No.

NATIONAL DISASTER MANAGEMENT
AGENCY (BNPB)

THE STUDY
ON
NATURAL DISASTER MANAGEMENT
IN
INDONESIA

FINAL REPORT

VOLUME 3:

SUPPORTING REPORT

MARCH 2009

JAPAN INTERNATIONAL COOPERATION AGENCY

ORIENTAL CONSULTANTS CO., LTD.
ASIAN DISASTER REDUCTION CENTER

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Abbreviations

Terms	Bahasa	English
APBN	Anggaran Pendapatan dan Belanja Negara	State Annual Budget
APBN-P	APBN - Perubahan	Revision of APBN– normally in October
APBD	Anggaran Pendapatan dan Belanja Daerah	Local government annual budget
BAKORNAS PB	Badan Koordinasi Nasional Penanganan Bencana	National Coordinating Board for Disaster Management
BAKOSURTANAL	Badan Koordinasi Survei dan Pemetaan	National Coordination Agency for Survey & Mapping
BAPPENAS	Badan Perencanaan Pembangunan Nasional	National Development Planning Agency
BKKBN	Badan Koordinator Keluarga Berencana Nasional	National Coordinator Agency for Family Planning
BMG	Badan Meteorologi dan Geofisika	Agency of Meteorology and Geophysics
BNPB	Badan Nasional Penanggulangan Bencana Alam	National Agency for Disaster Management
BOS	Bantuan Operasional Sekolah	School operational fund
BPHTB	Bea Perolehan Hak atas Tanah dan/Bangunan	Tax on every land & building transaction
BPPT	Badan Pengkajian dan Penerapan Teknologi	Agency for Assessment and Application of Technology
BPS	Badan Pusat Statistik	Statistic Indonesia
BRR NAD & Nias	Badan Rehabilitasi dan Rekonstruksi Nangroe Aceh Darusallam & Nias	Agency of Rehabilitation and Reconstruction for the Region and Community of Aceh and Nias
CPI	Indeks Harga Konsumen (IHK)	Consumer Price Index
DEPDAGRI	Departemen Dalam Negeri	Department of Home Affairs
DEPDIKNAS	Departemen Pendidikan Nasional	Department of National Education
DEPKES	Departemen Kesehatan	Department of Health
DEPHAN	Departemen Pertahanan	Department of Defense
DIPA	Daftar Isian Pelaksanaan Anggaran	Spending Warrant
DKP	Departemen Kelautan dan Perikanan	Department of Marine and Fisheries Affairs
DPD	Dewan Perwakilan Daerah	Council of Region Representative (Senator)
DPR	Dewan Perwakilan Rakyat	House of Representative (Parliament)
ESDM	Departemen Energi dan Sumber Daya Mineral	Department of Energy and Mineral Resources
GDP	Produk Domestik Bruto (PDB)	Gross Domestic Product
INPRES	Instruksi Presiden	Presidential Instruction
KEPPRES	Keputusan Presiden	Presidential Decree
LAPAN	Lembaga Penerbangan dan Antariksa Nasional	National Institute of Aeronautics and Space
LIPI	Lembaga Ilmu Pengetahuan Indonesia	Indonesian Institute of Science)
MPR	Majelis Permusyawarahan Rakyat	People's Consultative Assembly
NSPM	Norma,Standart, Pedoman, Manual	Norm, Standardization, Guideline and Manual
PBB	Pajak Bumi dan Bangunan	Land & Building Tax
PERDA	Peraturan Daerah	Local Government Regulation
PERMEN	Peraturan Menteri	Ministerial Regulation
PERPRES	Peraturan Presiden	Presidential Regulation
PERPU	Peraturan Pengganti Undang-Undang	Government Regulation in Lieu of Law
PP	Peraturan Pemerintah	Government Regulation
PPh	Pajak Penghasilan	Income Tax
PPN	Pajak Pertambahan Nilai	Value Added Tax (VAT)
PPnBM	Pajak Pertambahan Nilai Barang Mewah	Luxurious Goods VAT
PT. KAI	PT. Kereta Api Indonesia	State owned Train company
PT. PELNI	PT. Pelayaran Nasional Indonesia	State owned Shipping Company
PT. Pos Indonesia	PT. Pos Indonesia	Indonesian Post
PU	Departemen Pekerjaan Umum	Department of Public Works
RAPBN	Rancangan APBN	Draft of APBN
RKA-KL	Rencana Kerja Anggaran – Kementrian/Lembaga	Ministries/Agencies annual working plan
UUD 1945	Undang-Undang Dasar 1945	Constitution
UU	Undang-Undang	Law

CHAPTER 1 DEVELOPMENT OF GIS DATABASE AND BASICS FOR CREATIONS OF HAZARD MAP AND RISK MAP

This chapter explains the profiles of GIS database systems, which will be given to the counterpart organizations (BNPB, Kabupaten Jember, Kabupaten Padang Pariaman and Kota Pariaman) at the end of the JICA project. The hazard maps and risk maps prepared in this study cover the pilot regions (Kabupaten Jember, Kabupaten Padang Pariaman and Kota Pariaman) using the GIS database for Earthquake, Tsunami disaster, Sediment disaster and Flood disaster. The basics for creations of hazard map and risk map are also explained as well as the definitions of risk, hazard and vulnerability, and the GIS layers, which are the vulnerability indices (*e.g.* Population density, Built-up Area, *etc.*).

1.1 GIS database system turned over to counterpart organizations

A comprehensive GIS database was developed to grasp the current conditions of the four areas of interest of the study: namely, Indonesia at the national level, Kabupaten Jember, Kabupaten Padang Pariaman and Kota Pariaman. The database covers, in varying levels of detail, the administrative, natural, social, land cover, infrastructure, disaster and hazard conditions of the study areas. The database also supports the various analyses being conducted by multi-disciplinary experts of the study team. GIS database systems were established in the project offices in Jakarta and Kabupaten Jember, Kota Pariaman and Kabupaten Padang Pariaman, with GIS operators hired locally at each office to support the study team's experts. The GIS database systems will be turned over to Indonesian counterpart organizations (BNPB, Kabupaten Jember, Kabupaten Padang Pariaman and Kota Pariaman) at the end of the JICA project. The study team used ArcGIS Ver 9.2 software, developed by ESRI, installed in each workstation. The GIS database was used to organize data from the hazard and risk mapping activities during the study. The system consists of hardware (*e.g.* Desktop Computer, Printer, *etc*.) and software (*e.g.* GIS software, *etc*.). The inventory of equipment turned over to counterpart organizations including GIS database systems is shown in Table 1.1.1. It should be noted that GPS units and satellite images will only be turned over to Kabupaten Jember, Kabupaten Padang Pariaman and Kota Pariaman.

Table 1.1.1 Inventory of equipment turned over to each counterpart organization

No.	Items	Quantity
1	Desktop Computer with LCD Monitor 20" Dell Inspiron 530S	2
2	Computer Software WINDOWS XP Professional	2
3	Computer Software Microsoft Office Professional 2007	2
4	Computer Software Norton AntiVirus 2008	2
5	Computer Software Arc GIS (Arc View) 9.2	1
6	Inkjet Printer HP Bussiness Inkjet 2800	1
7	Laser Printer HP LaserJet 5200L Series	1
8	Copy Machine Xerox Document Centre 285	1
9	Scanner HP Scanjet G4010	1
10	Mobile GPS GARMIN GPS76	1
11	Satellite Images	1 set

The following tables summarize the contents of the GIS database.

Table 1.1.2 Data List in the GIS Workstations (1)

Coverage		Layer	Particulars	Source	Scale	Year	Feature Type	Coordinate System
Administrative	Indonesia	Propinsi	Provincial Boundaries	Bakosurtanal	1:250,000	2005	Polygon	GCS
		Kabupaten	District Boundaries	Bakosurtanal	1:250,000	2005	Polygon	GCS
		PlaceNames		Bakosurtanal		2005	Polygon	GCS
		Provinsi	Provincial Boundaries	BPS		2005	Polygon	GCS
		Kabupaten	District Boundaries	BPS		2005	Polygon	GCS
	Jember, East Java	Kabupaten	District Boundaries	Bakosurtanal	1:25,000	2002	Polygon	UTM49S
		Kecamatan	Sub-district Boundaries	Bakosurtanal	1:25,000	2002	Polygon	UTM49S
		Desa	Village Boundaries	Bakosurtanal	1:25,000	2002	Polygon	UTM49S
	Kota Pariaman and Kabupaten Padang Pariaman, West Sumatra	Population and Building data per Administrative Unit	Contains population and building data per Administrative unit. Administrative Unit is based on the best available detail the JST was able to collect. It may be by Kecamatan, or Nagari	JST		2008	Polygon	UTM47S
		Desa Boundaries	Desa Boundaries from BPS	BPS		2008	Polygon	UTM47S
		Kota/Kabupaten Boundaries	Kota/Kabupaten Boundaries	Bappeda		2008	Polygon	UTM47S
		Kecamatan Boundaries Kabupaten Padang Pariaman		Bappeda		2008	Polygon	UTM47S
		Kecamatan Boundaries Kota Pariaman		Bappeda		2008	Polygon	UTM47S
		Nagari Boundaries		Bappeda		2008	Polygon	UTM47S
		Islands		Bappeda		2008	Polygon	UTM47S
Natural Conditions	Indonesia	Digital Elevation Model (ETOPO)	Elevations from ETOPO2v2 (2006) database	US National Geophysical Data Center	Elevation @ 2min intervals	2006	Raster	GCS
		Water Bodies		Bakosurtanal			Line	
	Jember, East Java	Contour		Bakosurtanal	1:25,000		Line	UTM49S
		Spot Elevation		Bakosurtanal	1:25,000		Point	UTM49S
		Contours along Shoreline	Enhanced contours along shoreline processed from Spot Elev & available contour data	Bakosurtanal & JICA Study Team	1:25,000		Line	UTM49S
		Water Bodies		Bakosurtanal	1:25,000		Polygon	UTM49S
		Digital Elevation Model	DEM generated from 1:25,000 topo map	Bakosurtanal	1:25,000		Raster	UTM49S
		Slope	Slope map generated from 1:25,000 topo map	Bakosurtanal	1:25,000		Raster	UTM49S
		Ground Condition	Soil Class Types	JICA Study Team		2007	Polygon	UTM49S
		Geology		Pusat Survei Geologi Badan Geologi	1:100,000		Polygon	UTM49S
	Kota Pariaman and Kabupaten Padang Pariaman, West Sumatra							
		Aquifer Locations	Aquifer Locations	MACVINS			Polygon	UTM47S
		Bathimetry	Bathimetry	MCRMP				UTM47S
		Contour	Contour	Bakosurtanal 1:250,000 Topo	1:250,000		Line	UTM47S
		Contour	Contour	DITTOP TNI 1:50,000 Topo	1:50,000		Line	UTM47S
		Digital Elevation Model (SRTM)	Hole-filled seamless Shuttle Radar Topography Mission Data Version 3	International Centre for Tropical Agriculture (CIAT)	Elevation @ 90m intervals	2000	Raster	UTM47S
		Digital Elevation Model (SPOT)	Digital Elevation Model (SPOT)	SPOT Image	Elevation @ 20m intervals	2008	Raster	UTM47S
		Faults and Lineaments	Faults and Lineaments	JST		2008	Line	UTM47S
		Geomorphology	Geomorphology	JST		2008	Polygon	UTM47S
		Rainfall Stations	Rainfall Stations	PSDA			Point	UTM47S
		Rainfall Stations	Rainfall Stations	JST		2008	Point	UTM47S
		Watershed Boundaries	Watershed Boundaries	PSDA			Polygon	UTM47S
		River Branches	River Branches	JST			Line	UTM47S
		Main Rivers	Main Rivers	JST			Line	UTM47S
		River Polygons	River Polygons	DITTOP TNI 1:50,000 Topo			Polygon	UTM47S
		Slope Failure Lines	Slope Failure Lines	JST	1:50,000	2008	Line	UTM47S
		Lakes and Water Bodies	Lakes and Water Bodies	DITTOP TNI 1:50,000 Topo	1:50,000		Polygon	UTM47S
		Shoreline	Shoreline	DITTOP TNI 1:50,000 Topo	1:50,000		Line	UTM47S
Hazard	Indonesia	Indonesia Disaster Events		CRED		1900~		GCS
		Flood	Hisorical Flood Areas	Bakosurtanal	1:250,000	2007		GCS
		Landslides	Hisorical Landslide Areas	Bakosurtanal	1:250,000	2007		GCS
		Earthquake	Seismicty 1973-2007	USGS		2007		GCS
		Tsunami	Tsunami RunUp	BMG	1:6,000,000			GCS
		Faults	Active Faults	BMG	1:6,000,000	2002		GCS
	Jember	Jember Disaster Events	Database of Disasters in Jember	JICA Study Team Survey	1:25,000	2007	Polygon	GCS
		Flood Hazard Map		Bakesbang		2007	Polygon	UTM49S
		Flood Hazard Map		Dinas Pengairan (Irrigation Agency)		2006	Polygon	UTM49S
		Flood Hazard Map		PU website			Polygon	UTM49S
		Flood Hazard Map		Departamen Pertanian (Agriculture)		2004	Polygon	UTM49S
		Flood Hazard Location		JICA Study Team Survey		2007	Point	UTM49S
		Landslide Hazrd Map		Bakesbang		2007	Polygon	UTM49S
		Landslide Hazard map		PU website			Polygon	UTM49S
		Tsunami Hazard Map		Bakesbang		2007	Polygon	UTM49S
		Cyclone Hazard Map		Bakesbang		2007	Polygon	UTM49S
		Fire Hazard Map		Bakesbang		2007	Polygon	UTM49S
		Climate Prediction Zone (Rainfall)		BMG		2007	Polygon	UTM49S
	Kota Pariaman and Kabupaten Padang Pariaman, West Sumatra	Coastal Ersion	Coastal Ersion	MCRMP			Polygon	UTM47S
		Coastal Ersion	Coastal Ersion	MCRMP			Polygon	UTM47S
		Coastal Ersion	Coastal Ersion	MCRMP			Polygon	UTM47S
		Historical Earthquakes	Historical Earthquakes	MCRMP			Points	UTM47S
		Earthquake Zones	Earthquake Zones	MCRMP			Polygon	UTM47S
		Faults	Faults	MCRMP			Line	UTM47S
		Flooded Areas	Flooded Areas	PSDA			Polygon	UTM47S
		Flooded Areas	Flooded Areas	BAPPEDA			Polygon	UTM47S
		Geohazard Lines	Geohazard Lines	MCRMP			Polygon	UTM47S
		Distance To Coastlines	Distance To Coastlines	JST			Polygon	UTM47S
		Earthquake Incidence	Earthquake Incidence	MACVINS			Polygon	UTM47S
		Flooding Incidence	Flooding Incidence	MACVINS			Polygon	UTM47S
		Landslide Incidence	Landslide Incidence	MACVINS			Polygon	UTM47S
		Tide Rising Incidence	Tide Rising Incidence	MACVINS			Polygon	UTM47S
		Tide Incidence	Tide Incidence	MACVINS			Polygon	UTM47S
		PGA at Base Rock	PGA at Base Rock	BSN			Polygon	UTM47S
		Potential Disater by Sub District	Potential Disater by Sub District	MACVINS			Polygon	UTM47S
		Flood Potential	Flood Potential	MACVINS			Polygon	UTM47S
		Landslide Potential	Landslide Potential	MACVINS			Polygon	UTM47S
		Tide Potential	Tide Potential	MACVINS			Polygon	UTM47S
		Seismic Hazard	Seismic Hazard	JST			Polygon	UTM47S
		Tsunami Hazard	Tsunami Hazard	BAPPEDA			Polygon	UTM47S

Table 1.1.3 Data List in the GIS Workstations (2)

Coverage		Layer	Particulars	Source	Scale	Year	Feature Type	Coordinate System
Land Conditions	Jember, East Jawa	Land Cover	Land Cover data extracted from topo map	Bakosurtanal	1:25,000	1999	Polygon	UTM49S
	Kota Pariaman and Kabupaten Padang Pariaman, West Sumatra	Urban Area	Urban Area	BPN		2000	Polygon	UTM47S
		Land Cover Map	Land Cover Map	BAPPEDA		2007	Polygon	
Socio-economic		Geographic	Statistical Data by Desa	BPS - Jember		2005	Table	
		Administrative	Statistical Data by Desa	BPS - Jember		2005	Table	
		Demography	Statistical Data by Desa	BPS - Jember		2005	Table	
		Social	Statistical Data by Desa	BPS - Jember		2005	Table	
		Finacial	Statistical Data by Desa	BPS - Jember		2005	Table	
		Economic	Statistical Data by Desa	BPS - Jember		2005	Table	
Infrastructure	Indonesia	Roads		Bakosurtanal			Line	GCS
	Jember, East Jawa	Roads	Road centerlines	Bakosurtanal	1:25,000	1999	Line	UTM49S
		Irrigation Channels	Irrigation channel centerlines	Bakosurtanal	1:25,000	1999	Line	UTM49S
		Railways	Railway centerlines	Bakosurtanal	1:25,000	1999	Line	UTM49S
	Kota Pariaman and Kabupaten Padang Pariaman, West Sumatra							
		Airport Shape		MCRMP			Polygon	U47S
		Airport Location		MCRMP			Point	U47S
		Bridge Locations		JST			Point	U47S
		Railway Locations		MCRMP			Line	U47S
		Roads and Railways		MCRMP			Line	U47S
		Shipping lanes		MCRMP			Line	U47S
		Irrigation Points		BAPPEDA			Point	U47S
Building	Jember, East Jawa	Buildings	Symbolized Individual or Groups of Buildings	Bakosurtanal	1:25,000	1999	Polygon	UTM49S
		Building Counts by Desa	Total Building counts by desa	BAPEMAS - Badan Pemberdayaan Masyarakat (Society Cultivation Board)		2006	Table	
	Kota Pariaman and Kabupaten Padang Pariaman, West Sumatra	Historical Buildings	Historical Buildings	MCRMP			Point	UTM47S
		Hotels	Hotels	MCRMP			Point	UTM47S
Imagery	Jember, East Jawa	Satellite Image	ALOS satellite Imagery	RESTEC			Raster	
	Kota Pariaman and Kabupaten Padang Pariaman, West Sumatra	Satellite Image	SPOT satellite Imagery	SPOT			Raster	
Landmarks	Jember, East Jawa	Landmark Point Data	Schools, government buildings, mosques etc	Bakosurtanal	1:25,000	1999	Point	UTM49S

Abbreviations

ALOS: Advanced Land Observing Satellite
BAKOSURTANAL: Badan Koordinasi Survei dan Pemetaan Nasional
BAPEMAS: Badan Pemberdayaan Masyarakat (Society Cultivation Board)
BAPPEDA: Badan Percanaan Pembangunan Daerah
BMG: Badan Meteorologi Dan Geofisika
BPN: Badan Pertanahan Nasional
BPS: Badan Pusat Statistik
BSN: PGA map - Badan Standardisasi Nasional
DITTOP TNI: Direktorat Topografi TNI (Indonesian Army Topography Directorate)
GCS: Geographic Coordinate System
JST: JICA Study Team
MCRMP: Marine Coastal Management Project
NASA: National Aeronautics and Space Administration (USA)
NGDC: National Geophysical Data Center (USA)
PSDA: Pengelolaan Sumber Daya Air (Water Resources Management, Province of West Sumatra)
PSGBG: Pusat Survei Geologi Badan Geologi
PU: Dinas Pekerjaan Umum
RESTEC: Remote Sensing Technology Center (Japan)
SRTM: Shuttle Radar Topography Mission
USGS: US Geological Survey
UTM: Universal Transverse Mercator

1.2 GIS Database for National Level

1.2.1 Data Collection and Input

In order to build the database at the national level, the relevant data or information was collected from several government offices. Data collected came in both digital and hardcopy formats. The following describes the different types of data collected.

1) Base Map Data

The base maps used at the national level for the study were sourced from Badan Koordinasi Survei dan Pemetaan Nasional (Bakosurtanal). The national level base map data mainly consists of administrative boundaries at scale of 1:250,000 and generalized road and water body data.

2) Other Administrative Data

Provincial, Kabupaten, Kota and Kelurahan administrative boundaries data for 2005 were obtained from the BPS office in Jakarta.

3) Elevation Data

At the national level digital elevation data was sourced from the website of the Data Center ETOPO2v2 (2006) database of the U.S. Geological Survey (USGS). The digital elevation model contains elevations at 2 minute intervals. (Refer to Figure 1.2.1)

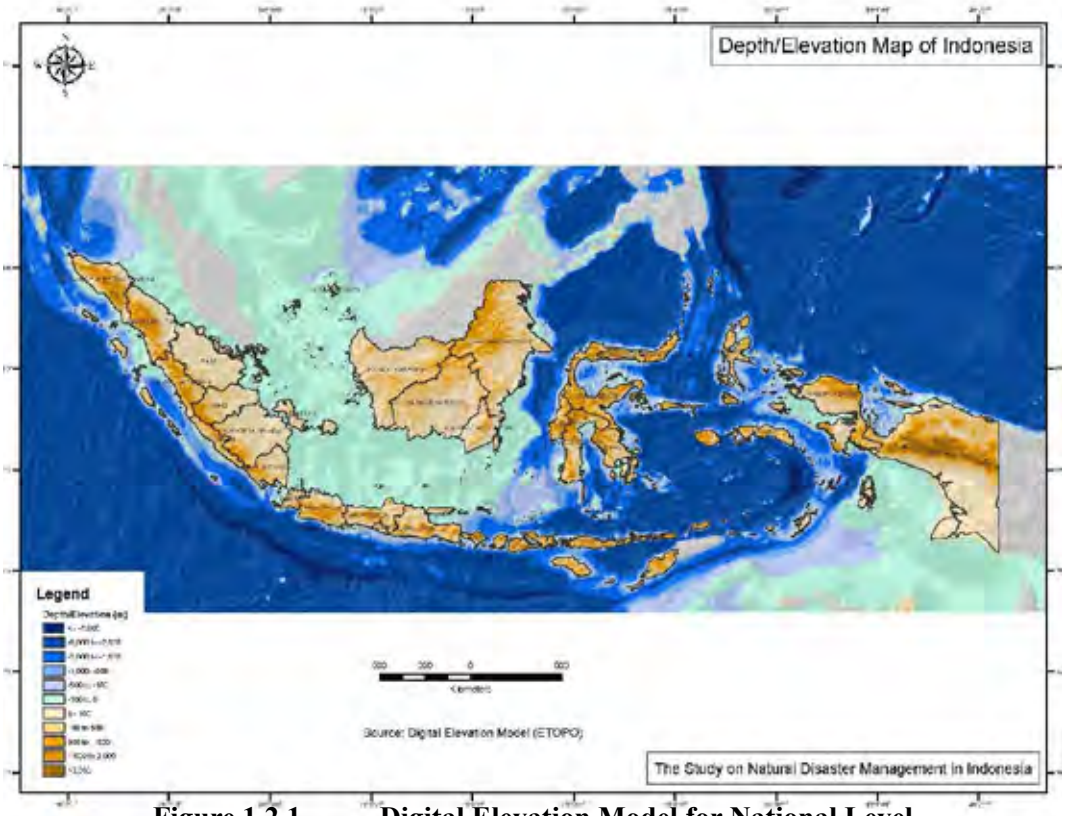


Figure 1.2.1 Digital Elevation Model for National Level

4) Hazard Data

Hazard data were collected from several sources. At the national level, maps showing flood and landslide hazard were obtained from Bakosurtanal. Tsunami and seismic hazard maps were obtained from Badan Meteorologi Dan Geofisika (BMG).

5) Disaster Data

At the national level, a table listing historical disasters from 1907 to 2007 was obtained from EM-DAT: The OFDA/CRED International Disaster Database. Records from the EM-DAT table were then plotted using the Bakosurtanal Indonesia base map to create a GIS map. This database contains different types of natural disasters such as, earthquake, flood, landslide, wind storm, wave/surge and volcano. The thematic map produced from this data shows the distribution of the different types of disasters that occurred in Indonesia in the past. (Refer to Figure 1.2.2)

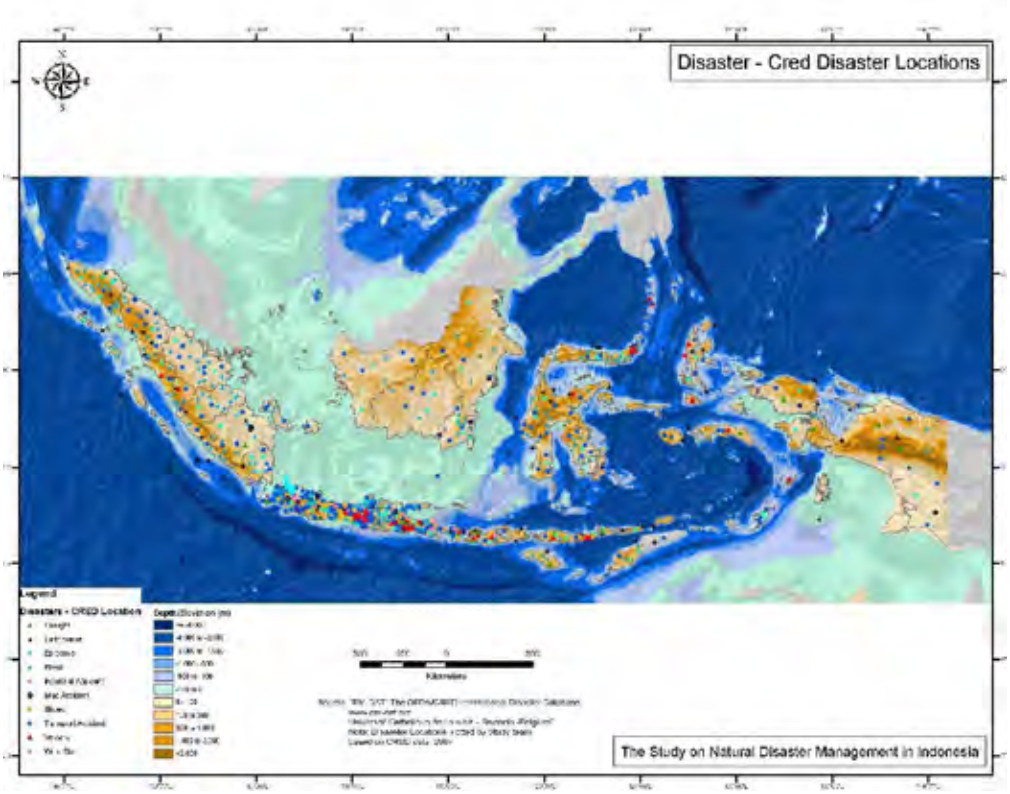


Figure 1.2.2 Locations of natural disasters in Indonesia

1.2.2 Data Integration

Data collected from the different sources were then integrated into the GIS database. Data integration mainly consists of converting hardcopy data to digital form and processing digital data to conform uniform standards adopted in the study. The GIS data format adopted for the study is ESRI shapefile format. At the national level the coordinate system used Geographic Coordinate System with WGS 84 as datum.

1.3 GIS Database for Kabupaten Jember

1.3.1 Data Collection and Input

In order to build the database for Kabupaten Jember, several government and private offices were visited to collect data. Data collected came in both digital and hardcopy formats. The following describes the different types of data collected.

1) Base Map Data

The base maps used for Kabupaten Jember were sourced from Bakosurtanal. A 1:25,000 scale topographic map compiled in 1999 in ESRI shapefile format was purchased from Bakosurtanal.

2) Census Data

For Kabupaten Jember, the local BPS office provided detailed census data at the desa (village) level as of 2005. The data includes demographic, social, agricultural and other data in table format. These data were then linked to administrative boundary using data from Bakosurtanal which were updated by the study team to match 2005 administrative boundary conditions.

3) Building Inventory

For Kabupaten Jember, the main source of the building inventory was the Badan Pemberdayaan Masyarakat (BAPEMAS, Society Cultivation Board). The data was compiled in 2006 and the data unit used is Desa.

4) Hazard Data

Several flood, landslide and tsunami hazard maps were collected from local offices in Kabupaten Jember. A seismic hazard map was produced by the study team based on investigation of ground conditions. Refer to the corresponding chapters (CHAPTER 3 to CHAPTER 6) for the details of the hazard maps as well as risk maps.

1.3.2 Data Integration

Data collected from the different sources were then integrated into the GIS database. Data integration mainly consists of converting hardcopy data to digital form and processing digital data to conform uniform standards adopted in the study. The GIS data format adopted for the study is ESRI shapefile format. For Kabupaten Jember, Universal Transverse Mercator Zone 49S was adopted as the standard coordinate system.

1.3.3 Examples of GIS Layer

1) Administrative Boundary

The admistrative boundaries for Kabupaten Jember mainly came from the 1:25,000 base maps (as of 1999) produced by Bakosurtanal. For the purpose of the study, the administrative boundaries from Bakosurtanal was updated by the study team using data from Kecamatans in Kabupaten Jember to match administrative boundary conditions used by the BPS in its survey in 2005.

Figure 1.3.1 Administrative Boundaries in Kabupaten Jember

2) Built-up Area

Built-up area, where buildings are densely constructed and population density are higher, for Kabupaten Jember was taken from the land cover map compiled by Bakosurtanal in 1999. The area in red indicates the built-up area.

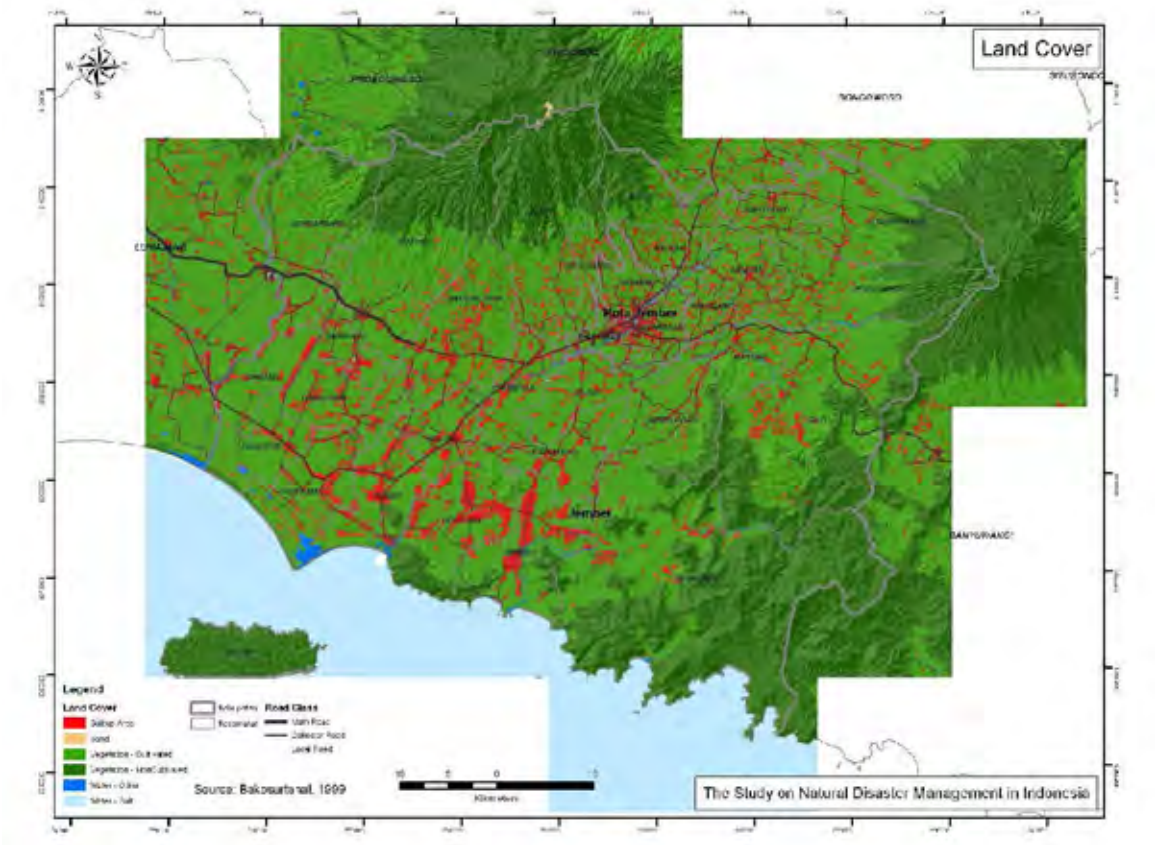


Figure 1.3.2 Built-up Area in Kabupaten Jember

3) Population Density

Census data for Kabupaten Jember was compiled by BPS local office in Jember in 2005. For the purpose of the study, the administrative boundaries from Bakosurtanal was updated by the study team using data obtained from Kecamatans in Kabupaten Jember to match administrative boundary conditions used by the BPS in its survey in 2005. To produce a net population density map, population data were then distributed to built-up areas of Kabupaten Jember. As shown in the map, Kecamatan Patrang, Kecamatan Kaliwates and Kecamatan Sumbersari belong to relatively higher populated area (more than 100 pop./ha).

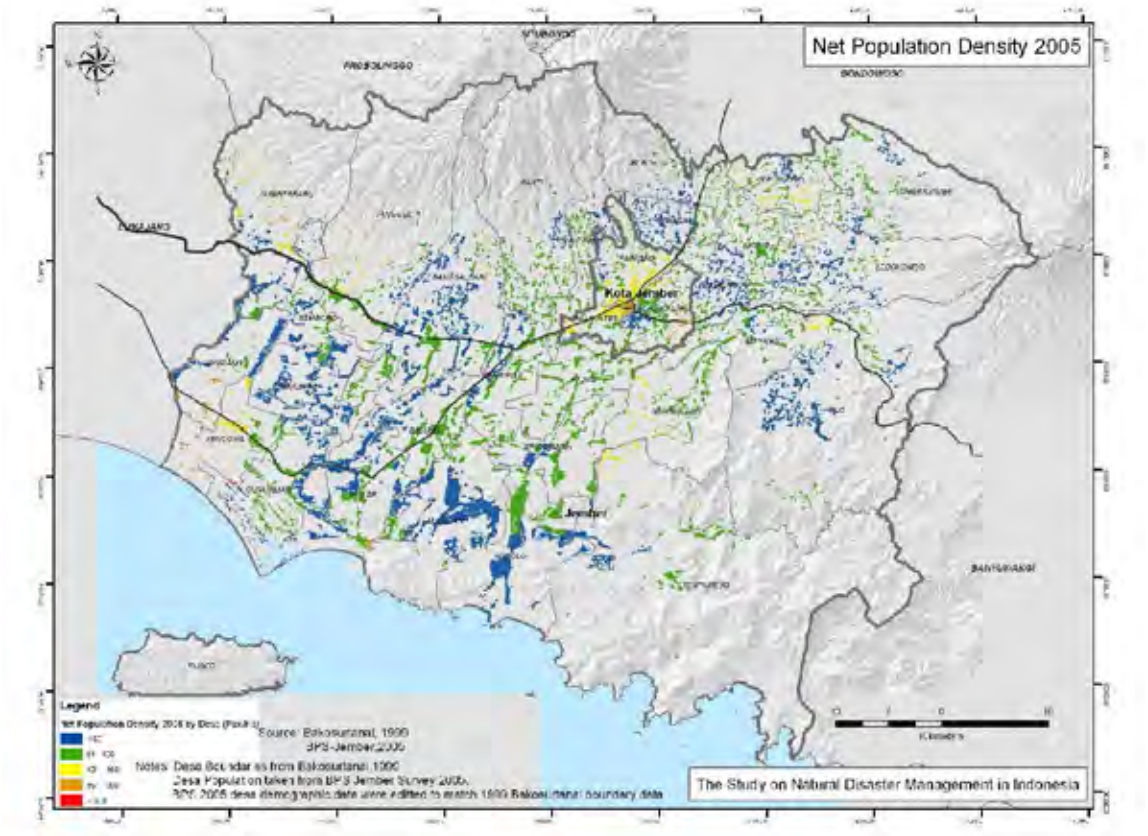


Figure 1.3.3 Population Density in Kabupaten Jember

4) Building Type

For Kabupaten Jember, the main source of the building inventory was the Badan Pemberdayaan Masyarakat (BAPEMAS, Society Cultivation Board). The data was compiled in 2006 and the data unit used is “desa (village)”. To produce a building type distribution map, the building data was summarized by Kecamatan.

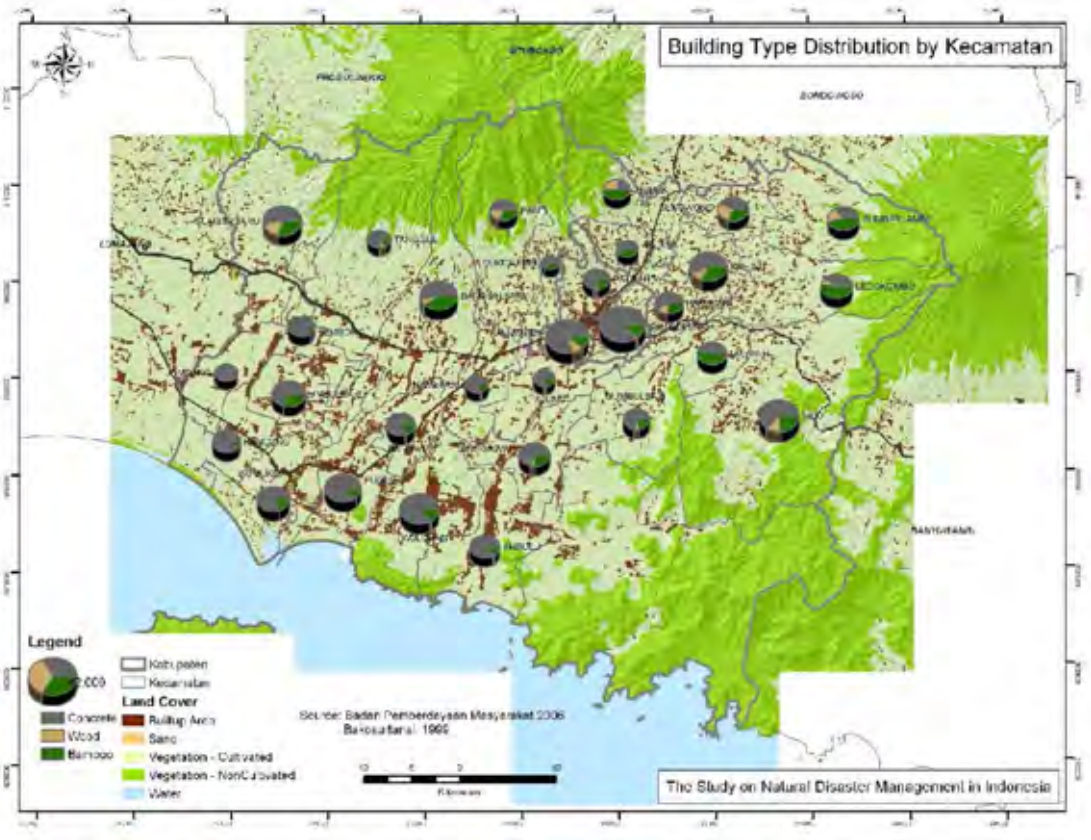


Figure 1.3.4 Building Type Distribution in Kabupaten Jember

5) Elevation (DEM)

A digital elevation model was compiled by the study team using contour and spot elevation data taken from the 1:25,000 scale topographic map produced by Bakosurtanal. The digital elevation model (DEM) contains elevations at 50 m intervals.

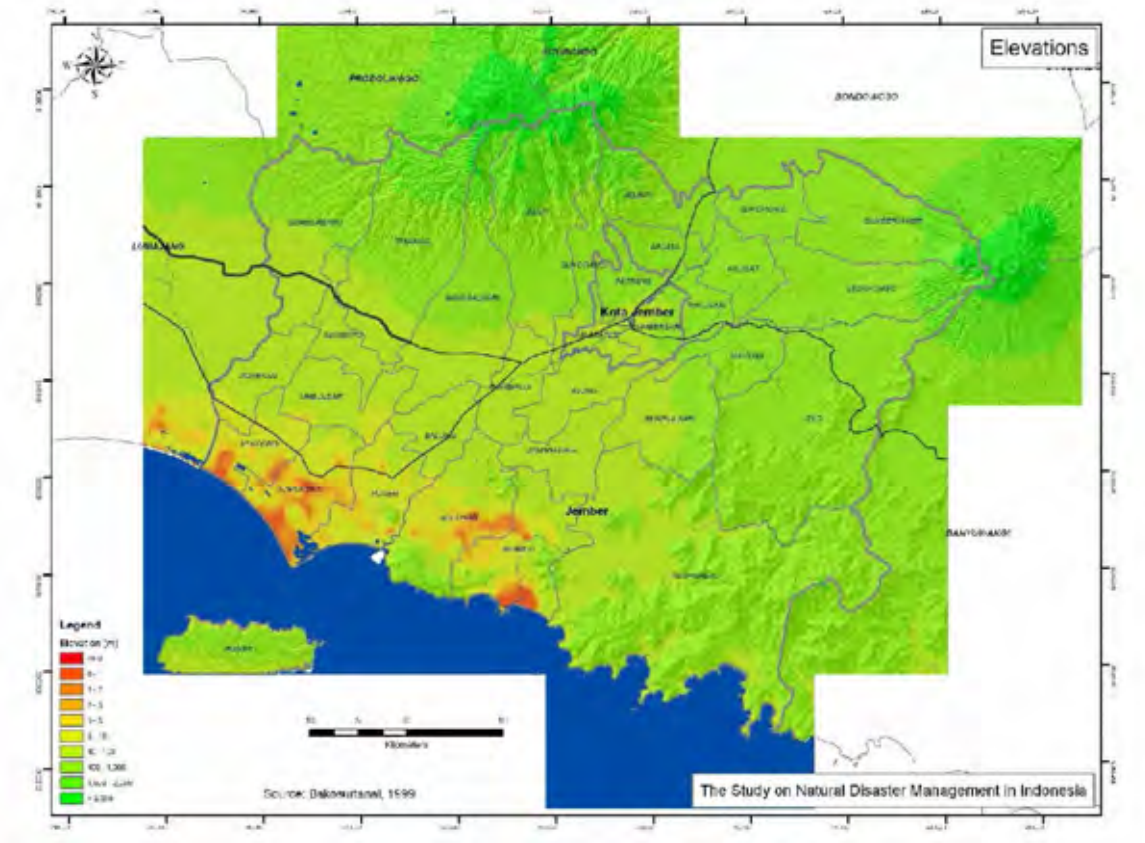


Figure 1.3.5 Digital Elevation Model (DEM) for Kabupaten Jember

6) Slope

Based on the digital elevation model (as shown in Figure 1.3.5) produced by the study team, a slope map was created for the different analyses conducted by the study team. The slope in a grid shows the maximum slope among the surrounding adjacent grids in degree.

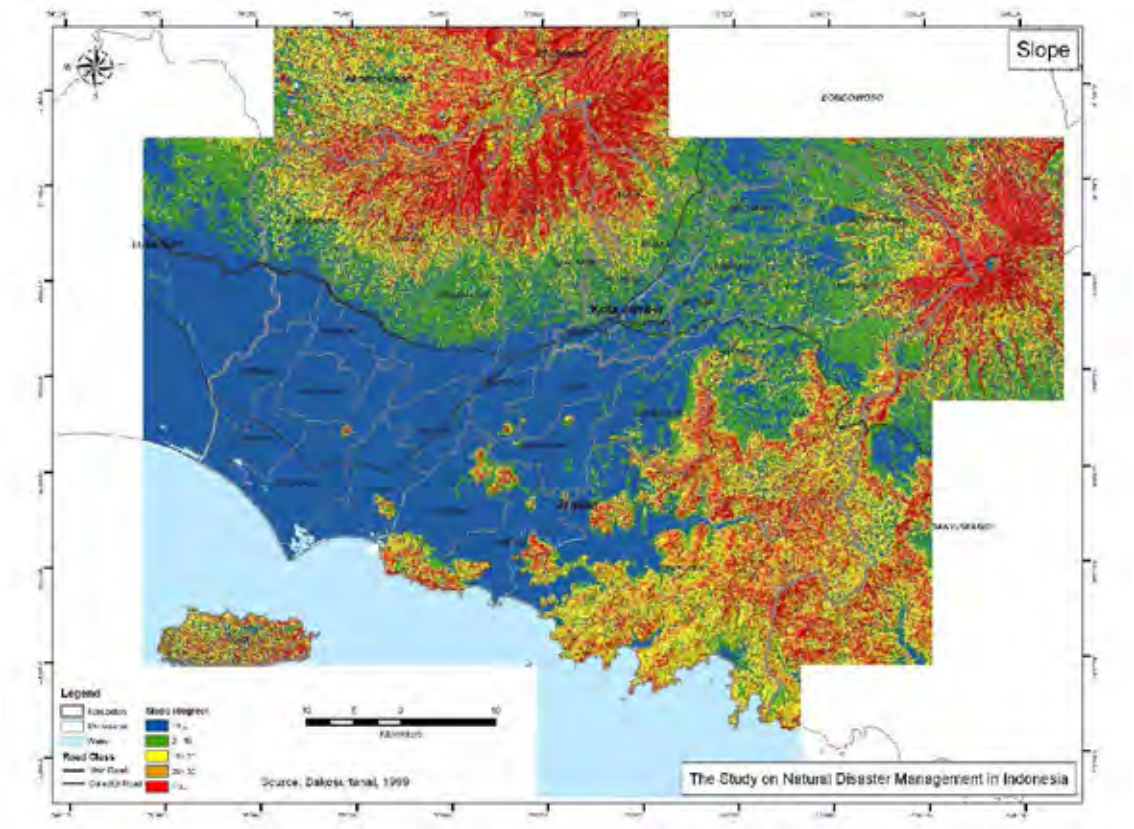


Figure 1.3.6 Slope Map based on Digital Elevation Model (DEM) in Kabupaten Jember

7) Land Cover

Land cover data compiled at scale 1:25,000 in 1999 was obtained from Bakosurtanal as shown in Figure 1.3.7. This was used for the various analyses conducted by the study team. As shown in the figure compared with the slope map in the previous page, most of "Built-up Area (Red in the map)" and "Vegitation – Cultivated (Light green in the map)" are located in flat land (less than 2.0 degree in slope) covering from the central urbanized area to south-west area of Kabupaten Jember.

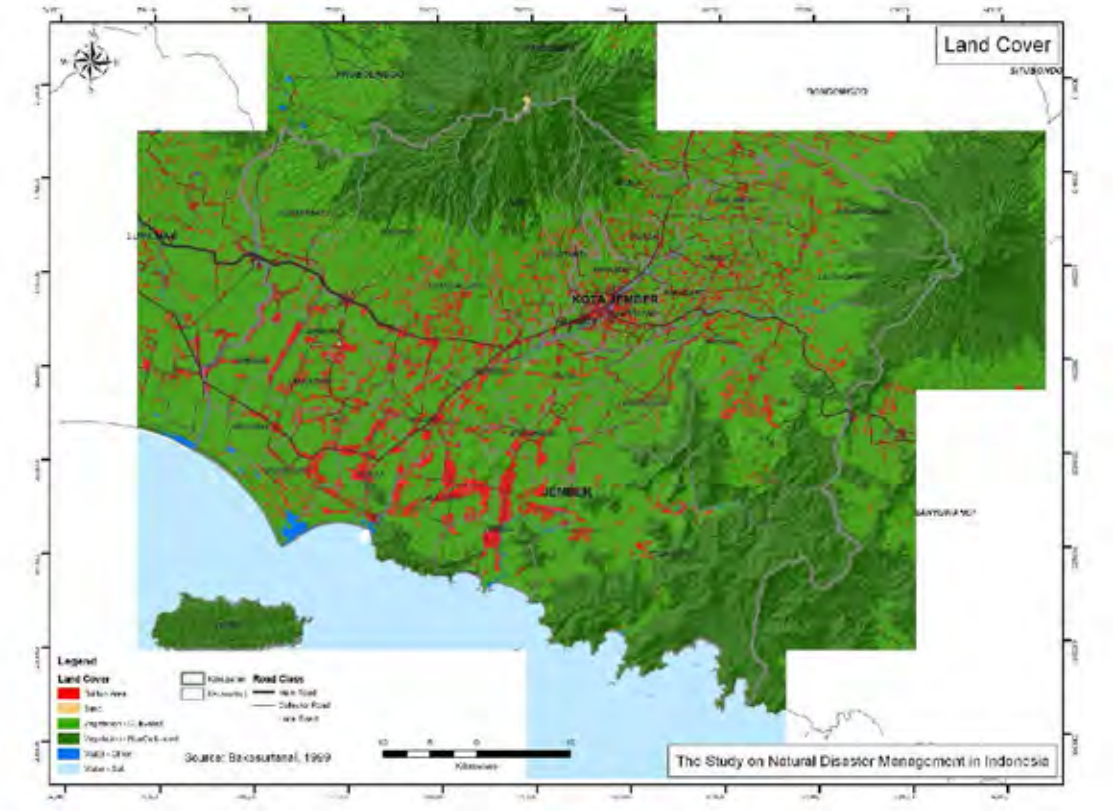


Figure 1.3.7 Land Cover Map for Kabupaten Jember

1.4 GIS Database for Kabupaten Padang Pariaman

1.4.1 Data Collection and Input

In order to build the database for Kabupaten Padang Pariaman, several government and private offices were visited to collect data. Data collected came in both digital and hardcopy formats. The following describes the different types of data collected.

1) Base Map Data

The base maps used for Kabupaten Padang Pariaman were provided by Pengelolaan Sumber Daya Air (PSDA) of West Sumatra Province based on 1:50,000 topographic maps from the Indonesian Army Topography Directorate published in 1985.

2) Census Data

Population and household count data were based on the data published by the local office of BPS in Kabupaten Padang Pariaman in 2007. For Kabupaten Padanag Pariaman, the administrative unit used in the census is either Kecamatan or Nagari.

3) Building Inventory

Building data were requested from each Kecamatan in Kabupaten Padang Pariaman but not all Kecamatans were able to provide the building information. For Kecamatans that were not able to provide information, building total counts were estimated based on either population or household counts for the Kecamatans. Building counts by type of structure for the Kecamatan that were not able to provide detailed data were estimated using the ratios of each type of building to the total buildings from those Kecamatans that submitted detailed data.

The following table summarizes the building counts including estimated counts used for the purpose of the study.

Table 1.4.1 List of Building Type in Kabupaten Padang Pariaman

Kecamatan	Nagari	Administrative Data Unit Used for Analysis	Population 2007	Household Count	Average Persons per Household	Building Count Data Source	Total Buildings	Building Made of Masonry	Building Made of Confined Masonry	Wooden Building	Building Made of Reinforced Concrete	Other Type of Building
2X11 Enam Lingkung	-	Kecamatan	17,086	Not Available	Not Available	Kecamatan	3,893	1,293	1,560	200	312	528
Enam Lingkung	-	Kecamatan	18,412	Not Available	Not Available	Estimated using Population	3,682	727	2,039	294	167	455
IV Koto Aur Malintang	-	Kecamatan	18,937	Not Available	Not Available	Kecamatan	5,609	3,392	1,480	190	357	190
Nan Sabaris	-	Kecamatan	25,972	Not Available	Not Available	Estimated using Population	5,194	1,025	2,877	415	236	642
Sintuk Toboh Gadang	-	Kecamatan	16,327	Not Available	Not Available	Estimated using Population	3,265	644	1,808	261	148	403
V Koto Kampung Dalam	-	Kecamatan	22,499	Not Available	Not Available	Kecamatan	5,075	-	3,657	913	199	306
2X11 Kayu Tanam	Anduring	Nagari	7,520	1,573.00	4.78	Kecamatan	1,690	348	1,105	65	76	96
	Guguk	Nagari	5,868	1,085.00	5.41	Kecamatan	1,193	239	710	120	61	63
	Kayu Tanam	Nagari	4,900	1,215.00	4.03	Kecamatan	1,329	264	796	133	67	69
	Kepala Hilalang	Nagari	5,709	1,232.00	4.63	Kecamatan	1,329	266	799	135	68	61
Batang Anai	Kasang	Nagari	12,564	2,548.00	4.93	Estimated using Household Count	2,548	503	1,411	204	116	315
	Ketaping	Nagari	12,043	2,212.00	5.44	Estimated using Household Count	2,212	437	1,225	177	100	273
	Sungai Buluh	Nagari	19,013	3,559.00	5.34	Estimated using Household Count	3,559	702	1,971	284	161	440
Batang Gasan	Gasan Gadang	Nagari	5,282	1,177.00	4.49	Kecamatan	1,024	328	394	131	37	134
	Malai V Suku	Nagari	5,814	1,215.00	4.79	Kecamatan	1,370	259	623	218	47	223
Lubuk Alung	Lubuk Alung	Nagari	40,372	7,726.00	5.23	Kecamatan	8,131	118	7,418	393	145	57
Padang Sago	Batu Kalang	Nagari	2,576	576.00	4.47	Kecamatan	1,207	589	589	29	-	-
	Koto Baru	Nagari	1,712	403.00	4.25	Kecamatan	873	430	430	6	7	-
	Koto Dalam	Nagari	3,889	982.00	3.96	Kecamatan	1,600	658	658	284	-	-
Patamuan	Sungai Durian	Nagari	4,552	1,663.00	2.74	Estimated using Household Count	1,663	328	921	133	75	205
	Tandikat	Nagari	10,812	2,778.00	3.89	Estimated using Household Count	2,778	548	1,539	222	126	343
Sungai Geringging	Kuranji Hulu	Nagari	19,511	5,140.00	3.80	Kecamatan	4,421	1,269	1,629	376	99	1,048
	Malai III Koto	Nagari	8,736	1,262.00	6.92	Kecamatan	1,261	311	391	245	151	163
Sungai Limau	Kuranji Hilir	Nagari	15,374	3,069.00	5.01	Kecamatan	2,931	-	2,423	228	157	123
	Pilubang	Nagari	13,264	2,742.00	4.84	Kecamatan	3,025	-	2,578	190	171	86
Ulakan Tapakis	Tapakis	Nagari	13,709	Not Available	Not Available	Estimated using Population	2,742	541	1,518	219	124	339
	Ulakan	Nagari	6,029	Not Available	Not Available	Estimated using Population	1,206	238	668	96	55	149
V Koto Timur	Gunung Padang Alai	Nagari	5,910	Not Available	Not Available	Estimated using Population	1,182	233	655	94	54	146
	Kudu Gantiang	Nagari	5,646	Not Available	Not Available	Estimated using Population	1,129	223	625	90	51	139
	Limau Purut	Nagari	3,119	Not Available	Not Available	Estimated using Population	624	123	345	50	28	77
VII Koto Sungai Sariak	Balai Aia	Nagari	8,369	1,784.00	4.69	Kecamatan	848	84	254	42	47	421
	Lareh Nan Panjang	Nagari	3,881	848.00	4.58	Kecamatan	1,416	142	424	70	69	711
	Lurah Ampalu	Nagari	6,228	1,416.00	4.40	Kecamatan	3,036	301	925	182	242	1,386
	Sei Sarik	Nagari	14,420	3,036.00	4.75	Kecamatan	1,784	178	535	89	95	887
Total			**386,055**	-	-	-	**84,830**	**16,741**	**46,980**	**6,778**	**3,848**	**10,478**

4) Hazard Data

Hazard data were collected from several sources. PSDA of West Sumatra Province provided past flood information such as flood area, duration time and depth. Several hazard maps were collected from the Marine and Coastal Project Management in West Sumatra such as earthquake, coastal erosion and other geo-hazards.

1.4.2 Data Integration

Data collected from the different sources were then integrated into the GIS database. Data integration mainly consists of converting hardcopy data to digital form and processing digital data to conform uniform standards adopted in the study. The GIS data format adopted for the study is ESRI shapefile format. For Kabupaten Padang Pariaman, Universal Transverse Mercator Zone 47S was adopted as the standard coordinate system.

1.4.3 Examples of GIS Layers

1) Administrative Boundary

Administrative boundary data used for the study were sourced from BAPPEDA of Kabupaten Padang Pariaman. These were adjusted by the study team to match the features of the 1:50,000 topographic map published by the Indonesian Army Topography Directorate.

Figure 1.4.1 Administration Boundaries in Kabupaten Padang Pariaman

2) Built-up Area

Built-up area, where buildings are densely constructed and population density are higher, for Kabupaten Padang Pariaman was taken from the land use map produced by Badan Pertanahan Nasional (BPN) in 2000. The area in red indicates the built-up area.

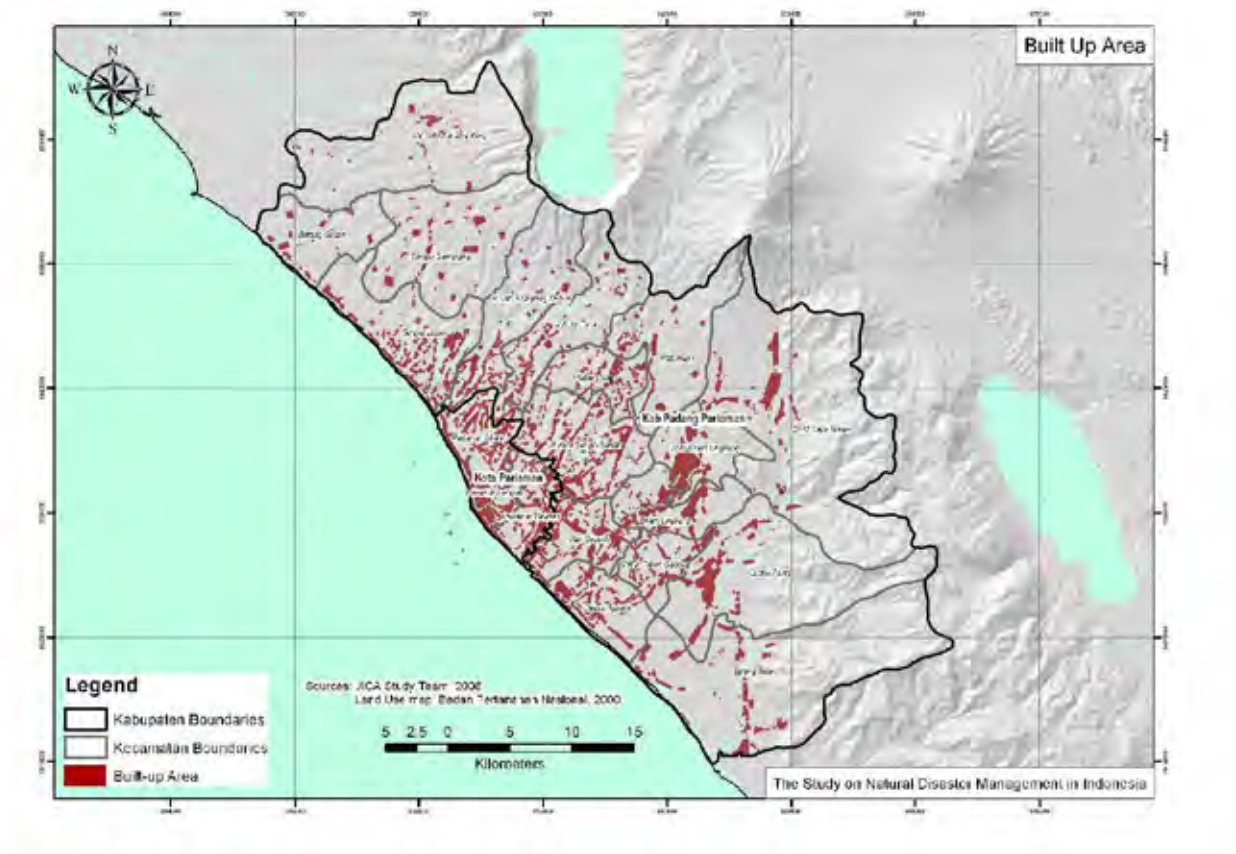


Figure 1.4.2 Built-Up Areas in Kabupaten Padang Pariaman

3) Population Density

Census data for Kabupaten Padang Pariaman were compiled by BPS local office in 2007. For the purpose of the study, the administrative boundaries from BAPPEDA were edited by the study team to match features of the topographic map produced by the Topography Directorate of the Indonesian Army. To produce a net population density map, population data were then distributed to built-up areas of Kabupaten Padang Pariaman using the urban areas map from BPN. As shown in the map, Kecamatan Lubuk Alung and Kecamatan Batang Anai, which are neighboring regions of Kota Padang known as one of the principal cities in Indonesia and Minangkabau international airport is located in, belong to relatively higher populated area (more than 5,000 pop./km^2). Further, Kecamatans in the northern part of Kabupaten Padang Pariaman (Kecamatan Sungai Geringging, Kecamatan IV Koto Aur Malintang and Kecamatan Batang Gasan) have densely population. The main reason may be attributed to smaller habitable area in forestry mountainous area in the region.

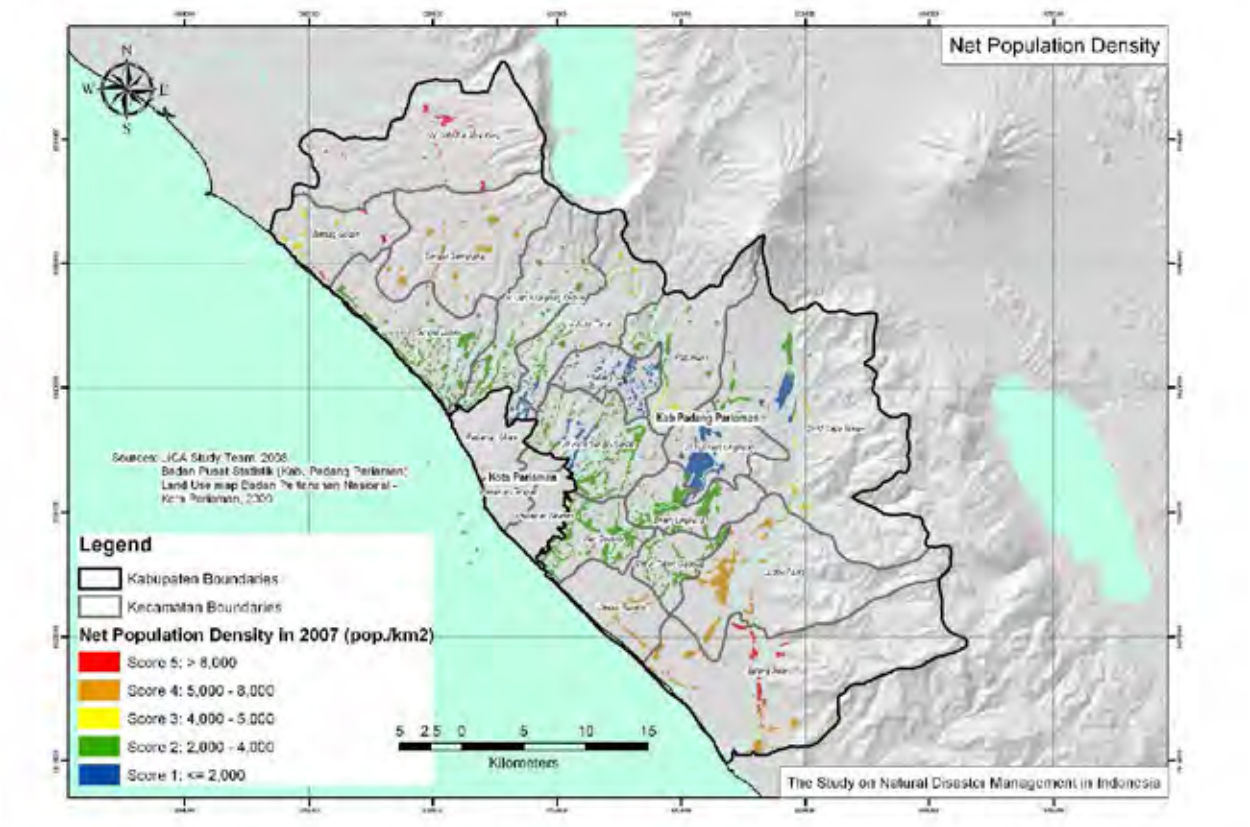


Figure 1.4.3 Population Density in Kabupaten Padang Pariaman

4) Building Type

The study team was able to compile a total building count inventory using data collected from Kecamatan in Kabupaten Padang Pariaman and BPS. Building counts by type of structure were determined using either direct building count data from Kecamatan or by estimating building type distribution using ratios of each type of building to the total buildings from those Kecamatan that provided the data to the study team.

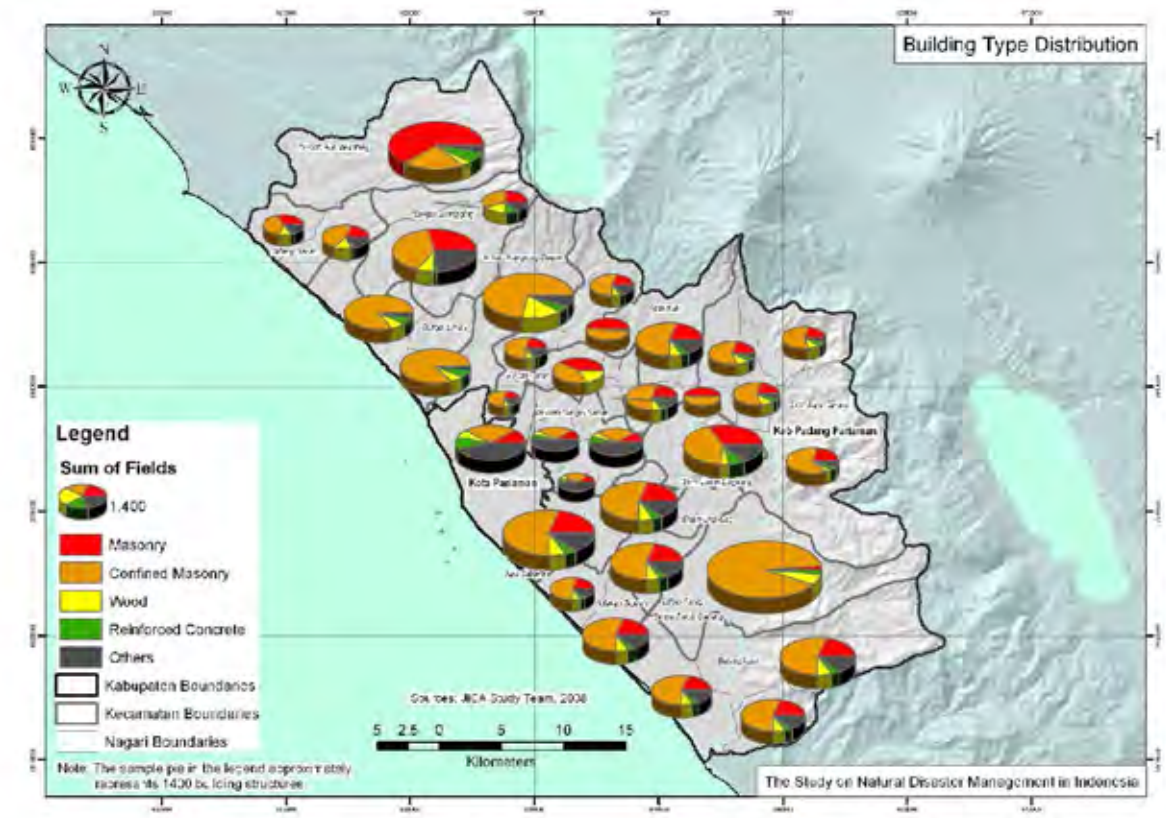


Figure 1.4.4 Building Type Distribution in Kabupaten Padang Pariaman

5) Elevation (DEM)

Digital elevation data for Kabupaten Padang Pariaman were obtained from processed Shuttle Radar Topography Mission (SRTM) data from the International Centre for Tropical Agriculture (CIAT) and SPOT Image. The digital elevation model from CIAT contains elevations at 90 m interval while the digital elevation model purchased from SPOT Image Corporation contains elevations at 20 m intervals. Some of the areas, where SPOT data does not exist, are substituted by SRTM data. Both models were used for the different analyses conducted by the study team depending on the purpose.

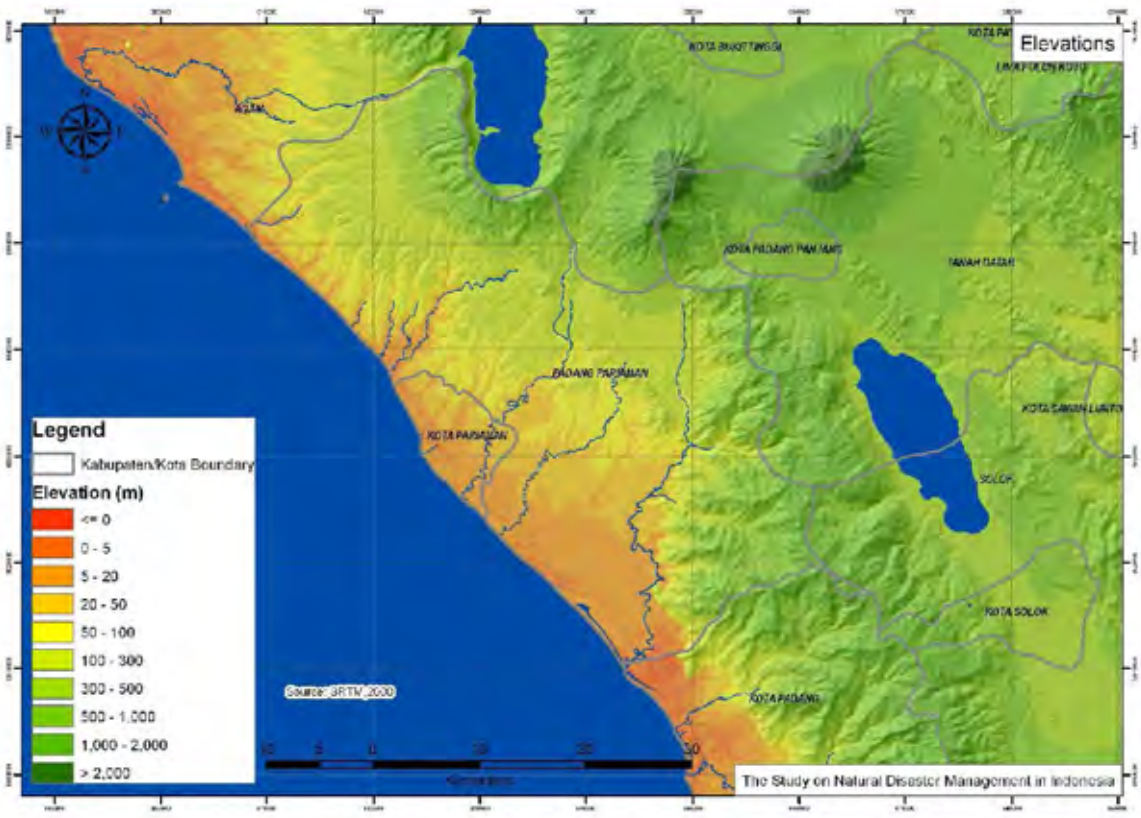
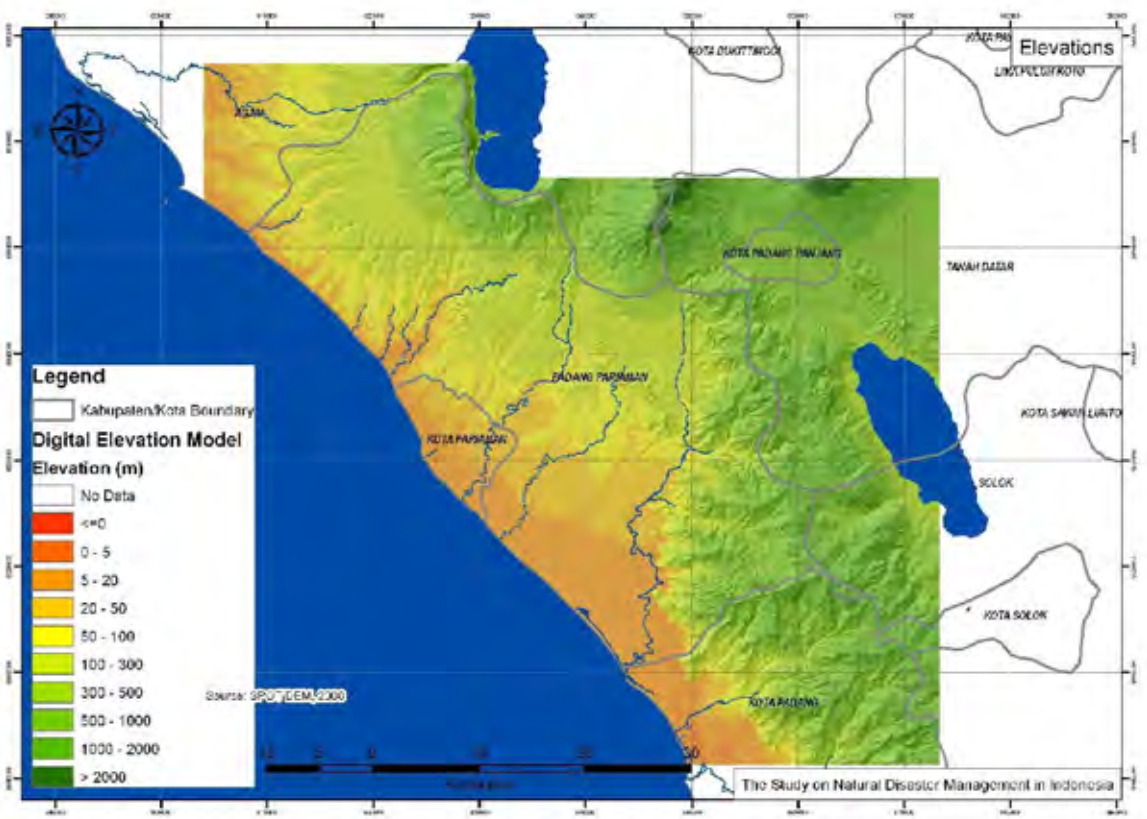


Figure 1.4.5 Digital Elevation Model (SRTM) for Kabupaten Padang Pariaman



Note: Some of the areas, where SPOT data does not exist, are substituted by SRTM data.

Figure 1.4.6 Digital Elevation Model (SPOT) for Kabupaten Padang Pariaman

6) Slope

Based on the digital elevation model (SRTM: Shuttle Radar Topography Mission) as shown in Figure 1.4.5, a slope map was created for the different analyses conducted by the study team. The slope in a grid shows the maximum slope among the surrounding adjacent grids in degrees.

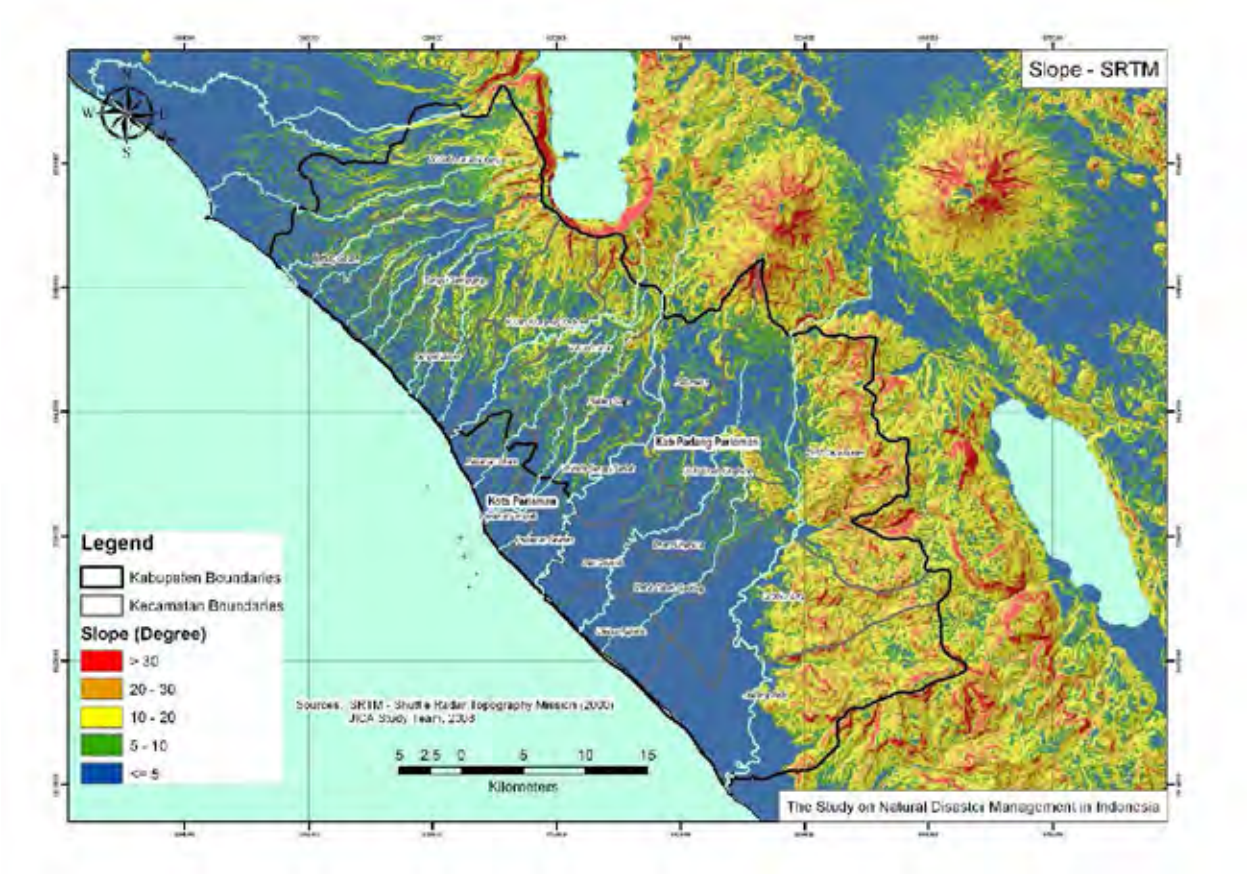


Figure 1.4.7 Slope Map based on DEM (SRTM) in Kabupaten Padang Pariaman

7) Land Cover

Land cover data compiled in 2007 using SPOT Satellite Imagery was obtained from BAPPEDA of Kabupaten Padang Pariaman. As shown in the figure compared with the maps for built-up area, elevation and slope, most of built-up area, rice-field and plantation area are located in flat low-land (less than 5.0 degree in slope and less than 50m in elevation) covering from the central area (Kota Pariaman) to south-west coastal area of Kabupaten Padang Pariaman.

Figure 1.4.8 Land Cover in Kabupaten Padang Pariaman

1.5 GIS Database for Kota Pariaman

1.5.1 Data Collection and Input

In order to build the database for Kota Pariaman, several government and private offices were visited to collect data. Data collected came in both digital and hardcopy formats. The following describes the different types of data collected.

1) Base Map Data

The base maps used for Kota Pariaman were provided by Pengelolaan Sumber Daya Air (PSDA) of West Sumatra Province based on 1:50,000 topographic maps from the Indonesian Army Topography Directorate published in 1985.

2) Census Data

Population and household count data were based on the data published by the local office of BPS in Kota Pariaman in 2007. For Kota Pariaman, the administrative unit used in the census is Kecamatan.

3) Building Inventory

Building data were requested from each Kecamatan in Kota Pariaman but the Kecamatans were not able to provide the building information. Building total counts were estimated using population counts for the Kecamatan. Building counts by type of structure for the Kecamatan were estimated using the ratios of each type of building to the total buildings from those Kecamatan that submitted detailed data in Kabupaten Padang Pariaman.

The following table summarizes the building counts including estimated counts used for the purpose of the study.

Table 1.5.1 List of Building Types in Kota Pariaman

Kecamatan	Nagari	Administrative Data Unit Used for Analysis	Population 2007	Household Count	Average Persons per Household	Building Count Data Source	Total Buildings	Building Made of Masonry	Building Made of Confined Masonry	Wooden Building	Building Made of Reinforced Concrete	Other Type of Building
Pariaman Utara	-	Kecamatan	24,188	Not Available	Not Available	Estimated using Population	4,838	955	2,679	387	220	598
Pariaman Tengah	-	Kecamatan	32,339	Not Available	Not Available	Estimated using Population	6,468	1,276	3,582	517	293	799
Pariaman Selatan	-	Kecamatan	20,312	Not Available	Not Available	Estimated using Population	4,062	802	2,250	325	184	502
Total			**76,839**	-	-	-	**15,368**	**3,033**	**8,511**	**1,229**	**697**	**1,899**

4) Hazard Data

Hazard data were collected from several sources. PSDA of West Sumatra Province provided past flood information such as flood area, duration time and depth. Several hazard maps were collected from the Marine and Coastal Project Management in West Sumatra such as earthquake, coastal erosion and other geo-hazards.

1.5.2 Data Integration

Data collected from the different sources were then integrated into the GIS database. Data integration mainly consists of converting hardcopy data to digital form and processing digital data to conform uniform standards adopted in the study. The GIS data format adopted for the study is ESRI shapefile format. For Kota Pariaman, Universal Transverse Mercator Zone 47S was adopted as the standard coordinate system.

1.5.3 Examples of GIS Layers

1) Administrative Boundary

Administrative boundary data used for the study were sourced from BAPPEDA of Kota Pariaman. These were adjusted by the study team to match the features of the 1:50,000 topographic map published by the Indonesian Army Topography Directorate.

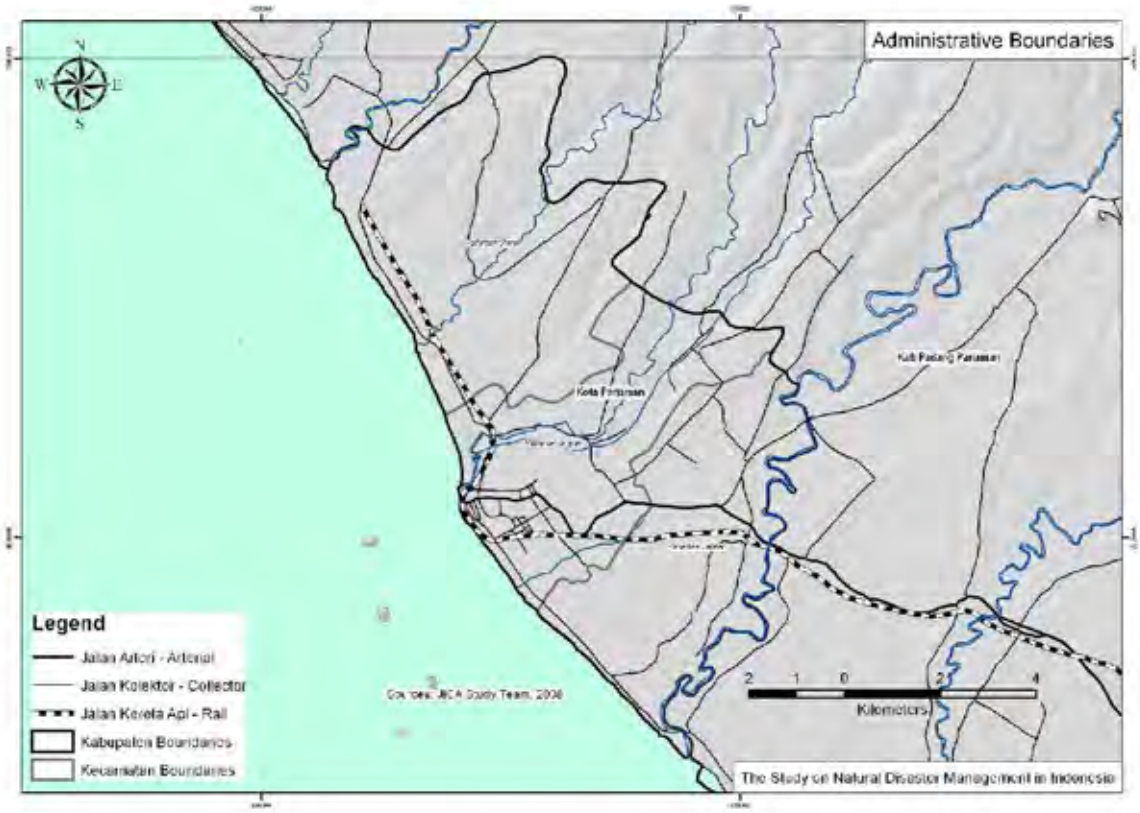


Figure 1.5.1 Administrative Boundaries in Kota Pariaman

2) Built-up Area

Built-up area, where buildings are densely constructed and population density are higher, for Kabupaten Padang Pariaman was taken from the land use map produced by Badan Pertanahan Nasional (BPN) in 2000. The area in red indicates the built-up area.

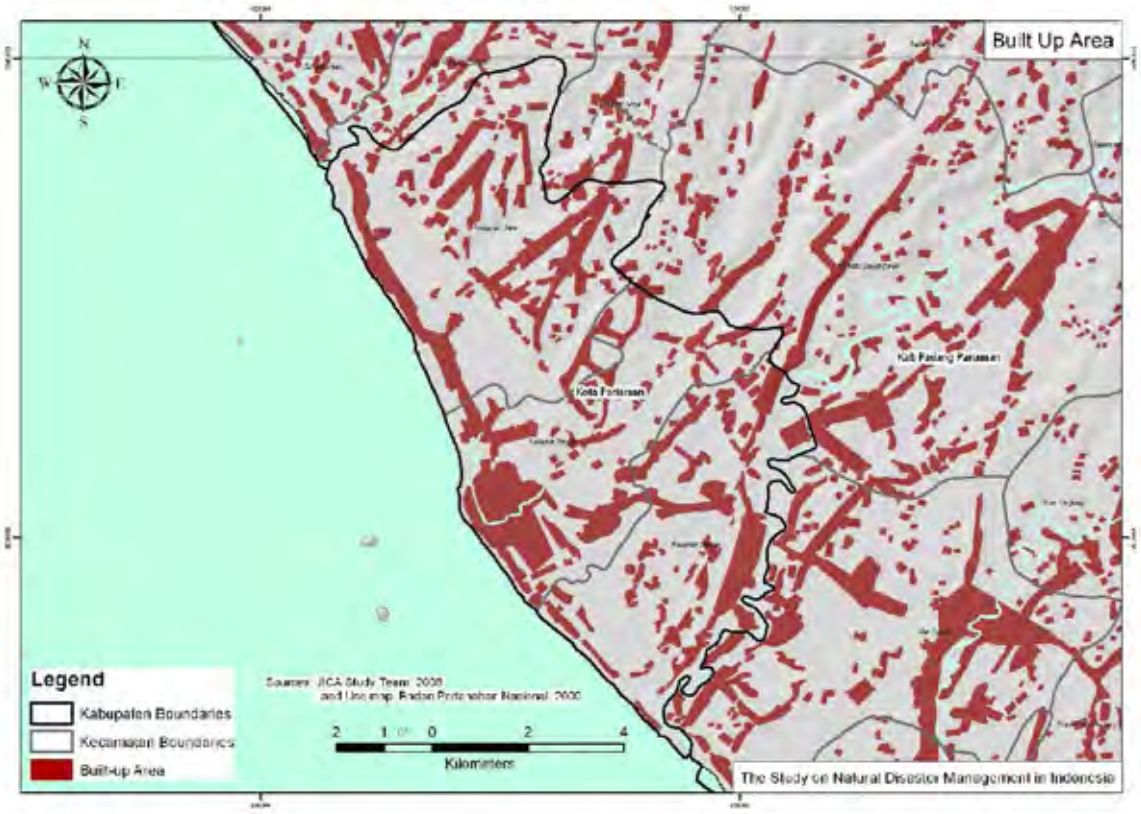


Figure 1.5.2 Built-Up Areas in Kota Pariaman

3) Population Density

Census data for Kota Pariaman were compiled by BPS local office in 2007. For the purpose of the study, the administrative boundaries from BAPPEDA was edited by the study team to match features of the topographic map produced by the Topography Directorate of the Indonesian Army. To produce a net population density map, population data were then distributed to built-up areas of Kota Pariaman using the urban areas map from BPN. As shown in the map, the population density of Kecamatan Pariaman Tengah are higher than those of Kecamatan Pariaman Utara and Kecamatan Selatan.

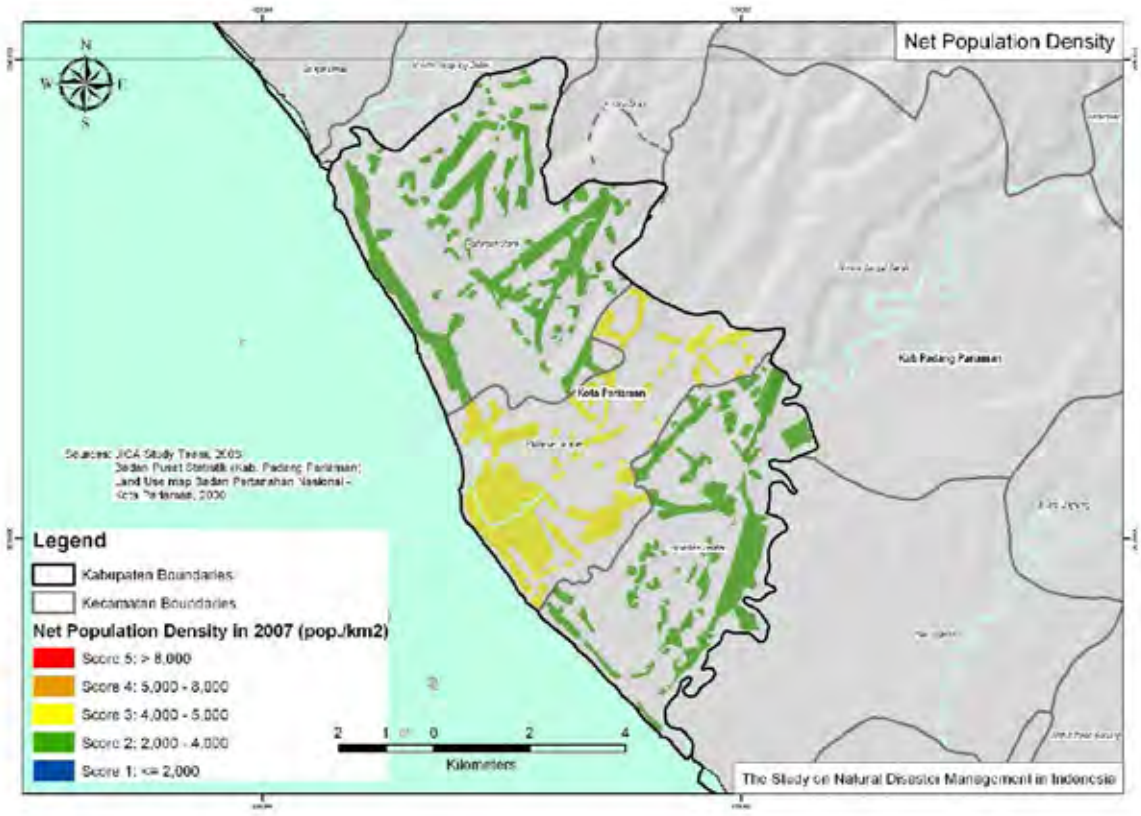


Figure 1.5.3 Population Density in Kota Pariaman

4) Building Type

The study team was able to compile a total building count inventory using data collected from Kecamatan in Kota Pariaman and BPS. Building counts by type of structure were determined by estimating building type distribution using ratios of each type of building to the total buildings from those Kecamatan that submitted detailed data in Kabupaten Padang Pariaman.

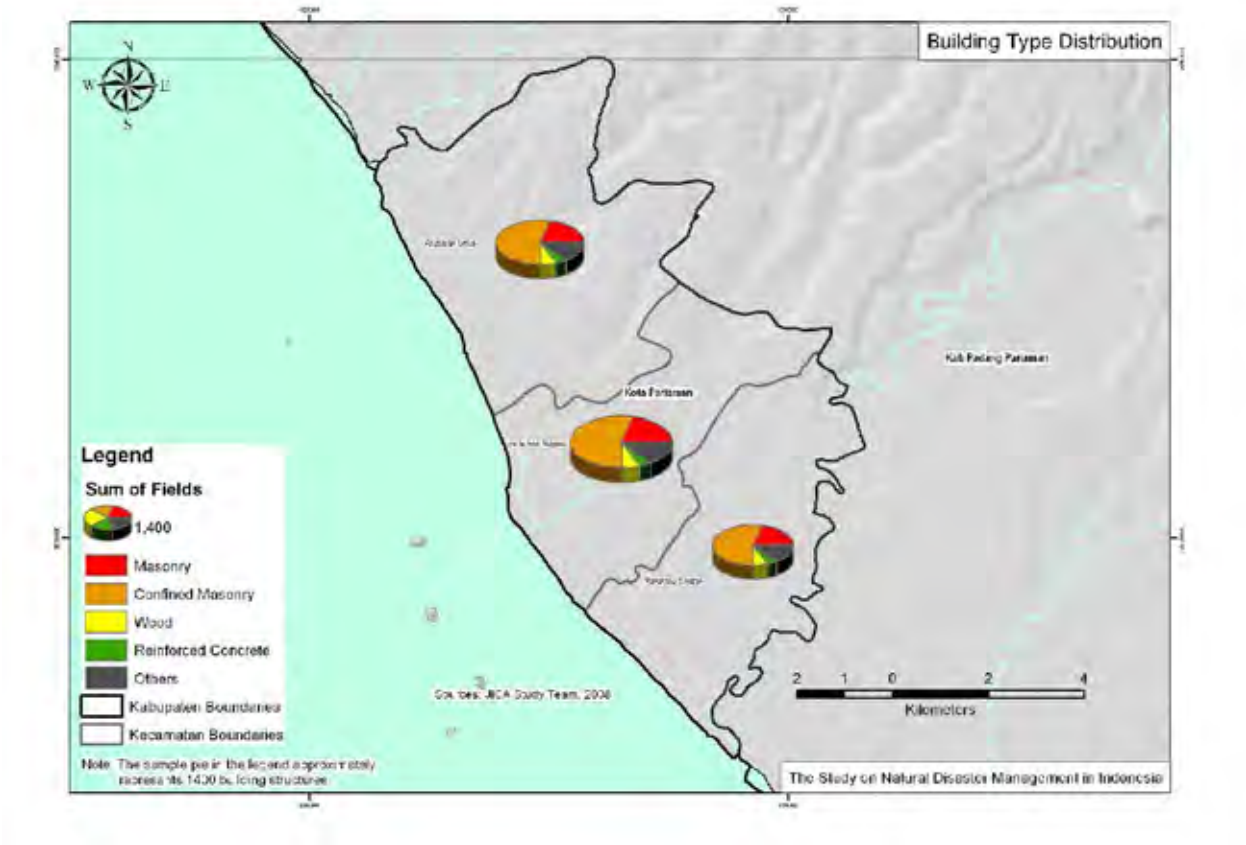


Figure 1.5.4 Building Type Distribution in Kota Pariaman

5) Elevation (DEM)

Digital elevation data for Kota Pariaman including Kabupaten Padang Pariaman were obtained from processed Shuttle Radar Topography Mission (SRTM) data from the International Centre for Tropical Agriculture (CIAT) and SPOT Image. The digital elevation model from CIAT contains elevations at 90 m interval while the digital elevation model purchased from SPOT Image Corporation contains elevations at 20 m intervals. Some of the areas, where SPOT data does not exist, are substituted by SRTM data. Both models were used for the different analyses conducted by the study team depending on the purpose.

Figures 1.4.6 and 1.4.7 show the digital elevation models including Kapbupaten Padang Pariaman from SRTM and SPOT Image covering Kota Pariaman.

6) Slope

Based on the digital elevation model (SRTM: Shuttle Radar Topography Mission) as shown in Figure 1.4.5, a slope map was created for the different analyses conducted by the study team. The slope in a grid shows the maximum slope among the surrounding adjacent grids in degrees.

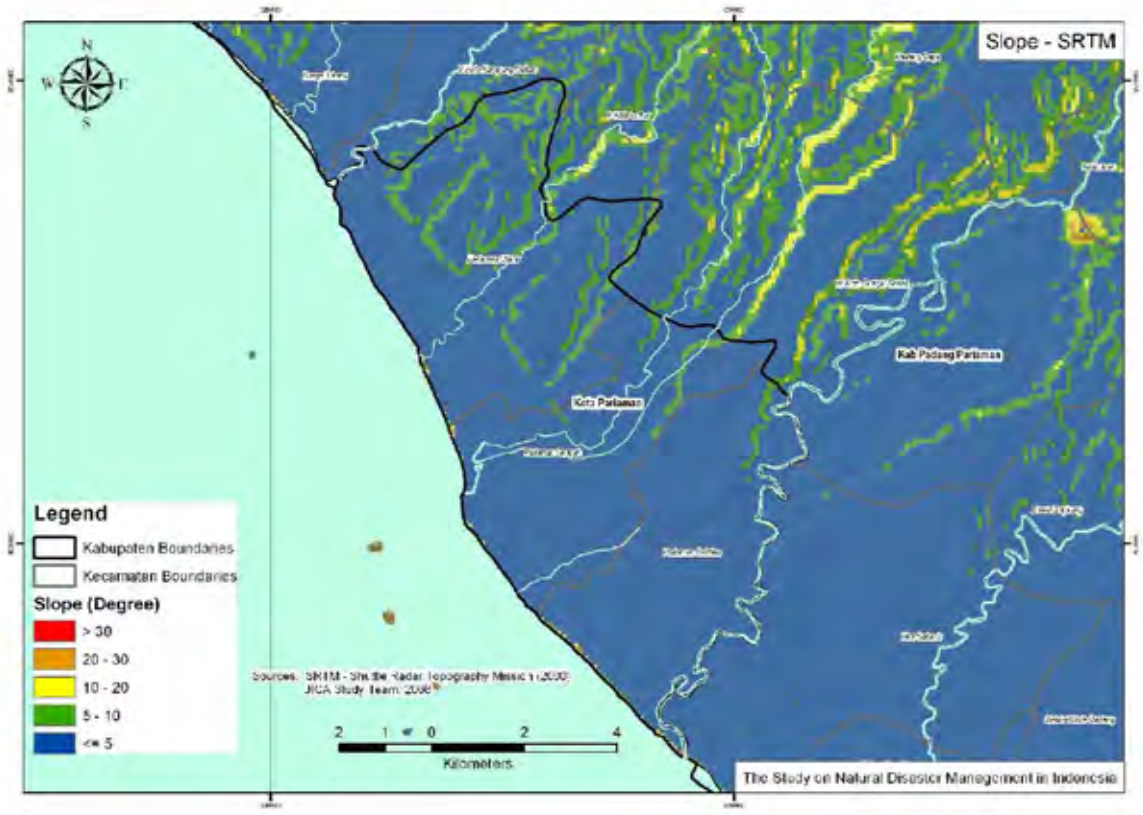


Figure 1.5.5 Slope Map Based on DEM (SRTM) in Kota Pariaman

7) Land Cover

Land cover data compiled in 2007 using SPOT Satellite Imagery was obtained from BAPPEDA of Kabupaten Padang Pariaman. The land cover data also covers Kota Pariaman. As shown in the figure, the most of Kota Pariaman except for the northern part of Kecamatan Pariaman Utara are for plantation including rice-field or built-up area. The land cover of the northern part of Kecamatan Pariaman Utara is mainly forest.

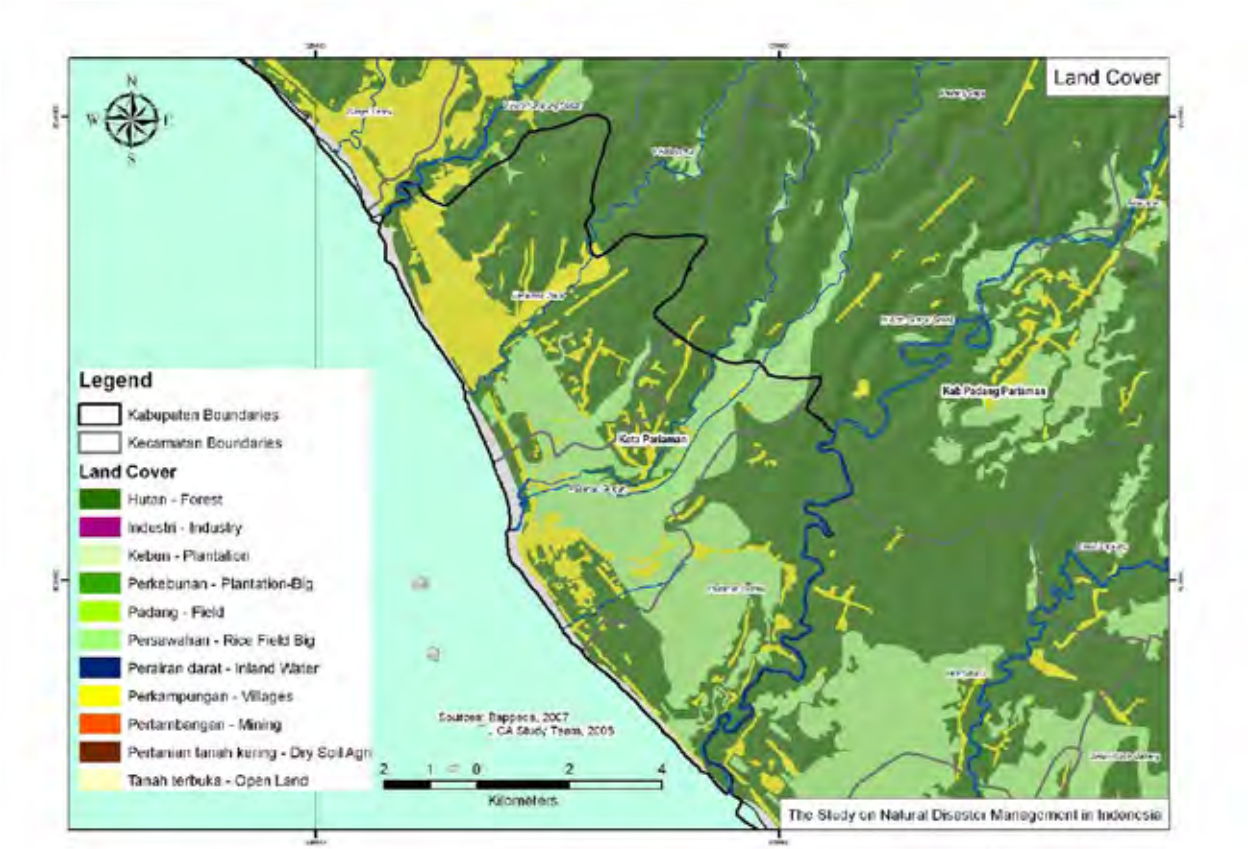


Figure 1.5.6 Land Cover in Kota Pariaman

1.6 Basics for Creations of Hazard Map and Risk Map

1.6.1 Objectives of Creations of Hazard Map and Risk Map

The objectives of the creation of hazard map and risk maps are

1) to identify the areas which are considered to be high-risk to natural disasters, and

2) to identify problems facing the area of concern for consideration in the preparation of regional disaster management plan.

1.6.2 Definition of Risk, Hazard and Vulnerability

According to "Living with Risk" published by Inter-Agency Secretariat of the International Strategy for Disaster Reduction (UN/ISDR) in 2004, Risk is defined as "The probability of harmful consequences, or expected losses (deaths, injuries, property, livelihoods, economic activity disrupted or environment damaged) resulting from interactions between natural or human-induced hazards and vulnerable conditions" and can be indicated in the formula below.

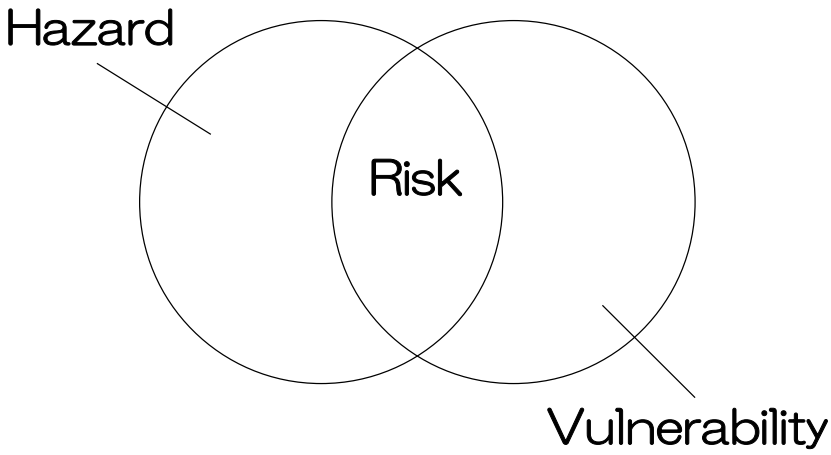
$$\text{Risk} = \text{Hazard} \times \text{Vulnerability} \qquad \text{(Eq. 1.1)}$$

Hazard: A potentially damaging physical event, phenomenon or human activity, which may cause the loss of life or injury, property damage, social and economic disruption or environmental degradation.

Vulnerability: The conditions determined by physical, social, economic, and environmental factors or processes, which increase the susceptibility of a community to the impact of hazards.

The definitions of risk, hazard and vulnerability above are the basis for the creation of hazard maps and risk maps. The relations among "Hazard", "Vulnerability" and "Risk" are shown as a conceptual figure (Refer to Figure 1.6.1), which is sourced from white book for disaster reduction (2006). According to the white book, the following elements are pointed out.

1. "Hazard", which is natural phenomena, is not be controlled by people.
2. For example, "Vulnerability" can be reduced by means of promotion for anti-seismic housing/building construction, etc. against seismic hazard; hence, the damage due to earthquake may be decreased considerably.
3. It is necessary to place more emphasis on disaster reduction activities in order to reduce "Vulnerability" prior to natural disaster event.



Source: White Book for Disaster Redution in Japan, 2006 (Altered)

Figure 1.6.1: Relation among Hazard, Vulnerability and Risk

1.6.3 Flow Chart for Creations of Hazard Map and Risk Map

The conceptual flow chart for the creations of hazard map and risk map is shown in Figure1 below. There are three (3) steps to producing a hazard map: namely 1) Data collection, 2) Calculation & Selection of indices, and 3) Creation of Hazard map. Further, a risk map is derived based on the formula of "Risk = Hazard x Vulnerability" with the hazard map and the vulnerability indices (or possibly a map representing "Vulnerability").

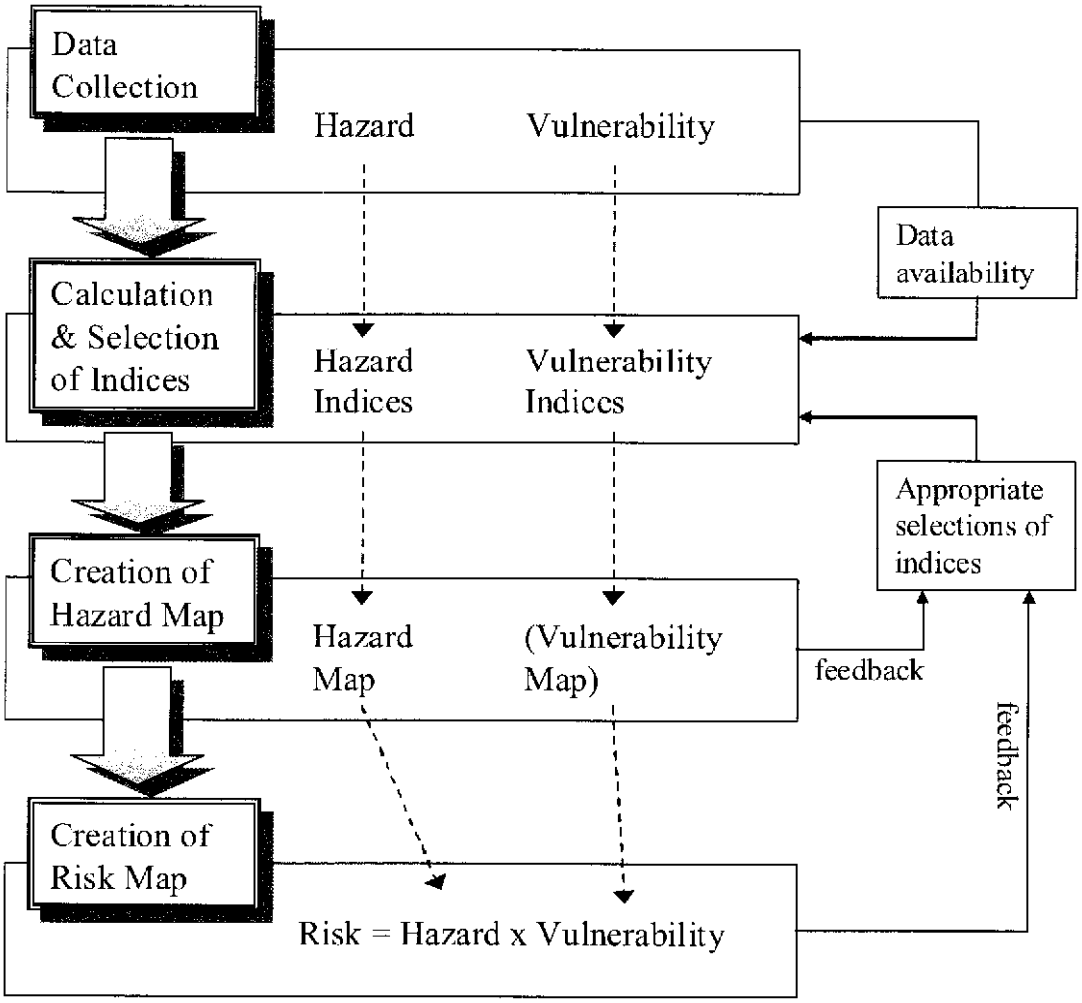


Figure 1.6.2 Conceptual Flow Chart for Creations of Hazard Maps and Risk Maps

At "Data collection" stage, the basic data in terms of hazard and vulnerability will be collected (*e.g.* affected disaster area, number of killed or injured, damage amount, rainfall, tidal level, surface ground condition, population, poverty rate, literacy rate, land use, *etc.*). Then, the indices for hazard and vulnerability will be calculated during the "Calculation & Selection of Indices" stage; they will be referred to as the candidate indices. The most appropriate indices for hazard and vulnerability can be selected amongst the candidate indices after the trial derivations of hazard map and risk map. Some of the indices were selected based on the discussions with the counterpart organizations/members of the pilot regions (Kabupaten Jember, Kabupaten Padang Pariaman and Kota Pariaman) during the workshops. After the selection of indices, the hazard map is created as the summation of the indices at the stage of "Creation of Hazard Map". The vulnerability map, consisting of the relevant selected indices, can be also created if necessary. Finally, the risk map will be created based on the formula of "Risk = Hazard x Vulnerability" as the result of the "Creation of Risk Map" stage.

Figure 1.6.3 shows the relations among risk, hazard, vulnerability, indices and basic data. "Risk" is composed of "Hazard" and "Vulnerability". "Hazard" and "Vulnerability" consist of their indices, respectively. "Hazard" is simply the summation of the hazard indices. "Vulnerability" can also be estimated in the same manner. Each index is derived or calculated based on the collected basic data (e.g. related documents, electric data, maps, etc.) from various information sources.

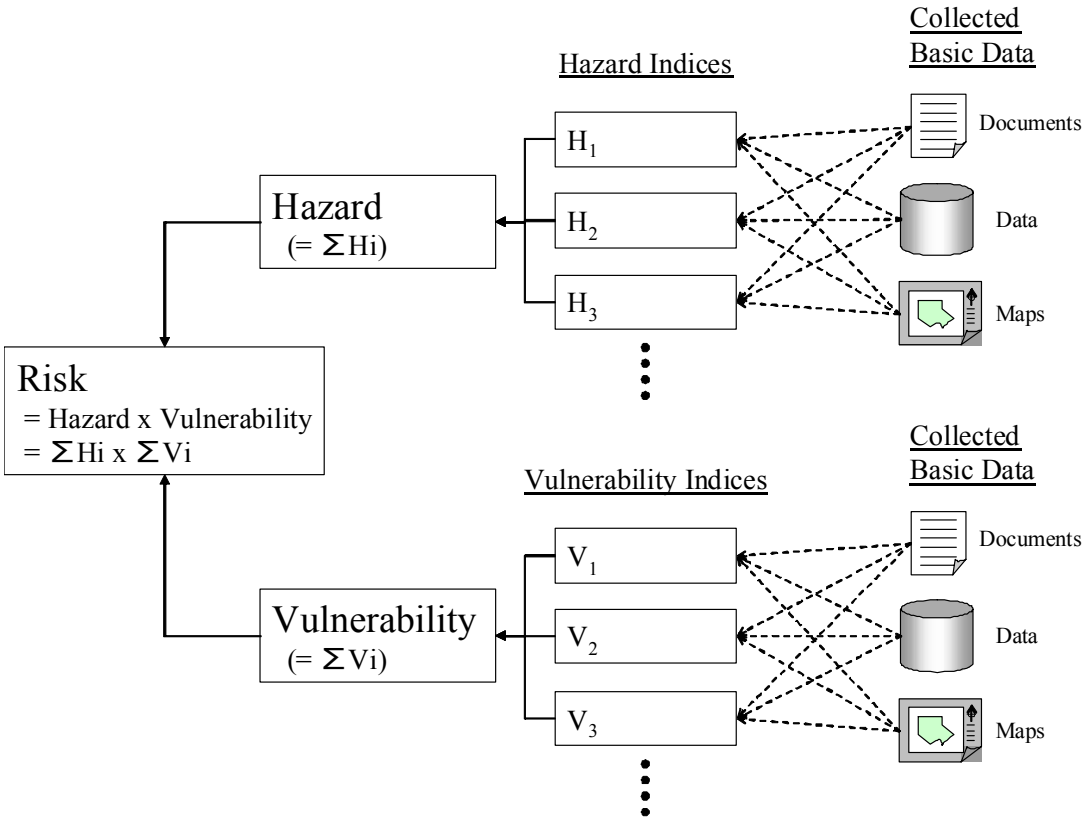


Figure 1.6.3 Relations among Risk, Hazard, Vulnerability, Indices and Basic Data

1.6.4 Vulnerability Maps for Kabupaten Jember

1) Population Density

To assess vulnerability of Kabupaten Jember in terms of population density, a population density grade map at 1,000 m grid intervals was created based on the population density map (Figure 1.3.3 on page 1-10). A scoring system to assess relative vulnerability in terms of population density ranges was then applied based on the following classification.

i)	Score 5	: > 50 (pop./ha)	<Highest Population Density>
ii)	Score 4	: 25 – 50 (pop./ha)	<Higher Population Density>
iii)	Score 3	: 10 – 25 (pop./ha)	<Moderate Population Density>
iv)	Score 2	: 5 – 10 (pop./ha)	<Lower Population Density>
v)	Score 1	: <= 5 (pop./ha)	<Lowest Population Density>

The figure below shows the vulnerability scoring for population density used by the study team. As shown in the map, Kecamatan Patrang, Kecamatan Kaliwates and Kecamatan Sumbersari belong to relatively highest populated area.

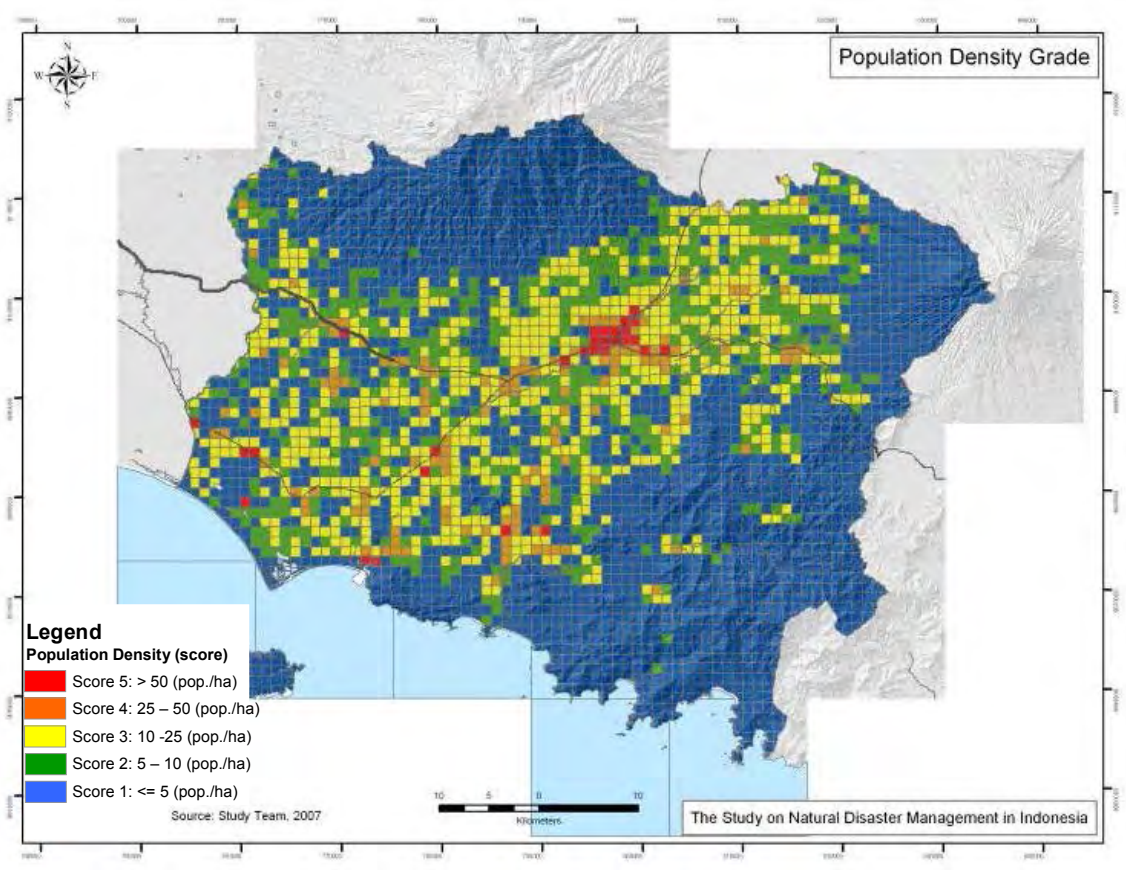


Figure 1.6.4 Population Density Grade in Kabupaten Jember

2) Built-up Area

To assess vulnerability of Kabupaten Jember in terms of built-up area, a built-up area grade map at 1,000m grid intervals was created based on the land cover map (Figure 1.3.2 on page 1-9). A scoring system to assess relative vulnerability in terms of built-up area ratio was then applied based on the following classification.

i)	Score 5	: > 50 (ha/km^2)	<Highest Ratio of Built-up Area>
ii)	Score 4	: 30 – 50 (ha/km^2)	<Higher Ratio of Built-up Area >
iii)	Score 3	: 20 – 30 (ha/km^2)	<Moderate Ratio of Built-up Area >
iv)	Score 2	: 5 – 20 (ha/km^2)	<Lower Ratio of Built-up Area >
v)	Score 1	: <= 5 (ha/km^2)	<Lowest Ratio of Built-up Area >

The figure below shows the vulnerability scoring for built-up area ratio used by the study team. As shown in the map, Kecamatan Patrang, Kecamatan Kaliwates, Kecamatan Sumbersari, Kecamatan Wuluhan and Kecamatan Ambulu have relatively higher ratio of built-up area.

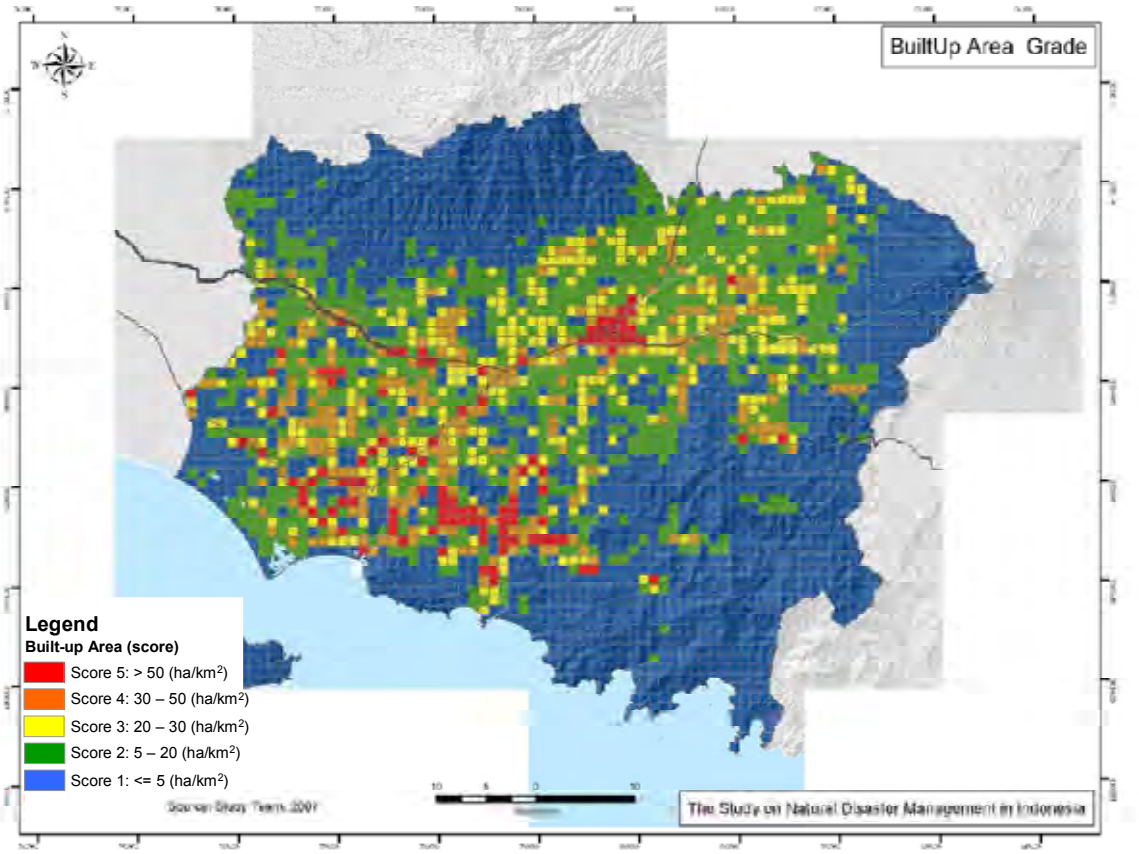


Figure 1.6.5 Built-up Area Grade in Kabupaten Jember

3) Land Cover

To assess vulnerability of Kabupaten Jember in terms of land cover, a land cover grade map at 1,000 m intervals was created based on the land cover map (Figure 1.3.2 on page 1-9). If a grid contains any small portion of "Built-up Area" within the grid, the grid is regarded as "Built-up Area". Except the grids for "Built-up Area", if a grid contains any small portion of "Vegetation – Cultivated Area", the grid is regarded as "Vegetation – Cultivated". A scoring system to assess vulnerability in terms of land cover types was then applied based on the following classification.

i) Score 5 : Built-up Area <Highest Vulnerability in terms of Land Cover>

ii) Score 3 : Vegetation - Cultivated <Moderate Vulnerability in terms of Land Cover>

iii) Score 0 : Others <No Vulnerability in terms of Land Cover>

The figure below shows the vulnerability scoring for land cover type used by the study team especially as one of vulnerability index for sediment disaster. As shown in the figure compared with the slope map (Figure 1.3.6), most of vulnerable areas in terms of land cover are located in flat land.

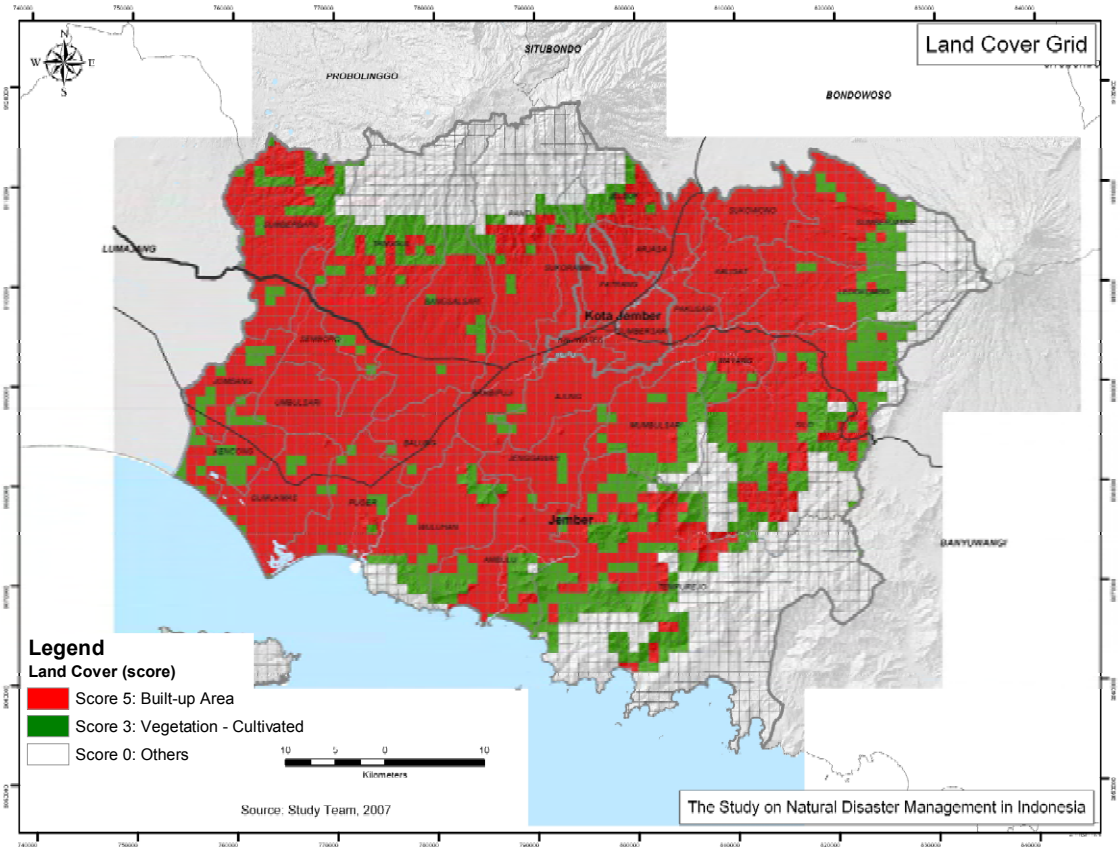


Figure 1.6.6 Land Cover Grade in Kabupaten Jember

4) Vegetation/cultivated Area

To assess vulnerability of Kabupaten Jember in terms of vegetation and cultivated area which may be affected by flood disaster, vegetation and cultivated area grade map at 1,000 m intervals was created based on the land cover map (Figure 1.3.7 on page 1-14). A scoring system to assess vulnerability in terms of area ratio of vegetation and cultivated area was then applied based on the following classification.

i)	Score 5	: > 90 (ha/km^2)	<Highest Ratio of Veg./Cul. Area>
ii)	Score 4	: 70 – 90 (ha/km^2)	<Higher Ratio of Veg./Cul. Area >
iii)	Score 3	: 40 – 70 (ha/km^2)	<Moderate Ratio of Veg./Cul. Area >
iv)	Score 2	: 15 – 40 (ha/km^2)	<Lower Ratio of Veg./Cul. Area >
v)	Score 1	: <= 15 (ha/km^2)	<Lowest Ratio of Veg./Cul. Area >

The figure below shows the vulnerability scoring for vegetation and cultivated area type used by the study team as one of vulnerability index for flood disaster. As shown in the figure compared with the slope map (Figure 1.3.6), most of vulnerable areas in terms of vegetation and cultivated area are located in flat land. Kec. Sumberbaru, Kec. Tanggul, Kec. Jombang, Kec. Kencong, Kec. Rambipuji, Kec. Ajung, Kec. Mumbulsari, Kec. Mayang, Kec. Silo and western part of Kec. Temprejo have relatively highest ratio of vegetation and cultivated area.

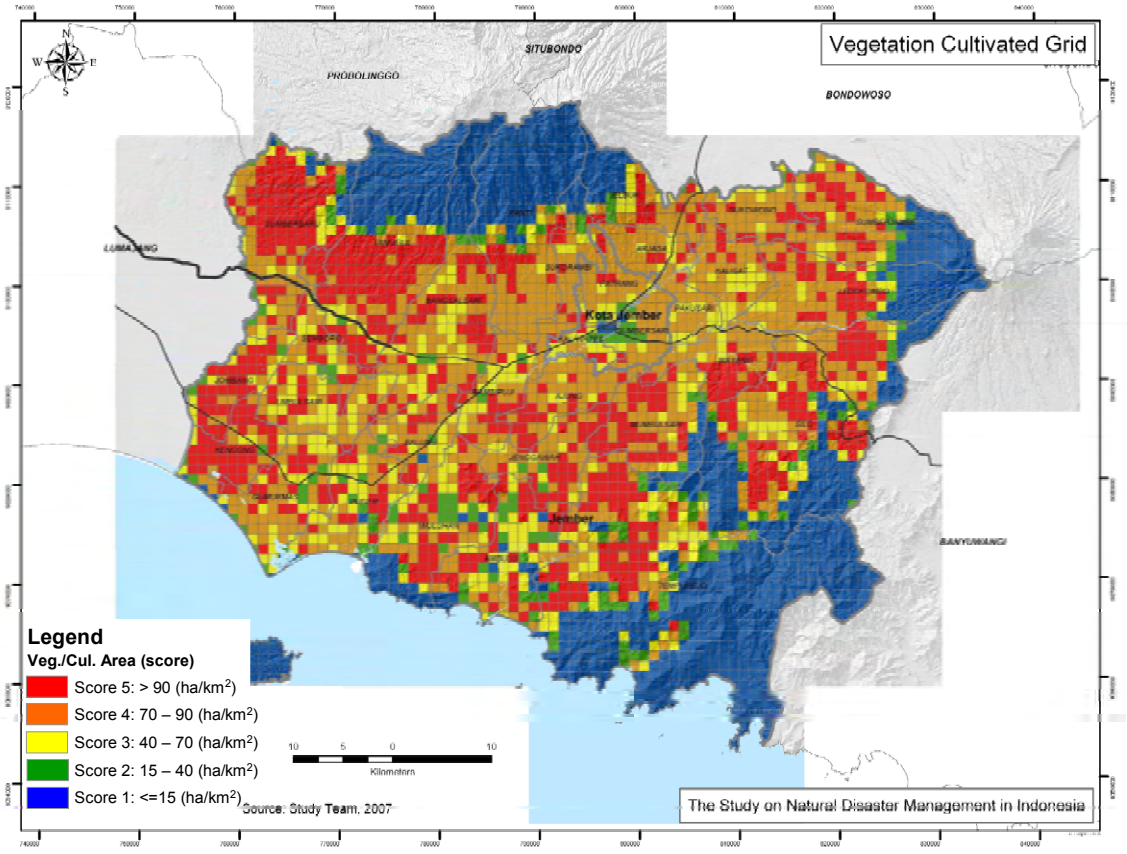


Figure 1.6.7 Vegetation/Cultivated Area Grade in Kabupaten Jember

1.6.5 Vulnerability Maps for Kabupaten Padang Pariaman

1) Population Density

To assess vulnerability of Kabupaten Padang Pariaman in terms of population density, a population density grade map at 1,000 m grid intervals was created based on the population density map (Figure 1.4.3 on page 1-19). A scoring system to assess vulnerability in terms of population density was then applied based on the following classification.

i)	Score 5	: > 50	(pop./ha)	<Highest Population Density>
ii)	Score 4	: 25 – 50	(pop./ha)	<Higher Population Density>
iii)	Score 3	: 10 – 25	(pop./ha)	<Moderate Population Density>
iv)	Score 2	: 5 – 10	(pop./ha)	<Lower Population Density>
v)	Score 1	: <= 5	(pop./ha)	<Lowest Population Density>
vi)	Score 0	: 0	(pop./ha)	<No Population>

The figure below shows the vulnerability scoring for population density used by the study team.

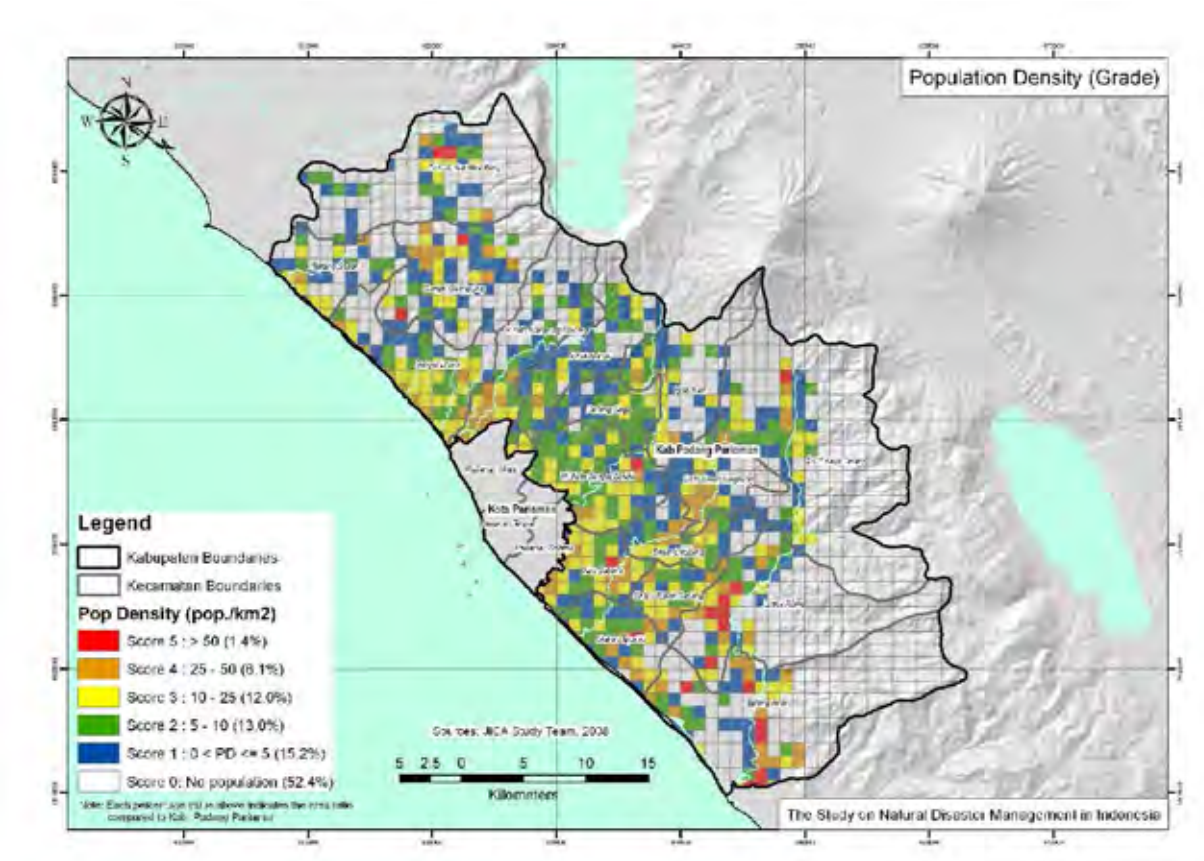


Figure 1.6.8 Population Density Grade in Kabupaten Padang Pariaman

2) Built-up Area

To assess vulnerability of Kabupaten Padang Pariaman in terms of built-up area, a built up area grade map at 1,000 m grid intervals was created based on the built-up area map (Figure 1.4.2 on page 1-18). A scoring system to assess vulnerability in terms of built up area ratio was then applied based on the following classification.

i)	Score 5	: > 50	(percent)	<Highest Ratio of Built-up Area>
ii)	Score 4	: 30 – 50	(percent)	<Higher Ratio of Built-up Area>
iii)	Score 3	: 20 – 30	(percent)	<Moderate Ratio of Built-up Area>
iv)	Score 2	: 5 – 20	(percent)	<Lower Ratio of Built-up Area>
v)	Score 1	: <= 5	(percent)	<Lowest Ratio of Built-up Area>
vi)	Score 0	: 0	(percent)	<No Building>

The figure below shows the vulnerability scoring for built-up area ratio used by the study team.

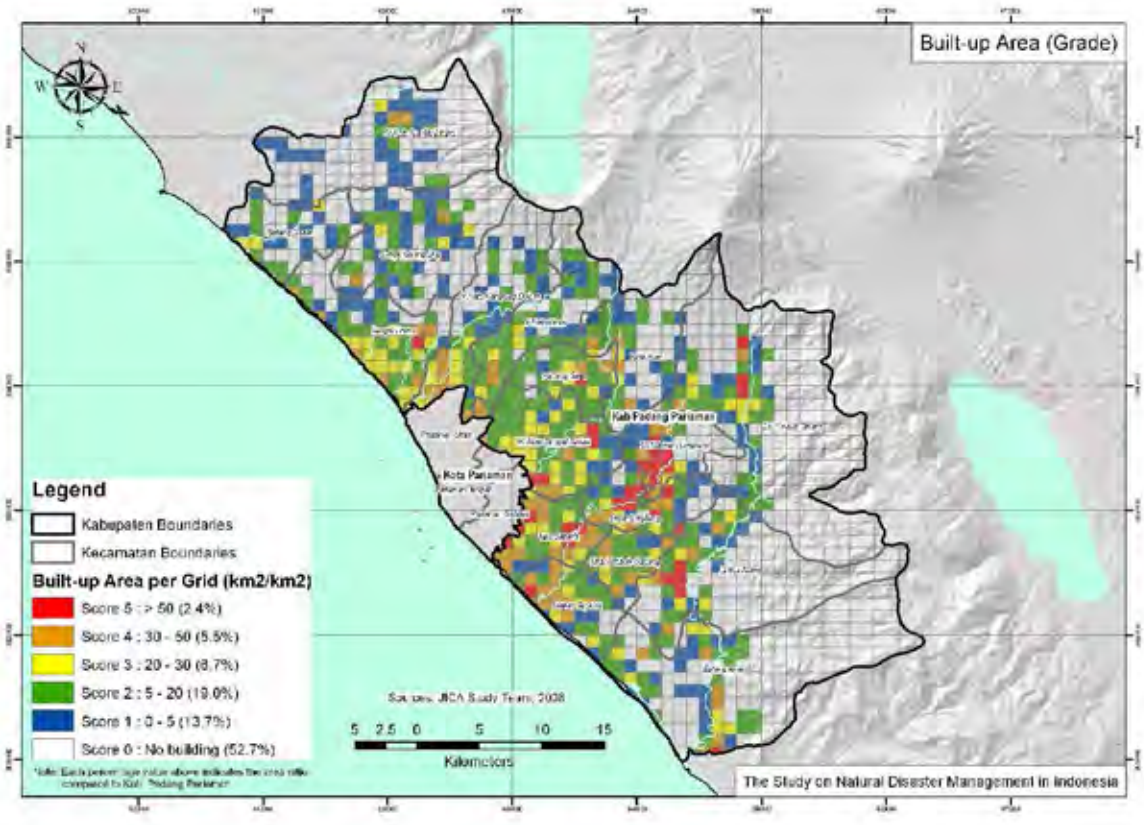


Figure 1.6.9 Built up Area Grade in Kabupaten Padang Pariaman

3) Road, Railway in Steep Slope Area

To assess vulnerability of Kabupaten Padang Pariaman in terms of the presence of road or railways in steep areas, a road/railway in steep area map at 1,000 m grid intervals was created based on the digital elevation maps (Figure 1.4.5 on page 1-18) as well as road and railway layers shown in Figure 1.4.1. Each grid is flagged if it satisfies the conditions that either a road or railway exists in the grid and that the grid has an average slope of greater than 30 degrees. A scoring system to assess vulnerability in terms of the presence of road or railway in steep areas was then applied. The figure below shows the vulnerability scoring for the presence of road or railway in steep areas used by the study team especially as one of vulnerability index for sediment disaster.

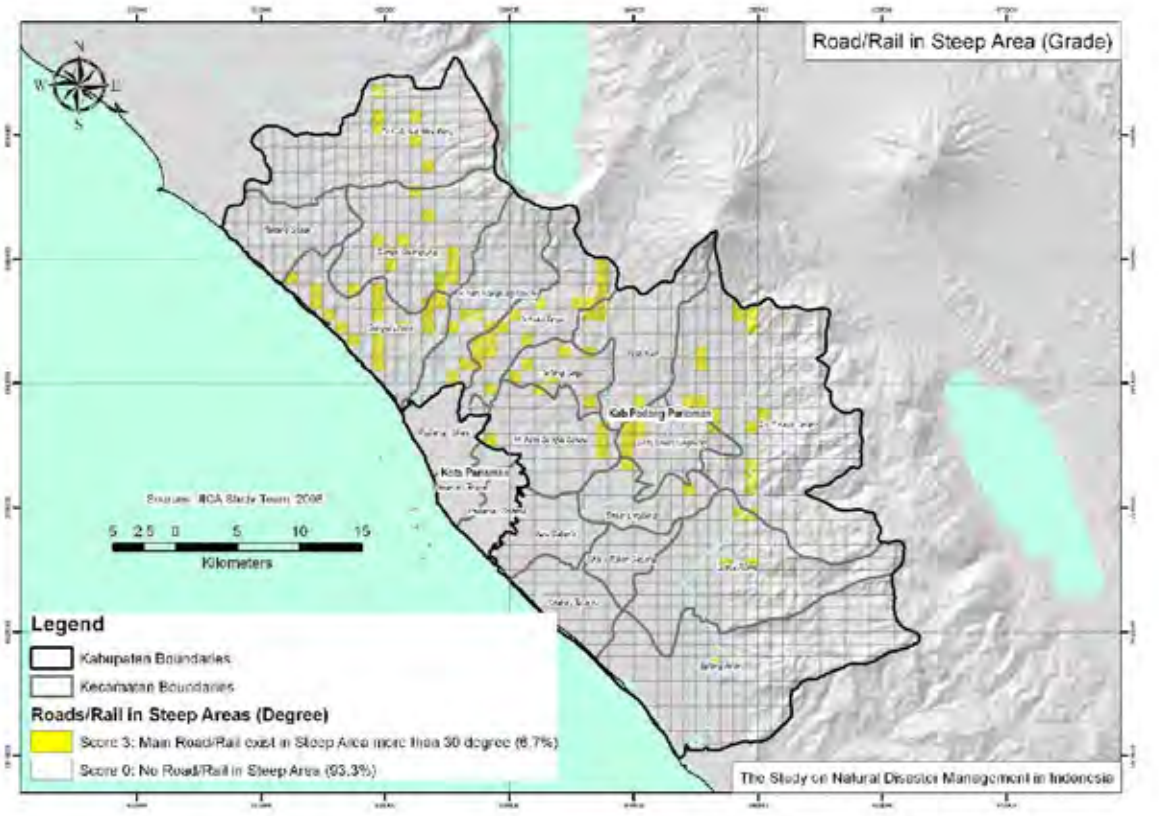


Figure 1.6.10 Grade for Road, Railway in Steep Slope Area in Kabupaten Padang Pariaman

4) Rice Field & Plantation

To assess vulnerability of Kabupaten Padang Pariaman in terms of plantation and ricefield area grade, a plantation and ricefield area grid map at 1,000 m intervals was created based on the land cover map (Figure 1.4.8 on page 1-24). A scoring system to assess vulnerability in terms of plantation and ricefield area cover types was then applied based on the following classification.

i)	Score 5	: > 80 (percent)	<Highest Ratio of Rice and Plantation>
ii)	Score 4	: 50 – 80 (percent)	<Higher Ratio of Rice and Plantation>
iii)	Score 3	: 30 – 50 (percent)	<Moderate Ratio of Rice and Plantation>
iv)	Score 2	: 10 – 30 (percent)	<Lower Ratio of Rice and Plantation>
v)	Score 1	: <= 10 (percent)	<Lowest Ratio of Rice and Plantation>
vi)	Score 0	: 0 (percent)	<No Rice and Plantation >

The figure below shows the vulnerability scoring for plantation and ricefield area cover type used by the study team especially as one of vulnerability index for flood disaster. As shown in the figure, most of highest ratio of plantation and rice-field are concentrated in flat lowland such as Kec. Batang Anai, Kec. Lubuk Alung, Kec. Ulakan Tapakis and Kec. Nansabris.

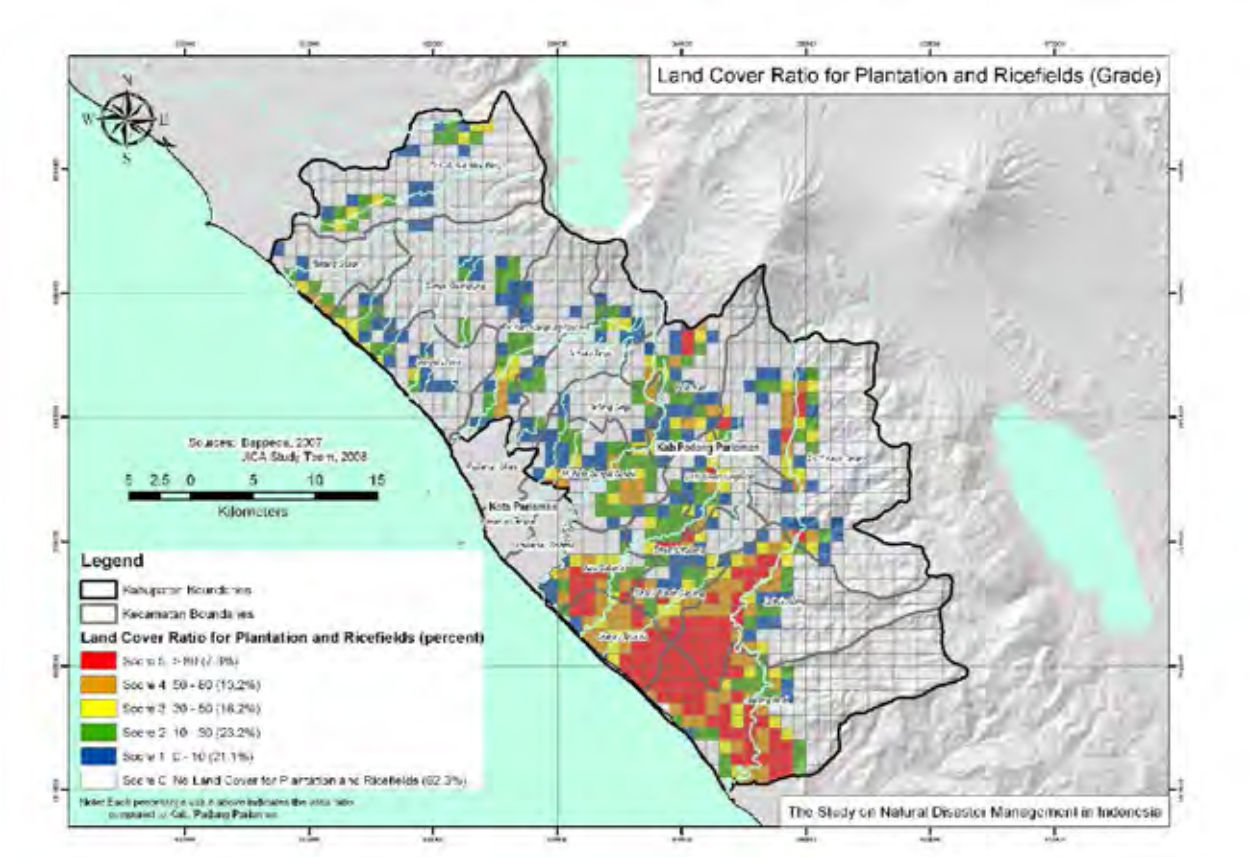


Figure 1.6.11 Grade for Rice Field & Plantation in Kabupaten Padang Pariaman

1.6.6 Vulnerability Maps for Kota Pariaman

1) Population Density

To assess vulnerability of Kota Pariaman in terms of population density, a population density grade map at 500 m grid intervals was created based on the population density map (Figure 1.5.3 on page 1-29). A scoring system to assess vulnerability in terms of population density ranges was then applied based on the following classification.

i)	Score 5	: > 50 (pop./ha)	<Highest Population Density>
ii)	Score 4	: 20 – 50 (pop./ha)	<Higher Population Density>
iii)	Score 3	: 10 – 20 (pop./ha)	<Moderate Population Density>
iv)	Score 2	: 5 – 10 (pop./ha)	<Lower Population Density>
v)	Score 1	: <= 5 (pop./ha)	<Lowest Population Density>

The figure below shows the vulnerability scoring for population density used by the study team.

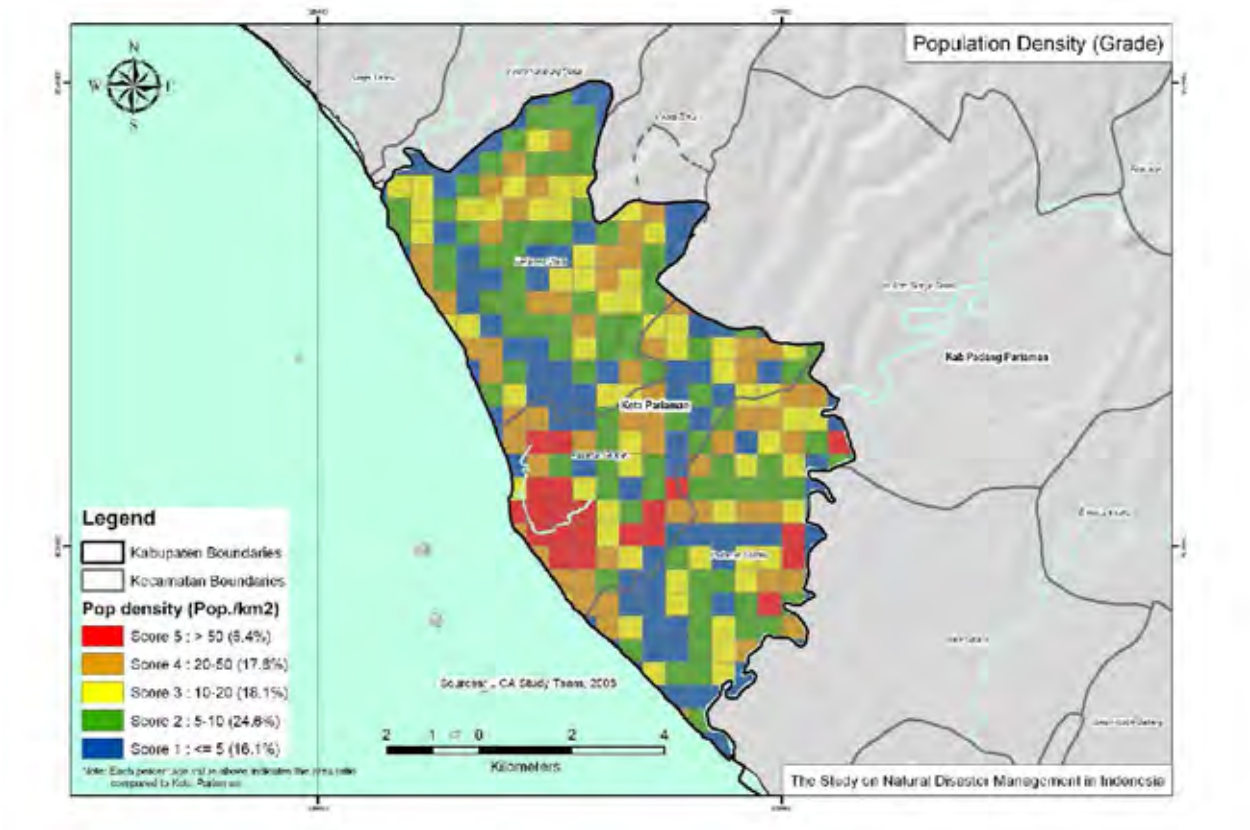


Figure 1.6.12 Population Density Grade in Kota Pariaman

2) Built-up Area

To assess vulnerability of Kota Pariaman in terms of built-up area, a built up area ratio grade map at 500 m grid intervals was created based on the built-up area map (Figure 1.5.2 on page 1-28). A scoring system to assess vulnerability in terms of built up area ratio was then applied based on the following classification.

i)	Score 5	: > 50	(percent)	<Highest Ratio of Built-up Area>
ii)	Score 4	: 30 – 50	(percent)	<Higher Ratio of Built-up Area>
iii)	Score 3	: 20 – 30	(percent)	<Moderate Ratio of Built-up Area>
iv)	Score 2	: 5 – 20	(percent)	<Lower Ratio of Built-up Area>
v)	Score 1	: <= 5	(percent)	<Lowest Ratio of Built-up Area>
vi)	Score 0	: 0	(percent)	<No Building>

The figure below shows the vulnerability scoring for built-up area ratio used by the study team.

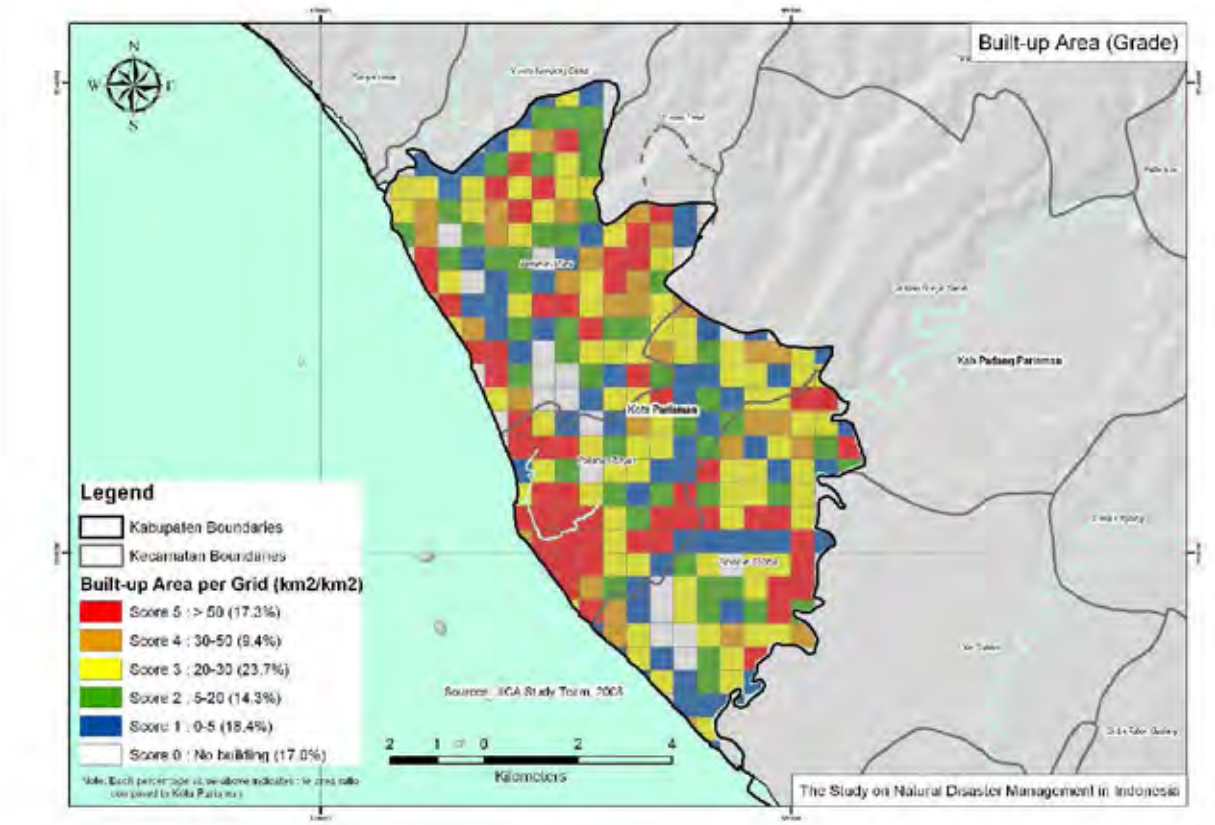


Figure 1.6.13 Built up Area Grade in Kota Pariaman

3) Road, Railway in Steep Slope Area

To assess vulnerability of Kota Pariaman in terms of the presence of road or railways in steep areas, a road/railway in steep area map at 500 m grid intervals was created based on the digital elevation maps (Figure 1.4.5 on page 1-18) as well as road and railway layers shown in Figure 1.5.1. Each grid is flagged if it satisfies the conditions that either a road or railway exists in the grid and that the grid has an average slope of greater than 30 degrees. A scoring system to assess vulnerability in terms of the presence of road or railway in steep areas was then applied. The figure below shows the vulnerability scoring for the presence of road or railway in steep areas used by the study team especially as one of vulnerability index for sediment disaster.

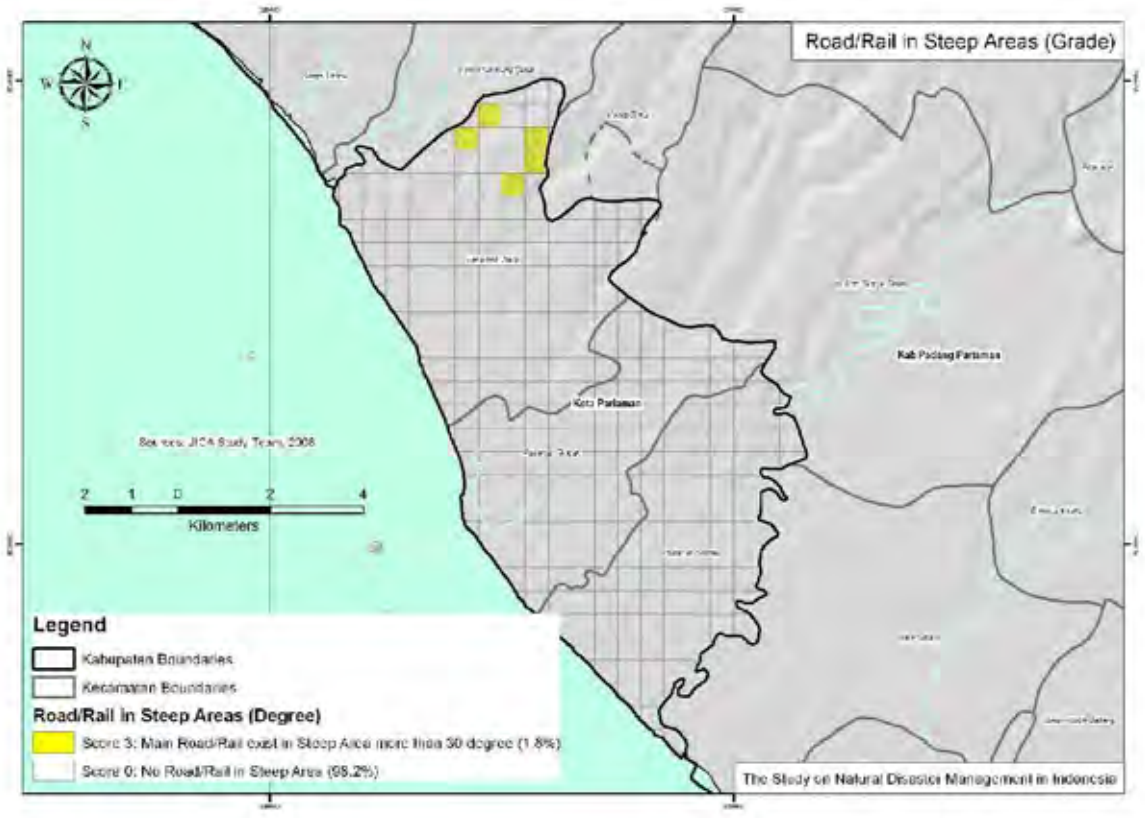


Figure 1.6.14 Grade for Road, Railway in Steep Slope Area in Kota Pariaman

4) Rice Field & Plantation

To assess vulnerability of Kota Pariaman in terms of plantation and ricefield area cover, a plantation and ricefield area grade map at 500 m intervals was created based on the land cover map (Figure 1.5.6 on page 1-32). A scoring system to assess vulnerability in terms of plantation and ricefield area cover was then applied based on the following classification.

i)	Score 5	: > 80 (percent)	<Highest Ratio of Rice and Plantation>
ii)	Score 4	: 50 – 80 (percent)	<Higher Ratio of Rice and Plantation>
iii)	Score 3	: 30 – 50 (percent)	<Moderate Ratio of Rice and Plantation>
iv)	Score 2	: 10 – 30 (percent)	<Lower Ratio of Rice and Plantation>
v)	Score 1	: <= 10 (percent)	<Lowest Ratio of Rice and Plantation>
vi)	Score 0	: 0 (percent)	<No Rice and Plantation >

The figure below shows the vulnerability scoring for plantation and ricefield area cover type used by the study team especially as one of vulnerability index for sediment disaster.

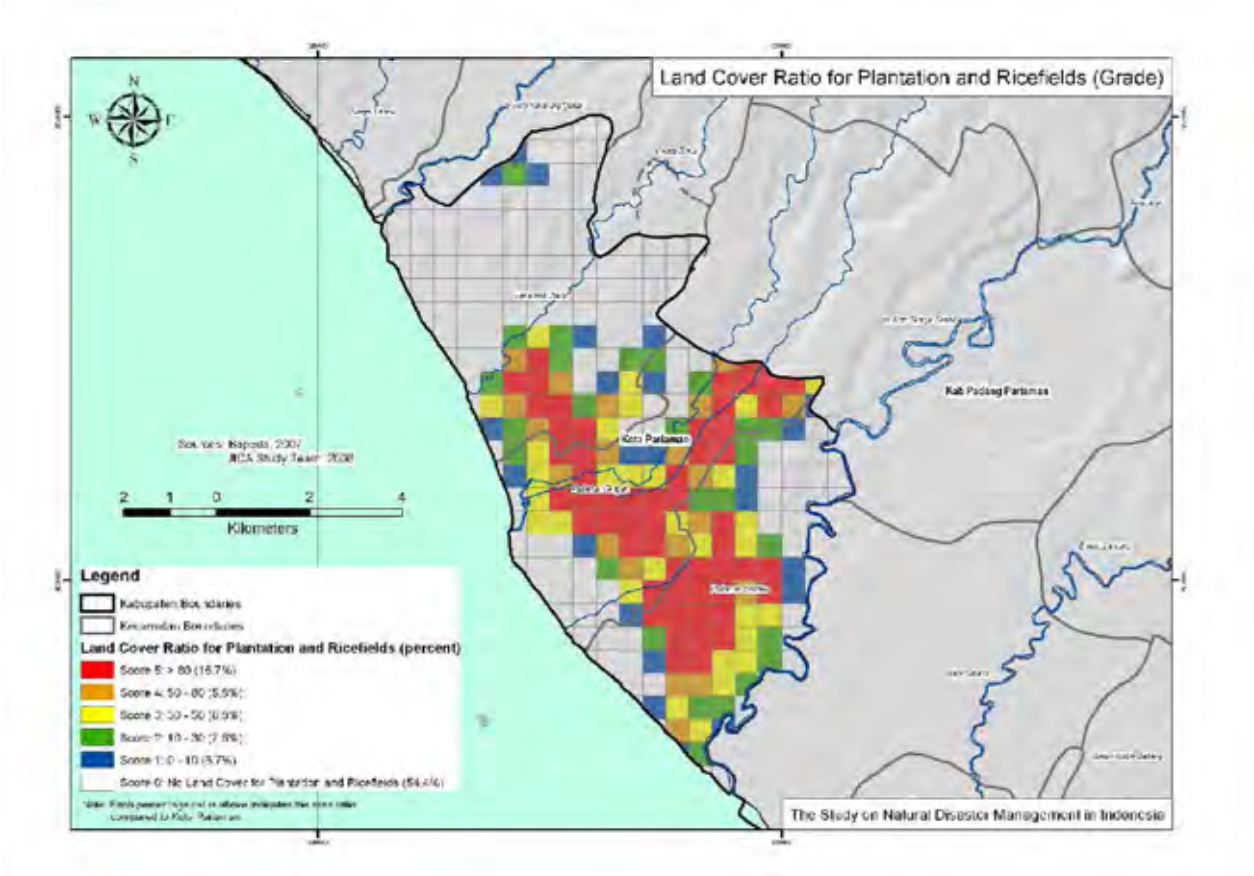


Figure 1.6.15 Grade for Rice Field & Plantation in Steep Slope Area in Kota Pariaman