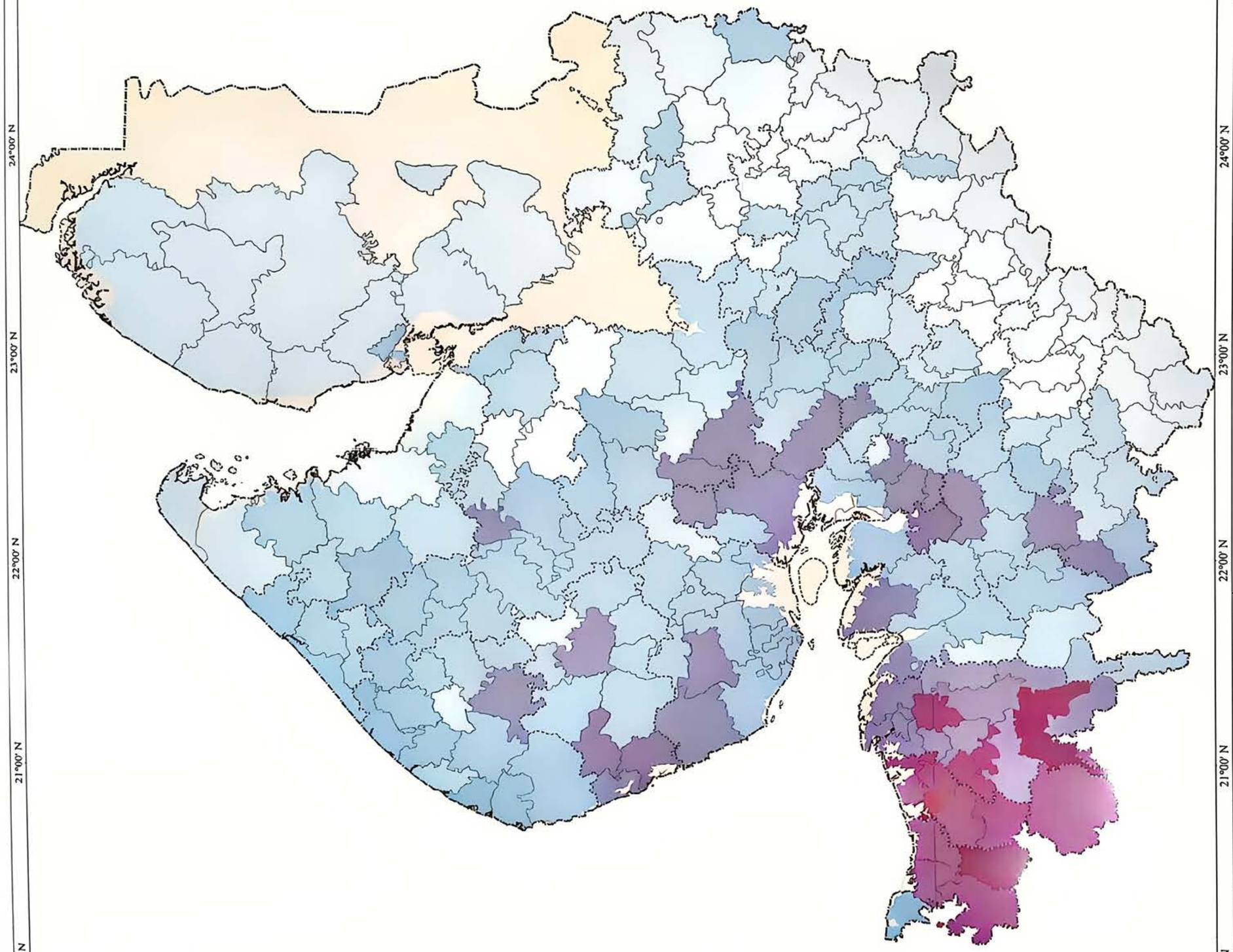
The maximum reported losses in the June 2005 event were by the Industries and Mines sector, followed by Power, Roads and Buildings, Urban Development and Agriculture. Direct losses were highest in Vadodara, Anand and Kheda districts. In the short-run, this unprecedented rainfall of June 2005 at the start of the monsoon season is a call for additional investment in recovery and preparedness for a possible spell of severe mid or late-monsoon rainfall and possible flooding in many of the same regions that have been affected. This is in spite of the fact that over 75 percent of the Talukas in Gujarat have received rainfall in July 2005, in excess of the historical 9th Decile rainfall, while 21 Talukas have received the highest rainfall recorded in over a century.

Rainfall in Gujarat (June 2005) (mm)

GSDMA

69°00' E 70°00' E 71°00' E 72°00' E 73°00' E 74°00' E

24°00' N 23°00' N 22°00' N 21°00' N 20°00' N



LEGEND

June 2005 Rainfall (in mm)

- < 100
- > 100 to 250
- > 250 to 500
- > 500 to 750
- > 750 to 1000
- > 1000 to 1500
- > 1500
- No Data

Source: TARU Analysis 2005;
GSDMA/Emergency Operation Centre; BISAG.

0 100 km

N

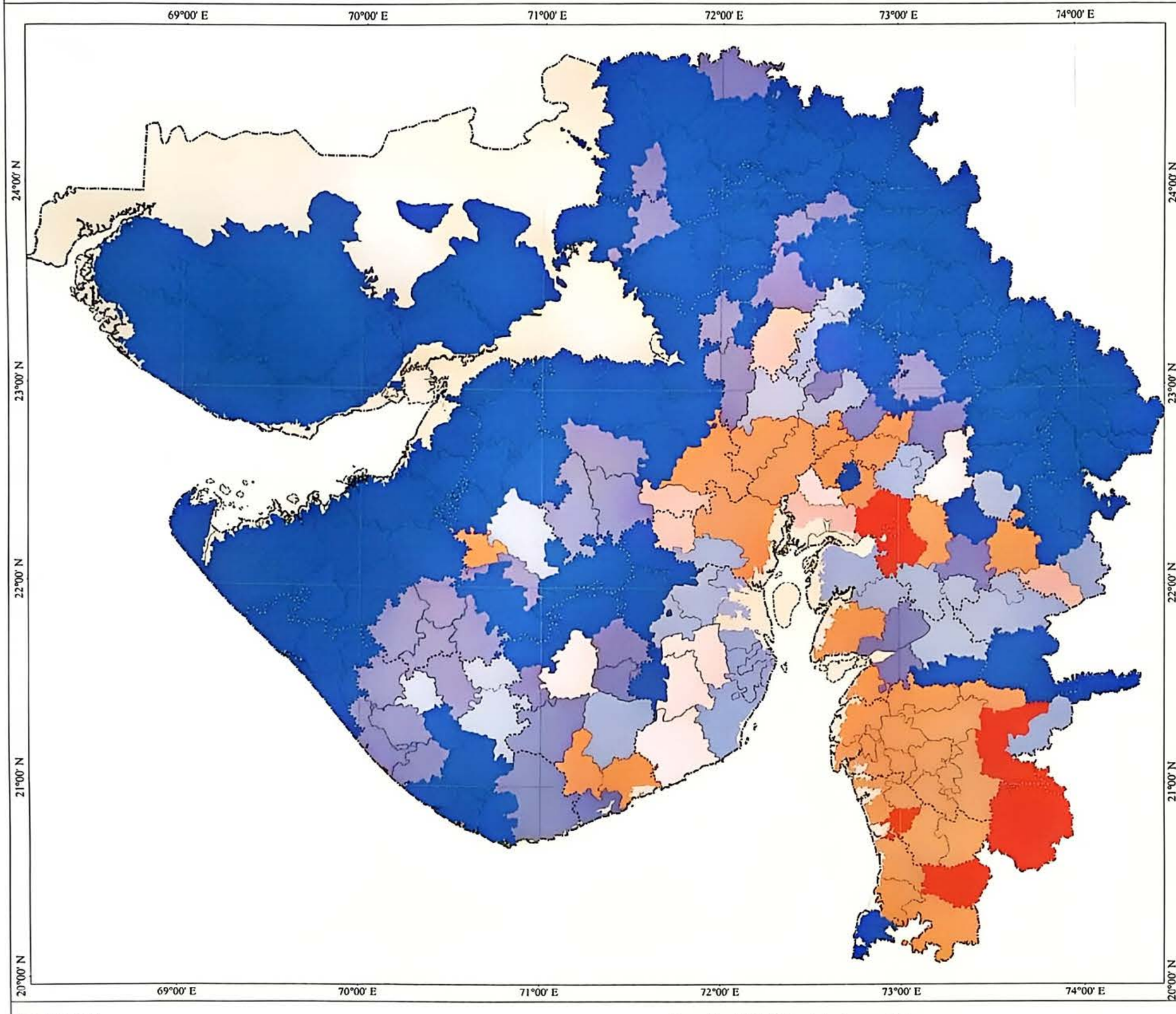
Projection : Lambert Azimuthal Equal Area
Datum : WGS 84

MAP No. : RFAM - 01 OF 02

Date : 1/9/2005

Gujarat Rainfall Analysis 2005: Estimated Equivalent Return Periods for June 2005 Rainfall (in percent)

GSDMA



LEGEND

Return Period for June RF (in years)

- < 10
- 10 to 25
- 25 to 50
- 50 to 75
- 75 to 100
- Extreme
- Unprecedented

Over 11 Talukas in Gujarat experienced extreme rainfall between the 50-year & 100-year return peak maximum rainfall in the month of June, 42 Talukas over 100-year peak maximum rainfall.

Extreme Rainfall: >100% to 150% of 100-year return period.
Unprecedented Rainfall: > 150% of 100-year return period.

Source: TARU Analysis 2005;
GSDMA/Emergency Operation Centre; BISAG.

0 — 100 km

N

Projection : Lambert Azimuthal Equal Area
Datum : WGS 84

MAP No. : RFAM - 02 OF 02

Date : 1/9/2005