D. Disaster Risk Assessment

1.Hazard Profile

Three (3) major types of hazards are affecting the municipality--hydrometerological geologic, and climate-related.

1.1.Hydrometeorologic Hazards

1.1.1Flood, Rain/Storm Induced Hazard

Teresa is not much prone to flooding. Based from the Flood Hazard Map of the province (Figure 14), Teresa is not susceptible to flooding. There is also no population exposed to flooding in moderate and high susceptible areas (Table 30).

Table 30. Municipal Population Exposure to Flood

Municipality	2010 Municipal Population	Exposed Population in High Susceptible Area	Exposed Population in Moderate Susceptible Area	Population Exposure Percentage in High Susceptible Areas	Population Exposure Percentage in Moderate Susceptible Areas
Cainta	311,845	250,676	26,220	80.38%	8.41%
Taytay	268,956	165,575	20,357	57.30%	7.05%
Morong	52,194	15,338	0	29.39%	0.00%
Baras	32,609	9,148	0	28.05%	0.00%
Angono	102,407	22,408	0	21.88%	0.00%
Binangonan	249,872	32,724	0	13.10%	0.00%
San Mateo	205,255	24,346	15,959	12.35%	7.78%
Cardona	47,414	5,612	0	11.84%	0.00%
Jalajala	30,074	1,909	2,027	6.35%	6.74%
Tanay	98,879	5,860	8	5.93%	0.01%
Pililla	59,527	2,496	3,391	4.13%	5.70%
Rodriguez	280,904	8,433	721	3.00%	0.26%
Antipolo City	677,741	14,357	4,465	2.12%	0.66%
Teresa	**47,163**	**0**	**0**	**0.00%**	**0.00%**

Source: Provincial Development & Physical Framework Plan (PDPFP)

In 2009, the municipality experienced flooding caused by Tropical Storm Ondoy, a rare event (Table 31). Waterways overflowed due to the unusually heavy amount of rainfall brought by the storm. TS Ondoy remained to be the most well remembered in terms of the experience and damages it brought to the municipality.In December 2, 2004, Typhoon Winnie damaged Php 513,500 worth or crops (Table 30). Typhoon Milenyo in September 2006, affected 207 families and damaged 65 houses, Php 20,000.00 worth of livestock and poultry and Php. 5,090,800.00 worth of crops. In 2008, Frank came and it was recorded that 15 families were affected and 15 houses were damaged. Tropical Storm Ondoy occurred last September 2009 and has the most number of casualties, families affected, and damage to properties. There were three (3) casualties, 3,935 families affected, 4,167 houses damaged, P370,500 worth of damage to livestock, P18,037,900 to crops, P120,000 to fisheries and P12,884,500 to infrastructure. This was followed by typhoon Basyang where a casualty was

recorded together with 1,524 families affected, 1,524 damaged houses and a total of Php. 394,267.70 damage to properties. Crops were only affected during Typhoon Juan. There were neither of the properties nor families were affected at typhoon Falcon and only two houses were damage at typhoon Pedring. Infrastracture worth Php. 180,000.00 was damaged during Typhoon Gener. There were only two casualties during Habagat.

Table31.Summary Matrix for Historical Occurrences of Rain/Storm Induced Hazard & Their Effects to Teresa

Date of Occurrence	No. of Casualties	No. of Families/ persons affected	No. of houses damaged	Damage to Properties			
				Livestock and poultry	Crops	Fishery	Infra-structure
August 7, 2012 (Habagat)	2	0	0	50,800	719,000.00	No Report	1,650,000.00
July 31, 2012 (Gener)	0	23 families/ 54 individuals	12	No Damage	No Report	No Report	180,000.00
September 27, 2011 (Pedring)	0	0	2	No Report	No Report	No Report	No Report
July 23, 2011 (Falcon)	0	0	0	No Damage	No Damage	No Report	No Report
October 18, 2010 (Juan)	0	0	0	No Damage	471,100.00	No Report	No Report
July 13, 2010 (Basyang)	1	1,524 families/ 7,135 individuals	1,524	2,000	392,267.70	No Report	No Report
September 26, 2009 (Ondoy)	3	3,935 families/ 16,921 individuals	4,167	370,500	18,037,900.00	120,000.00	12,884,500.00
June 22, 2008 (Frank)	0	15 families/ 78 individuals	15	No Report	No Report	No Report	No Report
September 29, 2006 (Milenyo)	0	207 families/ 795 individuals	65	20,000	5,090,800.00	No Report	No Report
December 2, 2004 (Winnie)	0	0	0	No Report	513,500.00	No Report	No Report

Source: Municipal Disaster Risk and Management Office

1.1.2 Landslide and Soil Erosion

From the rain-induced landslide susceptibility map of Teresa (Figure15) obtained from the Mines & Geo Sciences Bureau, there is high susceptibility in the quarry area near the Roman-Rojas Road. Based on the provincial data on municipal population

exposure to rain-induced landslide, 0.65% of the population in Teresa is exposed in high susceptible areas and 28.42% in moderate susceptible areas (Table 32).

Table 32. Municipal Population Exposure to Rain Induced Landslide

Municipality	2010 Municipal Population	Exposed Population in High Susceptible Area	Exposed Population in Moderate Susceptible Area	Population Exposed Percentage in High Susceptible Areas	Population Exposure Percentage in Moderate Susceptible Areas
Rodriguez	280,904	248,070	7,790	88.31%	2.77%
Antipolo City	677,741	306,698	269,218	45.55%	39.72%
San Mateo	205, 255	83,696	79,004	40.78%	38.79%
Tanay	98,879	31,846	40,469	32.21%	40.93%
Cardona	47,414	12,988	13,342	27.39%	28.24%
Pililla	59,527	7,501	4,871	12.60%	8.18%
Binangonan	249,872	30,350	92,862	12.15%	37.16%
Jalajala	30,074	3,001	10,138	9.98%	33.71%
Angono	102,407	3,085	71,328	3.01%	69.65%
Teresa	**47,163**	**305**	**13,405**	**0.65%**	**28.42%**
Taytay	288,956	1,008	50,924	0.35%	17.62%
Baras	32,609	0	17,986	0.00%	55.16%
Cainta	311,845	0	0	0.00	0.00%
Morong	52,194%	0	6,911	0.00%	13.24%

Source: Provincial Development & Physical Framework Plan

In the MGB Geohazard Assessment, all barangays in this municipality are considered low in landslide susceptible rating except Barangays Bagumbayan and Poblacion with high susceptibility. In this assessment, parameters are rated as low, moderate, high or very high. Low means gently sloping areas with no identified landslides. Moderate are areas with moderately steep slope and soil creep and other indications for possible landslide occurrence is present. Highly susceptible areas are usually with steep slopes, underlain by weak materials and areas with numerous old/inactive landslides.

In September 2012, MGB reported that there is a potential rock fall in Sitio Corocan, Brgy. Bagumbayan which would affect 50 families. It also mentioned that households along slopes at coordinates 14°33'39.1" N and 121°12'23.1" E of Poblacion are prone to landslide. It was also reported that there is a potential rockfall at Sitio Pulang Lupa at Brgy.Dulumbayan. It was also observed that there is a possible landslide in Brgy. San Roque if there will be an intense heavy rainfall. However, the coordinates given were not accurate as to the specific location.

1.2. Geologic Hazards

1.2.1. Earthquake

An earthquake is a weak to violent shaking of the ground produced by the sudden movement of rock materials below the earth's surface. Earthquakes are caused either by the sudden movement along faults and trenches (tectonic), or by the movement of magma beneath the volcanoes (volcanic).In the province, there is

the West Valley Fault System (WVFS) composed of two major northeast trending faults). The East Valley Fault and the West Valley Fault, traverse the MarikinaValley and the adjoining municipalities of Rodriguez, San Mateo, and Antipolo as well as some portions of eastern Metro Manila. The fault line is active and further study is being conducted by PHILVOCS. A fault line is one where vertical or lateral movement (displacement) is still likely to occur. Movement along the fault line causes earthquake with accompanying destruction of property and even loss of lives depending on its intensity and magnitude.

Teresa and its adjoining municipalities are prone to the disaster effects of earthquake as they are within the influence of the said faults (Figure 16).

The past earthquake event along the West Valley Fault was last August 19, 1658 while on the East Valley fault was on Feb. 1, 1771.

Most of the earthquake events experienced in the municipality have low intensity and magnitude. When talking about earthquake, some of the constituents would only remember the Luzon earthquake last July 16, 1990 which struck Luzon with a magnitude of 7.8. There was no reported severe damage in the municipality caused by the earthquake.

In terms of liquefaction, there is no known incident in the municipality.

There is no recorded active volcano in the municipality and other nearby areas. It was reported however that there are inactive volcanoes in Talim Island (Laguna Caldera) and Sembrano (Jalajala).

1.3 Climate-Related

1.3.1 El Niño

The El Niño phenomenon brought damage to the municipality. Agricultural production decreased. There is nil to low supply of water from irrigation and other water impounding system.

1.3.2 La Niña

Continuous rains brought by the La Niña phenomenon caused flooding in the municipality but the floods subsided within two (2) hour or less.

2. Likelihood of Hazard

Flooding that occurred in the municipality during TS Ondoy is a rare event experienced by the municipality. There were no reported incidents of rain-induced landslide and earthquake. These hazards are rare events with a score of 2 (Table 33). The Municipal Disaster Risk Reduction Management Office listed hazards that may affect each barangay in the municipality (Table 34). The flooding listed therein is of low susceptibility level.

Table 33. Likelihood of Occurrence of Hazards per Barangay

Barangay	Flood	Rain-Induced Landslide	Earthquake-induced Landslide
Bagumbayan	2	1	1
Dalig	2		
Dulumbayan	2	1	1
May-iba	2		
Poblacion	2	1	1
Prinza	2		
San Gabriel	2		
San Roque	2	1	1
Calumpang/Sto. Cristo	2		

Source: Municipal Disaster Risk Reduction Management Office (MDRRMO) and Barangay interview

Legend:

Measure of Likelihood	Score	Return Period in Years
Frequent or Very likely	6	Every 1 - 3 years
Moderate or Likely	5	Every 3 - 10 years
Occasional, Light chance	4	Every 10 - 30 years
Unlikely, improbable	3	Every 30 - 100 years
Highly unlikely, Rare event	2	Every 100 - 200 years
Very rare event	1	Every 200 - 300 years

Table 34. Checklist of Hazards per Barangay

Barangay	Hydro-Meteorological				Geologic			Climate
	Flood	Land slide	Typhoon	Soil Erosion	Earth quake	Liquefaction	Tsunami	Drought
Bagumbayan	/	/	/		/			/
Calumpang/ Sto.Cristo	/		/		/			/
Dalig	/		/		/			/
Dulumbayan	/	/	/		/			/
May-iba	/		/		/			/
Poblacion	/	/	/		/			/
Prinza	/		/		/			/
San Gabriel	/		/		/			/
San Roque	/	/	/		/			/

Source: MDRRMO

3. PAG-ASA Climate Projection

PAGASA has projected increase in temperature and decreasing rainfall using the baseline 1971-2000 and 2006-2035 (Table 35-A).Teresa, like all other parts of the Philippines will experience this change in climate. This status is under the medium-range emission scenario in the provinces in Region IV-A. The temperature increase ranges from 0.9-1.1 °C. The rainfall decreases from -13.1 to -30.1 percent during

northeast monsoon season (DJF), summer season (MAM) and transition season.

Table 35-A.PAGASA Climate Projection

Climate Variables	Climate Scenario							
	Observed Baseline (1971-2000)				Change in 2020 (2006-2035)			
	DJF	MAM	JJA	SON	DJF	MAM	JJA	SON
Temperature	25.4	27.9	27.6	26.8	0.9	1.1	0.9	1.0
Rainfall	262.4	241.5	1001.3	821.8	-13.1	-30.1	12.4	-0.9

Source: http://kidlat.pag-asa.dost.gov.ph/cab/climate_change/ClimateProjections.html#r4A

There are great changes in the number of days with greater than 35 °C, number of dry days and number of days with rainfall greater than 200mm (Table 35-B). The number of days with greater than 35 °C increases almost 300%, from 575 to 1720 days. The number of dry days decreases from 6893 down to 4520 days (-66% change). The number of days with rainfall greater than 200mm became longer from 23 to 54 days.

Table 35-B.PAGASA Climate Projection

No. of days w/ Tmax >35 °C		No. of Dry days		No. of Days w/ Rainfall > 200mm	
Observed Baseline (1971-2000)	2020	Observed Baseline (1971-2000)	2020	Observed Baseline (1971-2000)	2020
575	1720	6893	4520	23	54

Source: http://kidlat.pag-asa.dost.gov.ph/cab/climate_change/ClimateProjections.html#r4A

4. Vulnerability Analysis

Vulnerable population are those living in danger areas such as near waterways and, landslide prone areas. These vulnerable groups include Informal settlers, poor families and other groups such as children 0-9 years old, persons with disabilities and senior citizens 60 years old and above.

The flooding experienced by the municipality is a rare event. When a rare event happens, it is expected that it has great impacts as felt during the Ondoy experience.

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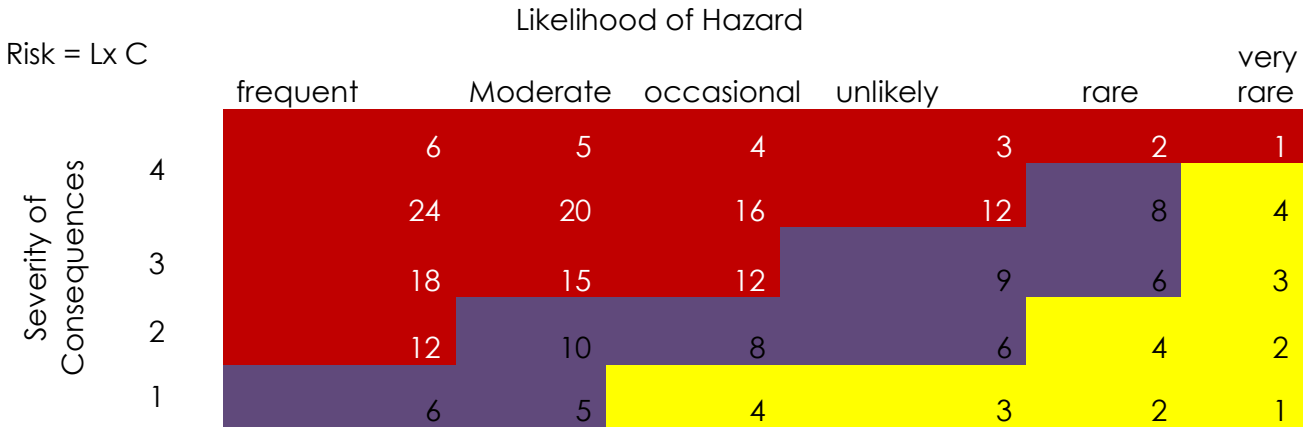
5. Risk Estimation

The municipality is generally low in hazard risks highlighted by the yellow color (Table 36).Yellow means low risk (occasional events with very weak consequences or very rare events but with very high severity impacts. It is therefore very important to prepare for these rare events to mitigate the effects they will have on the municipality.

Table 36. Hazard Risk Score Table

Hazard	Areas Affected	Likelihood Score	Consequence Severity Score			Risk Score		
			Human	Property	Opera -tional	Human	Property	Opera-tional
Flood	Bagumbayan	2	1	1	1	2	2	2
	Calumpang/ Sto.Cristo	2	1	1	1	2	2	2
	Dalig	2	1	1	1	2	2	2
	Dulumbayan	2	1	1	1	2	2	2
	May-iba	2	1	1	1	2	2	2
	Poblacion	2	1	1	1	2	2	2
	Prinza	2	1	1	1	2	2	2
	San Gabriel	2	1	1	1	2	2	2
	San Roque	2	2	2	2	4	4	4
Landslide	Bagumbayan	1	4	4	1	4	4	1
	Dulumbayan	1	2	2	1	2	2	1
	Poblacion	1	4	4	1	4	4	1
	San Roque	1	2	2	1	2	2	1

Source: MDRRMO
Legend:



The red color suggests a high risk: frequent events creating most severe impact/s
should be addressed immediately

Purple color suggests frequent events w/ moderate consequences or are severe but unlikely or rare to happen
Yellow color considered as low risk (occasional events w/ very weak consequences or very rare events
But w/ very high
severity impacts.)

Development Needs, Key Issues and Concerns

Although the municipality has generally low susceptibility to flooding, landslide and other hazards, Teresa needs to be disaster prepared and disaster resilient. It has to resolve issues and concerns identified pertaining to disaster risk management (Table 37). This include the need to install early warning devices, create database for affected population, structures and agricultural crops, prepare hazard maps and profiling of vulnerable areas, create public awareness about hazards, vulnerabilities and risks, their nature, and effects to the communities. Investment that will be spent on rehabilitation could have been used in other socioeconomic activities if the municipality is disaster ready and can bounce again in the shortest possible time.

Table 37.Disaster Risk Assessment Issues and Needs Matrix

Technical Findings/Issues/Concerns	Implication if not solved	Adaptation Measure		
		Structural	Non-Structural	Non-Structural
Early warning system are inadequate such as sirens, alarms, bells, flood markers and others in all hazard prone areas like flashflood and landslide in the nine (9) Barangays	Increase casualties	Installation of all EWS devices to all hazard prone areas	Utilization of the local disaster risk reduction and management fund (LDRRMF) to support the implementation and adoption of EWS in all barangays	Flood and storm forecasting
Lack of database on critical buildings and infrastructures that may be of hazard to life and properties to any man-made and natural disasters situation.	Pose danger to life and damage to properties.	Reinforcement and development of all critical buildings and infra to lessen the impact to life and properties.	Strict implementation of the Building Code	
There is partial development and/or updating of locally-driven hazard maps to include profiling of vulnerable communities	Residents living in hazardous area will most likely vulnerable to any man-made or natural disasters		Implement a detailed identification of all hazards (flashflood and landslide) to the communities by	Inclusion of all locally-driven hazard maps to the Comprehensive Land Use Plan (CLUP) of the

			way of creating new locally-driven maps which is readily available to the most vulnerable areas.	municipality and for future updating and profiling based on the project proposal introduced by Geohazards Mapping and Assessment Team of the Mines and Geosciences Bureau (MGB) Region IV-A
Lack of information dissemination and raise public awareness about hazards, vulnerabilities and risks, their nature, effects to the communities	Limited information to all form of hazards will increase the number of casualties and damage to properties			Conduct municipal-wide information and education on all types of hazard in the nine (9) barangays Adoption of an ordinance requiring all institutions, both public and private to conduct emergency drills in their repective jurisdication.

Source: MDRRMO

Additional mitigating measures could be regular monitoring and rehabilitation of the waterways through the Teresa River Council, posting of barangays hazard maps for available information and reference and submission of emergency operation plan for those in flood and landslide prone areas.

Other Planning Options and Measures (Table 38) that can be used are the following to ensure maximum tolerance on disaster risk.

Table 38. Other Planning Options

Land Use Planning Options	Description	Specific Hazard Applicability	Specific Structural Non-structural Land Use Measurement
Density Control	Applying occupancy and density ceiling for allowed land uses	Floor	Unit Families along or nearby those waterways located at the lower part of Teresa like in Barangays Dalig, San Roque and Bagumbayan where property damage is higher during typhoon Ondoy
		Landslide	Limit residents at landslide prone areas located at Sitio Corocan of Bagumbayan, at Pulanglupa near monark quarry site and near "imbutido" of Barangay Poblacion
Subdivision Development Control	Regulating subdivision to avoid irregularities on wastes management and in waterways or canals	Flood	Require subdivisions to submit or rehabilitate drainage system

Climate Change

Most of the extreme weather events observed today was due to the trending climate change issue. To resolve its hazard effects, being ecologically friendly or conversion to eco-towns have seen the benefit of surviving or even preventing climate change as reported in other countries. Minimizing carbon gasses emission while enhancing their capacity to maintain their supply on food, water and energy is the strategy being implemented.

Teresa needs long term planning on maintaining and improving the environment that will help in retaining or even improve its stability. As of today, Teresa is known for its excellence in managing solid waste and in preserving some of its agricultural lands and/or grasslands. Continuous promotion and conducting environmentally friendly programs are necessary investments to fight climate change. The municipality has the advantage since it has already the foundation in caring for the environment. It can make use of emerging trends such as green architecture and the like.

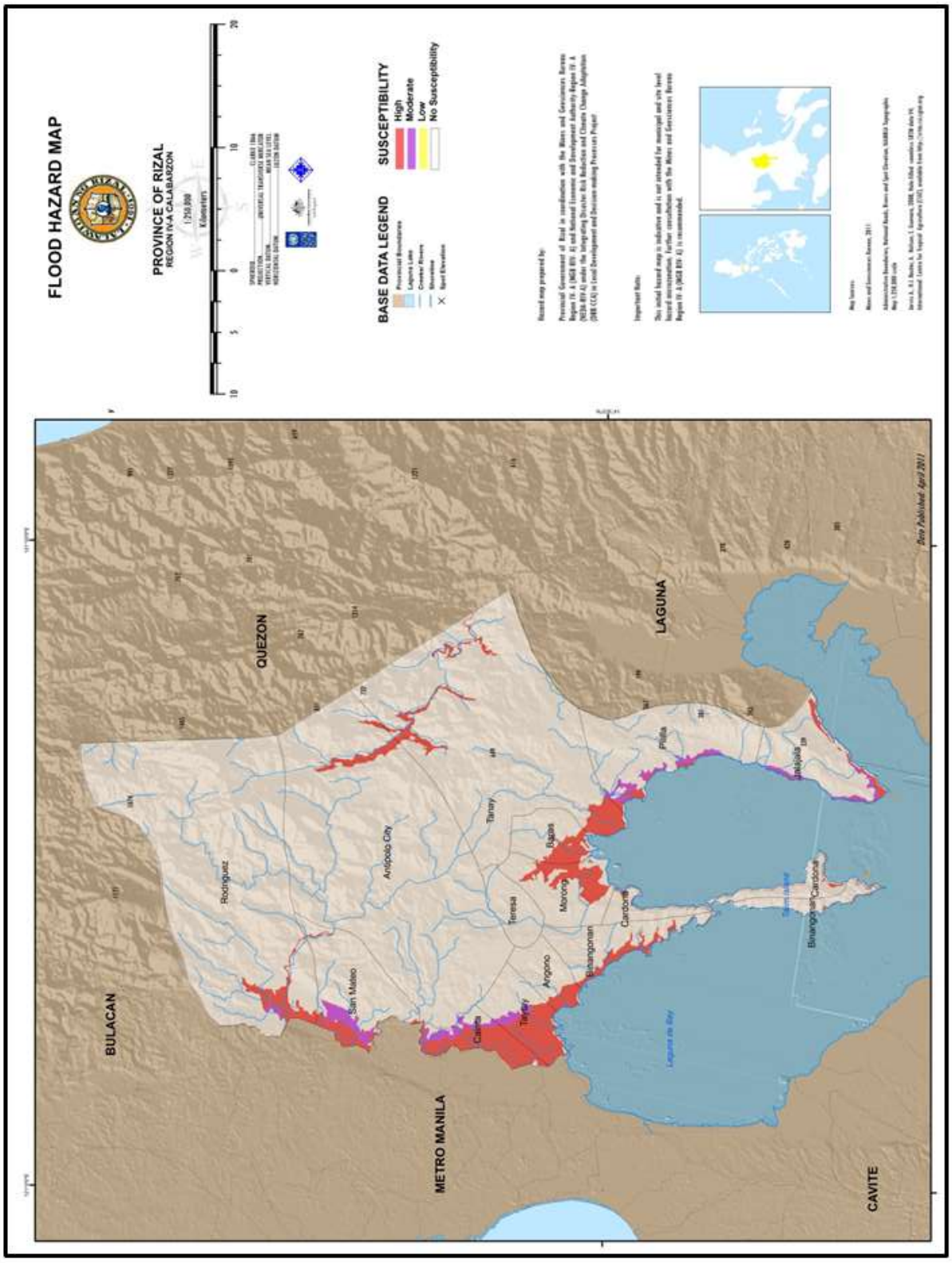


Figure 14. Flood Hazard Map, Rizal

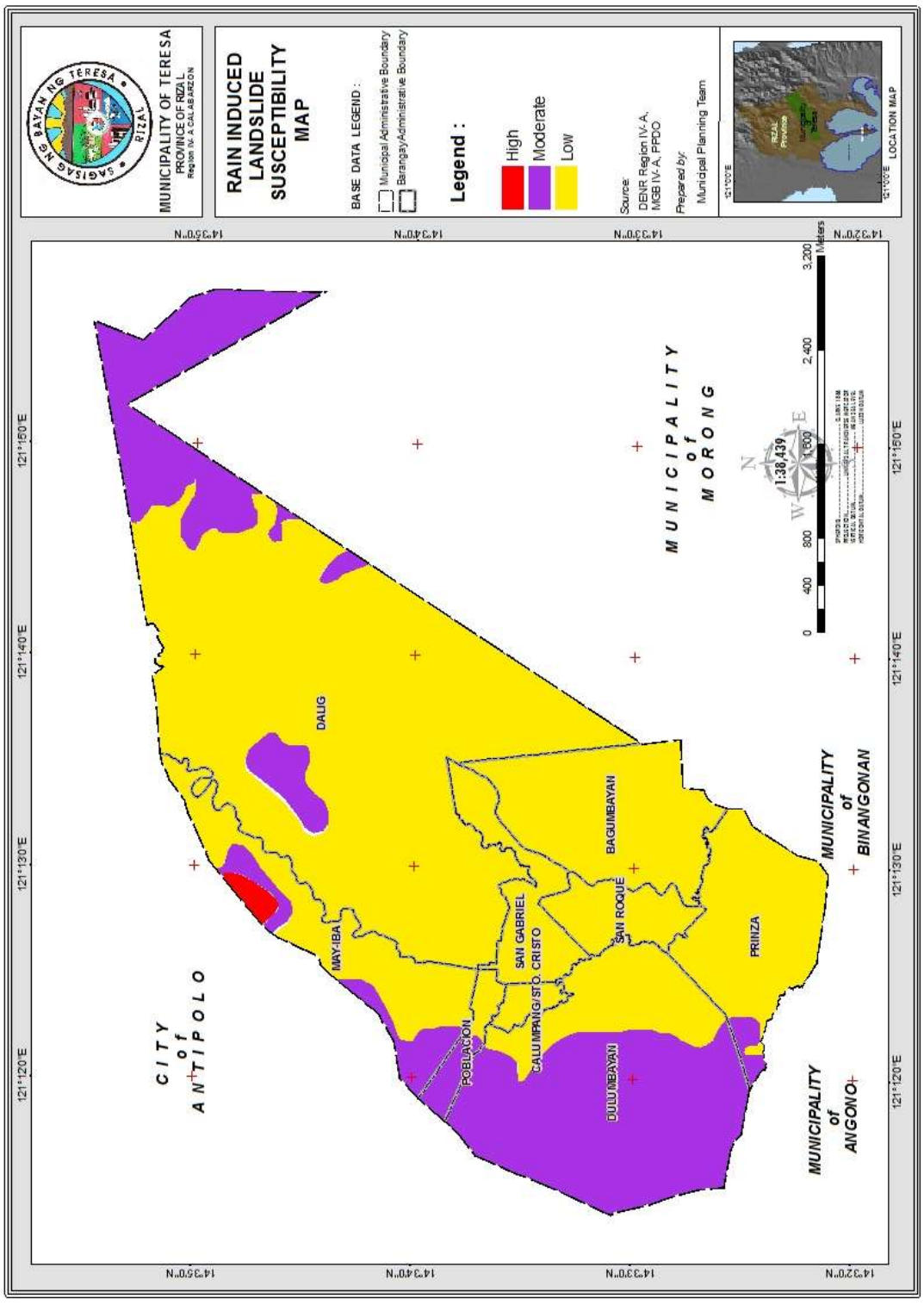


Figure15. Rain Induced Landslide Susceptibility Map of Teresa

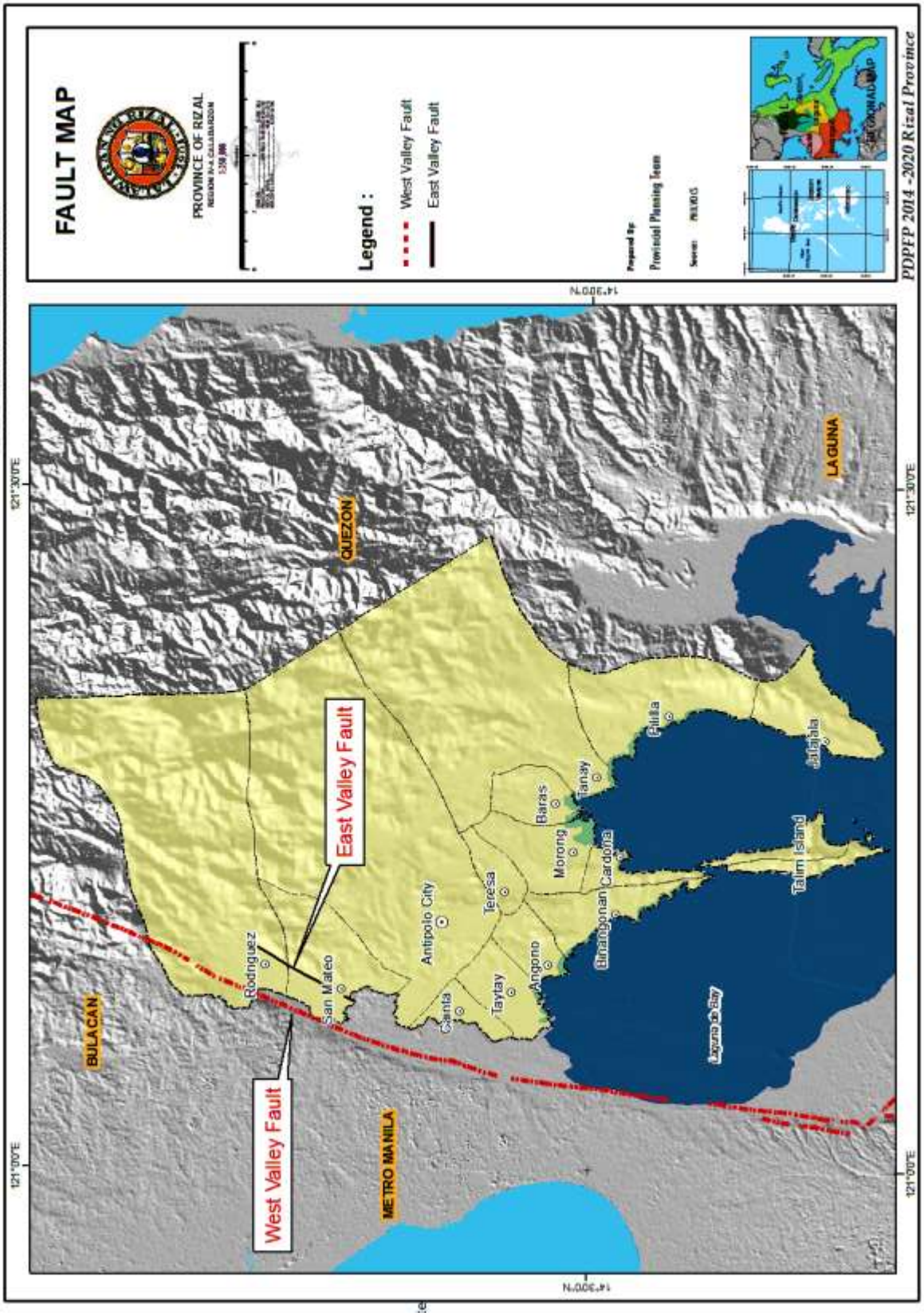


Figure 16. Fault LineMap, Rizal Province