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Department of Environment and Natural Resources
MIMAROPA Region
Provincial **E**nvironment and **N**atural **R**esources **O**ffice
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October 23, 2019

MEMORANDUM

FOR	:	The Regional Executive Director MIMAROPA Region
THRU	:	The Assistant Regional Director for Technical Services MIMAROPA Region
FROM	:	The OIC, PENRO Oriental Mindoro
SUBJECT	:	**SUBMISSION OF THE FINAL REPORT ON THE VULNERABILITY ASSESSMENT OF MAG ASAWANG TUBIG WATERSHED**

Submitted is the final report on Vulnerability Assessment of Mag-asawang Tubig River Watershed.

The results and recommendations of this study will serve as an important basis in the formulation of projects, programs, policies, and plans that would help in the mitigation of impact of climate change.

For information, record and reference.

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Republic of the Philippines
Department of Environment and Natural Resources
MIMAROPA Region
Community Environment and Natural Resources Office

October 14, 2019

MEMORANDUM

FOR	:	The Regional Executive Director
THRU	:	The OIC – PENRO
FROM	:	The OIC – CENRO
SUBJECT	:	**SUBMISSION OF FINAL REPORT ON VULNERABILITY ASSESSMENT (VA) OF MAG-ASAWANG TUBIG WATERSHED WITHIN THE AOR OF CENRO SOCORRO, ORIENTAL MINDORO**

We are submitting the final report on Vulnerability Assessment (VA) of Mag-asawang Tubog Watershed (MTW) which is the product of tedious study and research conducted by the personnel of this Office. The information and data used in the crafting of this report were gathered/collected from other government agencies, both local and national, and other entities based on their personal account/knowledge about MTW.

The formulated recommendations will serve as basis of the formulation of programs/projects in the future to mitigate the impact of climate change.

For information, review and further action, if any.

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MAG-ASAWANG TUBIG WATERSHED

Vulnerability Assessment

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EXECUTIVE SUMMARY

Watershed plays a vital role in our ecosystems. It is a complex habitat and home to different biological resources producing different goods and services beneficial to human. Watershed is an area drained by several tributaries. This is important in the water cycle because trees found inside the watershed stored water in its living parts, thus increasing the water store which drain downward to the water bodies such as rivers and lakes. Relative to this, importance of forest particularly the watershed and the trees had been recognized. Several flashfloods and landslide that occurred in most part of our country put an alarming state on the conditions of our watersheds. Thus, the effect of loss of forest cover are now prone to vulnerabilities caused by natural hazards affected by the climate change.

Based on the concept of Adger, (2006) vulnerability is the state of susceptibility to harm from exposure to stresses associated with environmental and social change and from the absence of capacity to adopt. Further it is believe that vulnerability assessment is a powerful and useful tool to determine the environmental harm brought by natural hazards such as floods, earthquake and landslide. Many believe that human beings will be vulnerable to climate change particularly the third world countries like the Philippines. Mag-asawang Tubig watershed found in the province of Oriental which is hit by many disasters such as typhoon and flooding.

Mag-Asawang Tubig watershed located at 121^{0}13'33.9''' East longitude 13^{0}07'21.2'' North latitude. This whole watershed is approximately about 43,534.24 hectares stretching towards Sablayan, Occidental Mindoro to Victoria and Naujan, Oriental Mindoro. The biggest portion is being part of Sablayan, Occidental Mindoro with 31,625.24 hectares. However in terms of barangays occupying the Mag-asawang Tubig watershed, Naujan has 22, Victoria has 3 and Sablayan has 2 barangays. Territorial jurisdiction of Mag-asawang Tubig Watershed area is jointly shared by CENRO Socorro, Oriental Mindoro and CENRO Sablayan, Occidental Mindoro.

From the result of the characterization of the Mag-asawang Tubig watershed it has been assessed that the most hazardous events commonly occurring in the downstream communities of Mag-asawang Tubig is the flooding. Based on the gathered information from the Office of the Oriental Mindoro PDRRMO which recorded the flooding incidents from 2005 to 2018 damages to agriculture and infrastructure amounted to billions of pesos.

Flooding is a type of phenomena that is popular and one of the dominantly natural calamities many countries in the world seriously attended with outmost perseverance and dedication. In tropical countries like the Philippines, floods are commonly caused by heavy rainfall where the magnitude may bring flash floods. In other parts of the world the threshold level is 100mm per day but in the Philippines particularly in Oriental Mindoro it is higher compared to the world record. There are three critical factors identified as the causes of the flooding in the vicinities of the downstream communities of Mag-asawang Tubig watershed. These are physiography, rainfall and river and channel aggradation.

Displacement, anxiety, trauma and stress are the most common effect of the disasters in the area affected by calamities particularly flooding. In the vicinities of Mag-asawang Tubig watershed floods affected the residences of the stakeholders especially when the river overflows in the lower valley portion. Damages to properties and agricultural crops were also experienced by the residents in the flood prone areas of this watershed.

According to the residents in the area, flood occurrence is a natural phenomenon that they experienced for many years. They have no other choice but to be always ready and alert when the typhoon and rainy season of the year came. Communities in the vicinities of Mag-asawang Tubig from the Municipalities of Naujan and Victoria, Oriental Mindoro employed various strategies to cope and adapt themselves to flooding.

In order to lessen the impact of flooding, the following are the summarized recommendations towards the capacitation of the stakeholders inside the watershed:

1. Planting of trees in the open and denuded area to prevent flooding.
2. Construction of dike to prevent overflowing of river.
3. Protection of riverbank through the construction of gabion and planting of bamboos along the riverbank.
4. Construction of the foot bridge to allow the people to cross the river even there is flood.
5. Dredging of the riverbeds to remove the bed loads of sediments hampering the flow of water.

VULNERABILITY ASSESSMENT OF MAG-ASAWANG TUBIG WATERSHED

I. Introduction

Watershed is a common property hence management is conflicting sometimes because of the different users involved (Kerr, 2007). Among the identified effects of watershed destruction are deforestation, forest fire, loss of biodiversity, soil erosion, flooding in the lowland areas and poor supply of water and worst, the climate change. In addition to these, factors that also contributed to further destruction of our watershed are lack of awareness and information on the part of the people or the communities living outside and inside the watershed area.

Watershed plays a vital role in our ecosystem. It is a complex habitat and home to different biological resources producing different goods and services beneficial to human. Watershed is an area drained by several tributaries. This is important in the water cycle because trees found inside the watershed stored water in its living parts, thus increasing the water store which drain downward to the water bodies such as rivers and lakes. Relative to this, importance of forest particularly the watershed and the trees had been recognized. Several flashfloods and landslide that occurred in most part of our country put an alarming state on the conditions of our watersheds. Thus, the effect of loss of forest cover are now prone to vulnerabilities caused by natural hazards affected by the climate change.

Today our world climate changes significantly affected human lives due to the neglect to our environment. This climate change has become one of the vital issues everyone must be aware of as we are experiencing today different weather variability such as extreme hot and cold environment. On this event the poor and developing countries are the most affected and vulnerable because they are heavily dependent on forestry and agriculture for the production of goods and services.

Our country as one of the most visited by natural hazards such as tropical cyclone, flooding, changes in temperature and sea level rise. According to DOST-PAGASA the observed temperature in our country is warming at average rate of 0.1^0Celsius per decade. From their analyzed projections of the country's temperature suggested that we will experience warming in the future. While for the rainfall it was observed also of this climate agency an upward rends. Though there is a slight decrease in the number of tropical cyclones passing the Philippine Area of Responsibility intensity remain to be dominant for the country's future climate conditions. On the aspect of sea level rise from the data analyzed for the period 1993 to 2015 it has been noted as risen by nearly double of the global average in other parts of the country. Such scenario increases the vulnerability of many parts of our country from natural hazards, watershed is included.

Based on the concept of Adger, (2006) vulnerability is the state of susceptibility to harm from exposure to stresses associated with environmental and social change and from the absence of capacity to adopt. Further it is believed that vulnerability assessment is a powerful and useful tool to determine the environmental harm brought by natural hazards such as floods, earthquake and landslide. Many believe that human will be vulnerable to climate change particularly the third world countries like the Philippines. The province of Oriental having visited by many disasters such as typhoon and flooding is also prone to vulnerability to natural hazards.

According to Soares et. al. 2012 the "*concept of vulnerability in climate change literature is underpinned by numerous theoretical contributions across different disciplines leading to disparate understandings of what climate change vulnerability entails, as well as different methodological frameworks for assessment*". This provide greater contributions not only in the aspect of vulnerability but as well as in the concept of elements comprising vulnerability assessment that also found critical in climate change analysis (Soares et. al. 2012).

Mag-asawang Tubig watershed straddle lies in the Municipalities of Victoria and Naujan of Oriental Mindoro and Sablayan, Occidental Mindoro, a known food basket in Southern Tagalog. However the human continues exploitation of the watershed area lead to it,s present state today. The combinations of both human and natural hazards destroyed the once pristine forest of Mag-asawang Tubig watershed.

Mag-asawang Tubig watershed which is now the subject of the assessment of vulnerability for this year by CENRO Socorro will be analyzed based on the features of this ecosystem and how the stakeholders coping mechanisms allow them to hurdle the hardship brought by disasters due to changing climate. This especially true to the downstream communities of Victoria and Naujan, Oriental Mindoro where the water coming from the upstream rivers of Aglubang and Ibolo affected them especially during the times of heavy downpour of rainfall.

The main purpose of this vulnerability study in Mag-asawang Tubig is to provide our policy makers with an effective information coming from the analysis of the data from scientific findings. This is important in determining the degree of and magnitude of the effect of the destruction to watershed brought by unrelenting anthropogenic activities. Hopefully this research study on the vulnerability of Magasawang Tubig watershed will be a good tool for the effective formulation of effective and realistic Integrated Watershed Management Plan.

II. Review of Literature

One of the greatest threats of the century to humanity is the climate change or the global warming. In global warming the planet's average surface temperature inceases. The culprit for this phenomenon is the higher emmissions of the carbon dioxide due mainly from the burning of fossil fuels accumulated in the atmosphere which in effect causing the climate change or global warming. (Kundu, 2016).

Based on the records average, earth temperature is now 0.740 ^{0}C (International Panel Climate Change (IPCC), 2007). Heavy atmospheric concentration of carbon dioxide on the earth surface is 385 parts per million comparing this record for the last 650,000 years resulted to the present dilemma, the climate change (Onoja et. al. 2011). Productions of artificially created absorbent such as the chlorofluorocarbons and halons put into delicate balance between the incoming solar radiation and outgoing heat radiations (Khan, 2012).

One of the contributory factors that affect our climate condition is due largely to the unrelenting anthropogenic activities. These are the continued logging and removal of forest cover that causes rapid deforestation (Stanturf, 2017).

It is well known that deforestation altered land-use and one of the major drivers of climate change (Canziani, and Benitez, 2012). In deforestation large trees are first destroyed then followed by the other plant community. In totality the whole forest was destroyed. The removal of forest cover resulted to the changes in vegetation distributions and structure that affected the whole biological diversity (Omprakash, 2014).

Conversion of land into other uses altered land cover of the natural forest particularly the watershed area (Tkahashi et. Al. 2017). These changes affected the hydroclimate condition of the whole ecosystem.

Upland migration is affected by the rapid population growth. Increase of the population increases the demand and supply of the natural resources which put the whole society vulnerable to the environmental changes. (Khan, 2012).

Human neglect of the environment further contributed to the continued destruction of our planet. Flooding, submerging of the coastal areas, loss of biological diversity, depletion of water availability due to soil erosion and reduction of agricultural production are but some of the many pervasive effects of the climate change. According to Perkins (2010), by 2050 our planet earth will be inhabited by around 9 billion people. With the reduction of food productions due to the climate change how can these people be fed.

Flooding is the result of intense rainfall resulting to the submerging of the lowland areas. Among the common effects of this phenomenon is the derailment of human movement and transportation of goods and services. In flooding, road is destroyed but there is also health impact on this. While on the part of people's property, destruction of livelihood and infrastructure also happened including the agricultural areas (Mohamed et. al. 2017). Flood are not only cause by natural hazard but also by human activities. Areas vulnerable to flood should have strong preparedness to counter the impact of disasters that may be brought to prevent destruction of lives and properties (Eguaroje 2015).

Loss of biological diversity is inimical in climate change given the high rates of species extinction, therefore it is critical to protect our natural resources particularly the watershed (O'Connor and Crowe, 2005).

Rawat et. al. 2017 indicates that the effect of soil erosion is not only reduction of harvest but also the sustainability of agricultural production. This effect threatened the livelihood of the community in the rural areas. Further, it was reported that the soil productivity on global scale on a yearly basis became economically unfeasible on a more or less 20 million hectares of world agricultural land (United Nation Agricultural Program, 1991). It is estimated that around 1 to 2% soil storage capacity had been lost of sedimentation of river due to soil erosion (Rawat et.al.2017).

Soil productivity will increase if the soil loss will be brought near or below the tolerance level of the soil (Singh, 2006). At this point over utilization of the land area should be prevented to be able to preserve the soil level of fertility vital to agricultural production.

Global average economic impacts of climate change are higher in the poor countries compared to developed countries (Tol, 2008). Large chunk of the greenhouse gases that accumulated in the atmosphere are contributed by the developed and industrialized countries but the suffering is being carried by the poor countries, the Phiippines is one in this group.

Vulnerable areas are situated in some coastlines and area near the river basins (Hung et. al. 2016). Watershed areas are identified as vulnerable to climate change thus needed to be carefully assessed. Support of this ecosystem to sustainable development as a matter of fact is well known. Policy formulation towards the development and protection of the river basins all throughout of the country must include the local level approach or the stakeholders directly affected.

Vulnerability as defined by Parry et. al. 2007 is *the degree to which a system is susceptible to, and unable to cope with adverse effects of climate change, including climate variability and extremes. Further, vulnerability is a* *function of character, magnitude and rate of climate change and variation to which a system is exposed, [and] the sensitivity and adaptive capacity of that system.* Watershed as a part of the forest ecosystem could be one of the biggest factors in mitigating this climate change. Let the components of this ecosystem be keep intact to contribute to the existence and survival of a balance ecological communities.

Previous researches conducted by different groups and agencies about the Philippine watersheds are still lacking to provide enough information on the impact of climate change on the economy of the country and to the livelihood and conditions of the communities inside this ecosystem. We hope that perhaps now that the integrated study of the river basins is supported by enough logistics to come up with a more detailed results vital to human existence.

Climate change or global warming is believed to continue for decades or even beyond, this would affect the Mag-asawang Tubig Watershed. In response to this scenario there must be management strategies such as the coping mechanisms and adaptive capacity of the communities living inside the watershed.

The study of Lemieux et. al. in 2012 enumerated the following as an adaptive management process as part of the risk management strategies to cope with the climate change (1) assess readiness and capacity to respond; (2) conduct vulnerability analyses to identify and prioritize adaptation needs; (3) develop adaptation strategies (4) monitor adaptation success and determine if vulnerabilities have been reduced/eliminated.

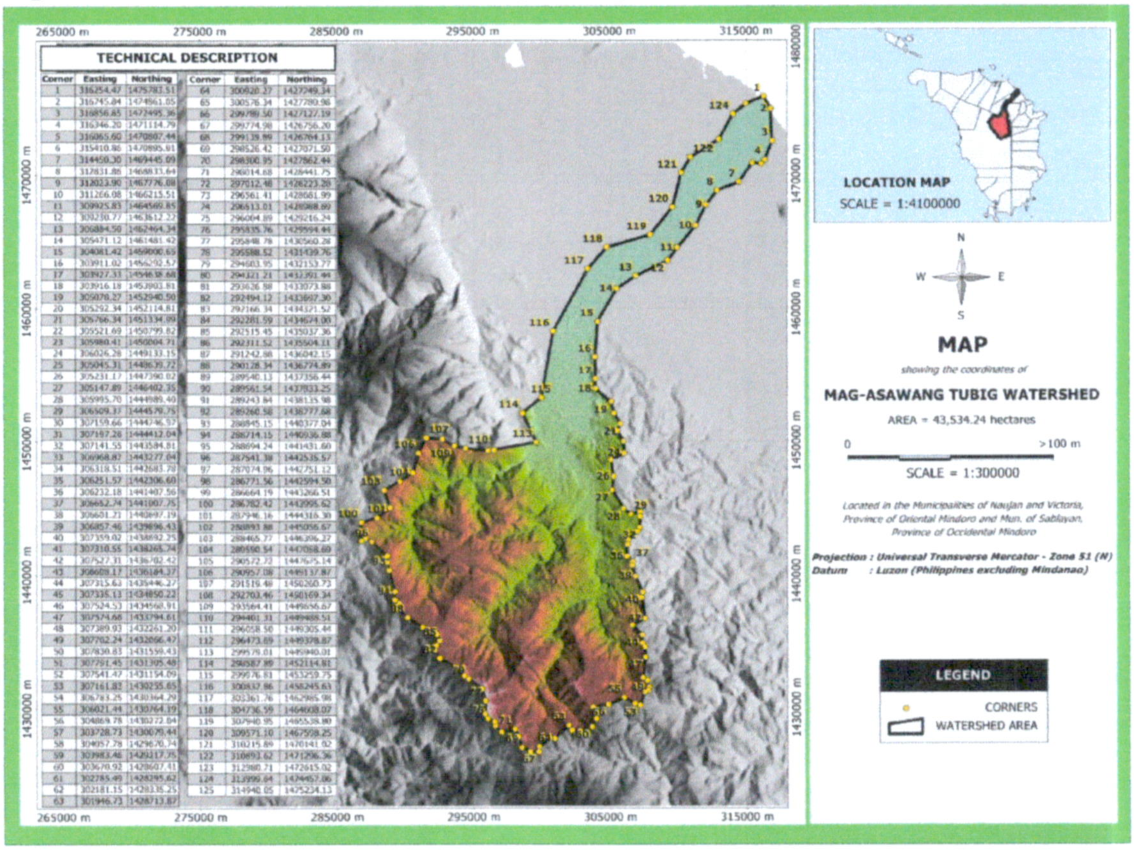
Vulnerabilities of communities inside the watershed area will be dependent on the different strategies as well as coping mechanisms and adaptation prepared. Still, it is important that the government give support by institutionalizing the adaptive capacity to address the adverse impact of climate change that vulnerability can be lessen in terms of worse effect to humanity and the society as a whole.

III. Description of the Watershed

A. Geographic Location

Mag-Asawang Tubig watershed located at 121⁰13'33.9"' East longitude 13⁰07'21.2"' North latitude (Figure 1).

Figure 1. Location of Mag-asawang Tubig Watershed

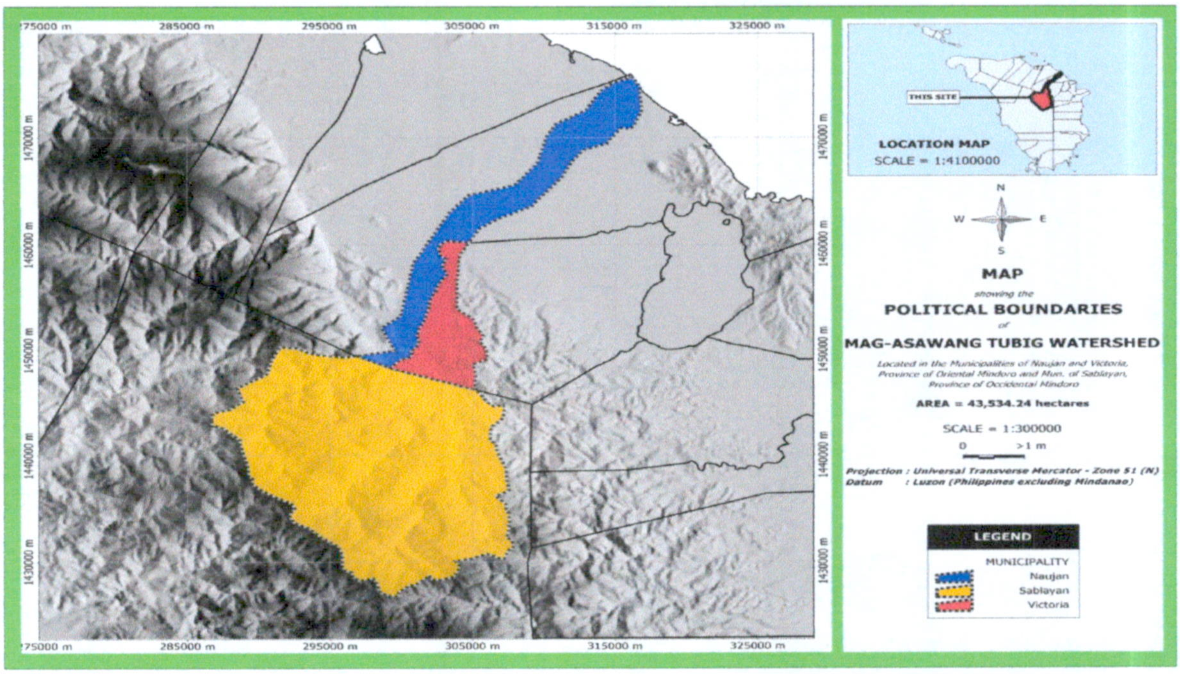


Source: NAMRIA, Digital Elevation Model (DEM) ASTER data

This whole watershed is approximately about 43,534.24 hectares stretching towards Sablayan, Occidental Mindoro to Victoria and Naujan, Oriental Mindoro (Figure 2). The biggest portion is being part of Sablayan, Occidental Mindoro with 31,625.24 hectares (Figure 3). However, in terms of barangays occupying the Mag-asawang Tubig watershed, Naujan has 22, Victoria has 3 and Sablayan has 2 barangays.

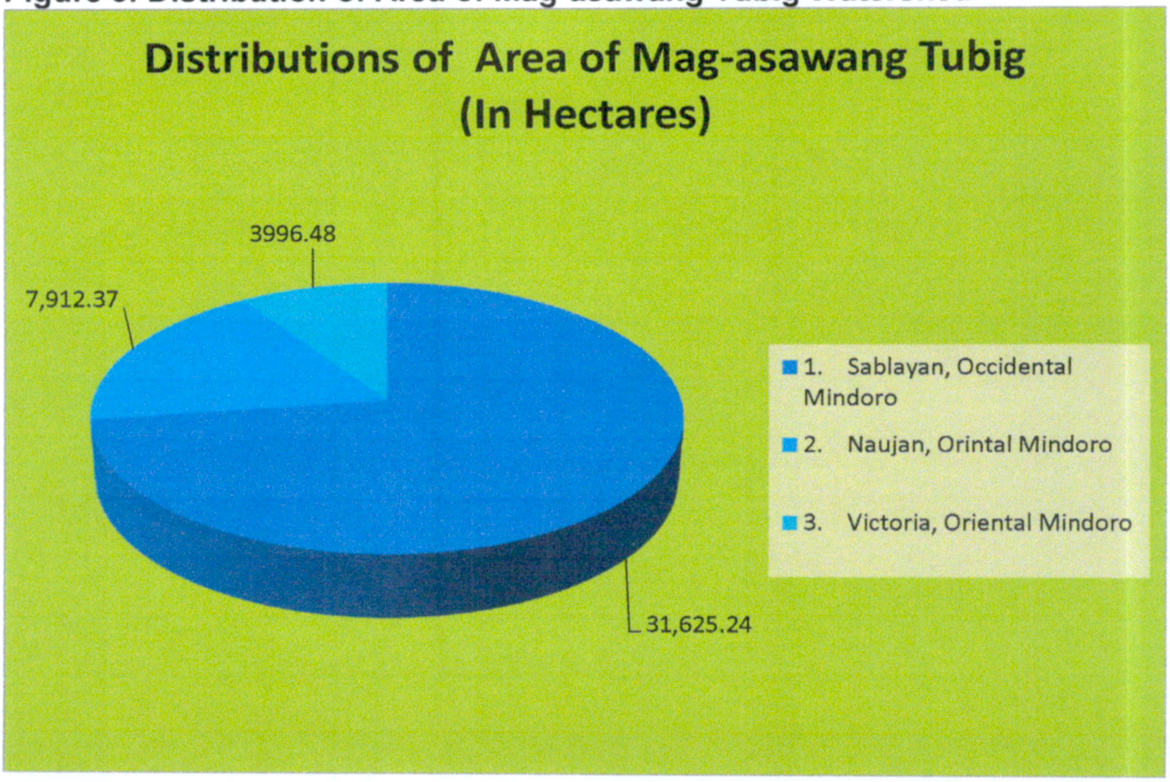
Territorial jurisdiction of Mag-asawang Tubig Watershed area is jointly shared by CENRO Socorro, Oriental Mindoro and CENRO Sablayan, Occidental Mindoro.

Figure 2. Map showing the political boundary of Mag-asawang Tubig Watershed



Source: NAMRIA, Digital Elevation Model (DEM) ASTER data

Figure 3. Distribution of Area of Mag-asawang Tubig Watershed



B. Topography/Geo-morphological Features

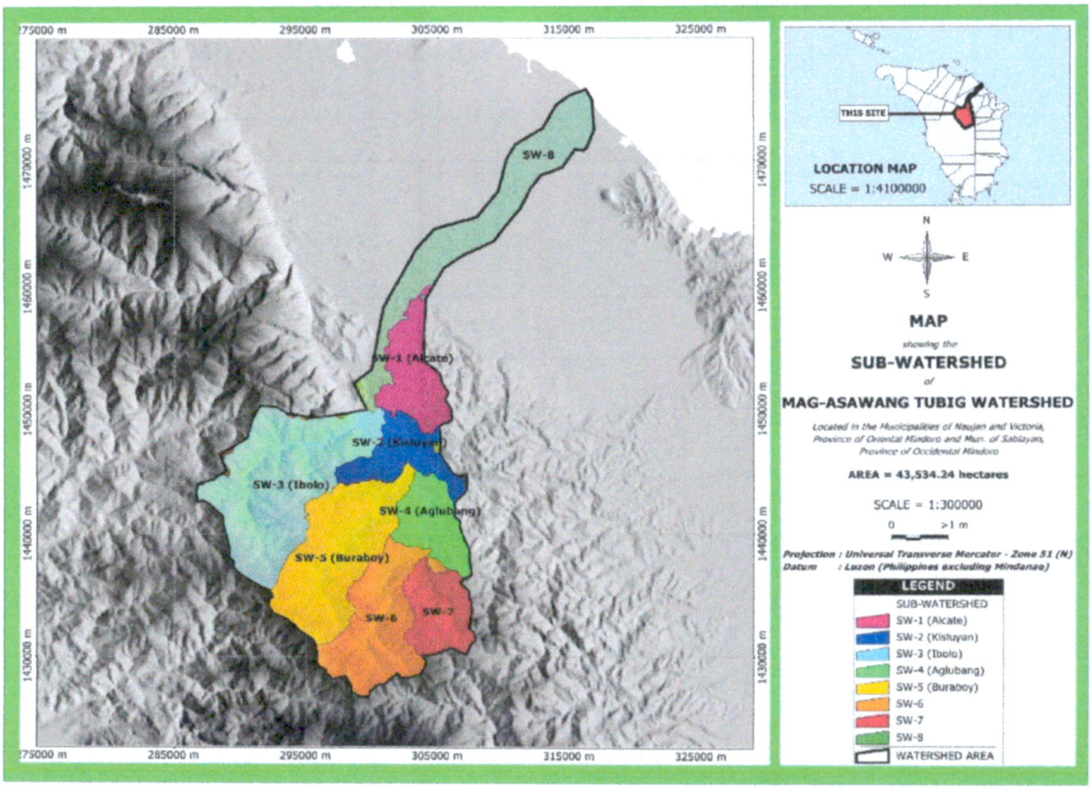
1. Watershed shape Parameters:

Shape parameters affect the hydrologic behavior of the watershed such as the run-off. A circular watershed has the tendency to have its run-off reached simultaneously at the outlet. While elliptical shape watershed with the same drainage area as the circular watershed will spread out it's run-off behavior.

a. Area

Located in the mountainous portion of Occidental and Oriental Mindoro Mag-asawang Tubig watershed area is subdivided into seven (7) Sub-watersheds (Figure 4). The biggest sub-watershed is SW No. 3 with an area of 10,213.83 hectares while the smallest one is SW No.5 (Table 3). These sub-watersheds are important for hydrological design because it reflects the volume of water generated from the rainfall. For run-off, it may be assumed that the volume of water available is the product of rainfall depth and drainage area.

Figure 4. Map showing the Sub-watershed area of Mag-asawang Tubig Watershed.



Source: NAMRIA, Digital Elevation Model (DEM) ASTER data

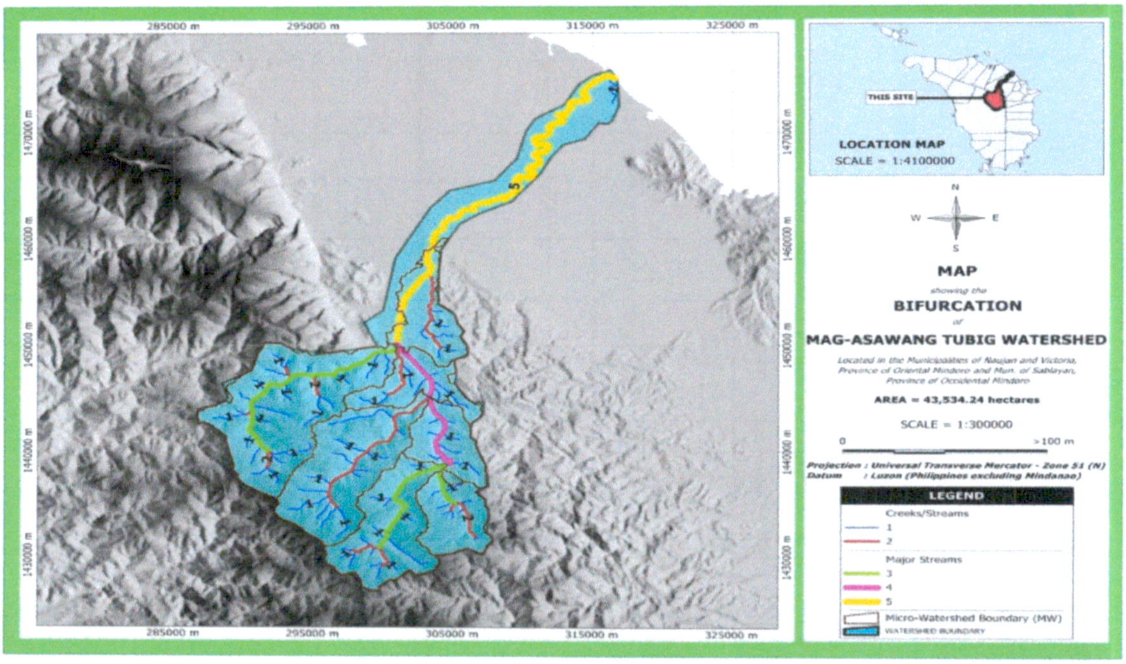
b. Gravelius form factor

Form Factor is the ratio of the basin area to the square of the basin length (Horton, 1932). According to Horton (1932) and Pareta and Pareta(2011) the value of form factor for a circular watershed should be always less than 0.754 . The smaller the value of a form factor, the watershed is said to be elongated. Computed form factor of Mag-Asawang Tubig is 0.04. This value indicated that Mag-asawang Tubig watershed has an elongated shape and has a low peak flows for a longer duration. Computed form factor of each sub-watershed is found in Table 3.

c. Bifurcation ratio

Schuman, 1956 defined bifurcation ratio as the ratio of the number of streams of given order to the number of streams of the next highest order. Horton (1945) says that bifurcation is an index of relief and dissertation. According to Pareta and Pareta (2011) normally bifurcation ratio ranges from 3 to 5. If the value computed is low, the water discharges are higher with sharp peaks however if the result of the computation of ratio is higher, the discharge is low but with broader peaks. A watershed with lower value of bifurcation ratio is characterized with less structural disturbances (Strahler, 1964) while no distortion on the drainage pattern. For this watershed average bifurcation ratio is 3.65. This computed value of bifurcation indicates that there are less structural disturbances in Mag-asawang Tubig watershed. Figure 5 shows the bifurcation map of the said watershed while Table 1 shows the number of streams and the computed value of Bifurcation of the watershed area.

Figure 5. Bifurcation Map of Mag-asawang Tubig Watershed



Source: NAMRIA, Digital Elevation Model (DEM) ASTER data

Table 1. No. of Streams and the computed value of Bifurcation of the watershed area.

Stream Order	No. Of Stream	Bifurcation ratio
1	79	6.58
2	12	4
3	3	3
4	1	1
5	1	

Note: Average Bifurcation ratio is 3.65

d. Elongation ratio

Elongation ratio is the ratio of the diameter of a circle (Dc) having the same area as the basin to the maximum basin length (Lbm) (Schumn,1956).

Table 2. Index of Elongation Ratio.

Range of Elongation Ratio	Remarks
0.90-1.00	Circular
0.80-0.90	Oval
0.70-0.80	Less Elongated
0.50-0.70	Elongated
Less Than 0.50	More Elongated

Source: (Pareta and Pareta, 2011)

Table 2 shows the index of elongation ratio. Elongation ratio is said to be circular if the computed value approaches 1, this circular watershed has its run-off from different parts of the basin reaching the outlet at the same time that will result to a more peak run-off and flood-peak as compared to elliptical or elongated watershed. Computed elongation ratio of Mag-asawang Tubig is 0.25 (Table 3). Comparing this result to the index above, it falls within the category of more elongated shape.

e. Circulatory ratio

The ratio of the watershed to the area having the same perimeter as the watershed is called as the circulatory ratio. According to Miller (1953) basin of the circulatory ratio ranges from 0.4 to 0.5 that indicates strongly elongated and highly permeable homogenous geologic materials (Pareta and Pareta, 2011). Several factors influenced the circulatory ratio such as the length and frequency of streams, geologic structure, land-use, land cover, climate and relief with slope of the basin (Parveen et. al. 2012) If the value computed is approaching 1, this indicated that the shape of the basin is circular, infiltration is uniform and the excess water will take longer time to reach the basin outlet. Computed value of circulatory ratio of Mag-asawang Tubig range from 0.24 to 0.58 does not corroborate Miller's study but less than the value of 1 which means that the shape of the basin is less circular (Table 3).

f. Basin length.

According to Schumn (1956) this is the straight line from the mouth of the basin to the farthest point of the basin perimeter. Measured basin length of Mag-Asawang Tubig Watershed is 101.22 kilometers (Table 3).

Table 3. Computed value of watershed parameters

SUB-WATERSHED	WATERSHED SHAPE PARAMETERS				
	Area (HAS.)	Form Factor	Elongation	Circulatory	Basin Length(m)
SW1(Alcate)	3,288.21	0.25	0.56	0.3	11,572.00
SW2(Kisluyan)	2,859.11	0.33	0.65	0.24	9,302.69
SW3(IBOLO)	10,213.83	0.08	0.07	0.46	16,960.46
SW4(AGLUBANG)	7,700.21	0.03	0.62	0.48	1,600.73
SW5(BURABOY)	2,834.57	0.11	0.65	0.54	9,274.73
SW6	5,925.57	0.08	0.66	0.35	13,199.83
SW7	3,072.18	0.12	0.74	0.58	8,514.42
SW8	7,578.48	0.08	0.50	0.40	30,791.50
TOTAL	35,893.68				101,216.36

2. Watershed Relief Features

a. Relief Ratio

Watershed relief has an important role in the drainage system development, surface and subsurface water flow, permeability, landform development and erosion property of the terrain. Relief ratio is the difference in elevation between the highest point of a watershed and the lowest point of the floor valley. Table 5 indicates the computed relief ratio of the watershed area. This shows that Sub-watershed 6 and 7 has the highest computed value in terms of relief ratio.

b. Relative Relief

This is the ratio between the highest elevation and the perimeter of the basin. Value of relative relief for Mag-asawang Tubig is found in Table 4.

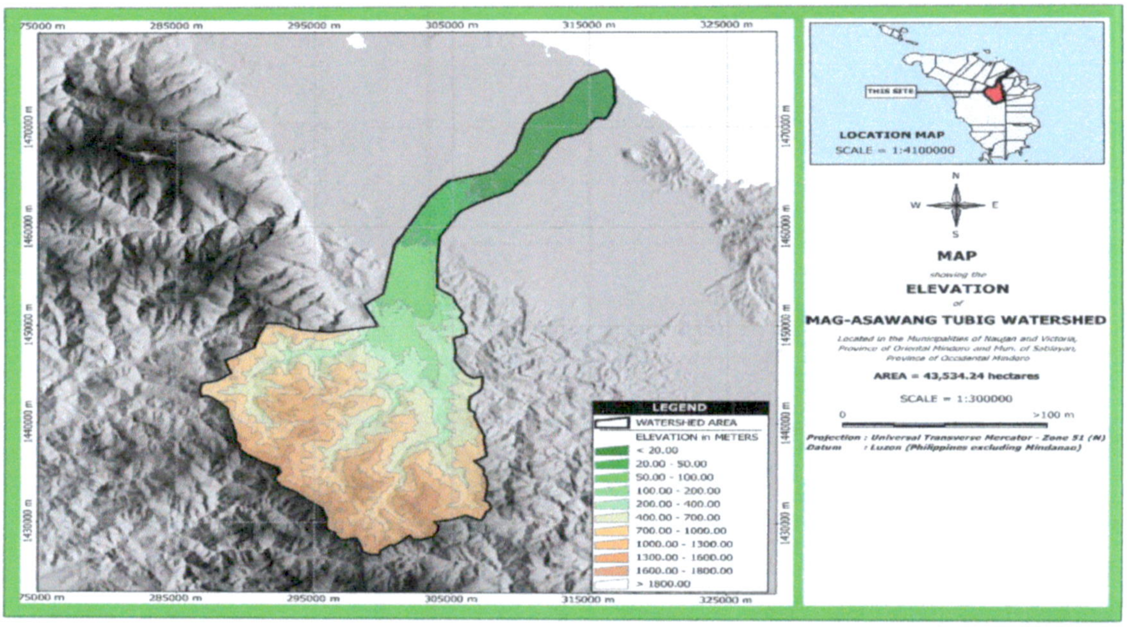
Table 4. Distribution of elevation, Relief Ratio and Relative relief of the watershed area.

SUB-WATERSHED	PERIMETER	RELIEF RATIO	RELATIVE RELIEF	ELEVATION		BASIN LENGHT
				MAXIMUM	MINIMUM	
SW1 (ALCATE)	36.87	0.04	468	498	30	11.57
SW2 (KISLUYAN)	38.36	0.05	906	1020	114	9.30
SW3 (IBOLO)	53.11	0.09	1542	1656	114	16.96
SW4 (AGLUBANG)	45.72	0.10	1668	1842	174	1.60
SW5 (BURABOY	25.7	0.09	828	981	153	9.27
SW6	46.41	0.12	1560	1862	302	13.19
SW7	26.63	0.16	1333	1659	326	8.51
SW8	69.64	0.10	258	258	0	30.79
TOTAL	341.44					101.22

c. Elevation

The highest elevation found in the area is within Sub-watershed No. 6 while the lowest with 30 meters above sea level is found in Sub-watershed No. 1 (Alcate area) (Figure 6). Table 4 shows the distributions of the elevation in seven sub-watersheds of Mag-asawang Tubig. Elevation is key in species survival as well as in development of growth thus needed in determining what species are going to be used as planting material. In a higher elevation, the temperature is lower but higher in terms of precipitation.

Figure 6. Elevation Map of Mag-asawang Tubig Watershed area

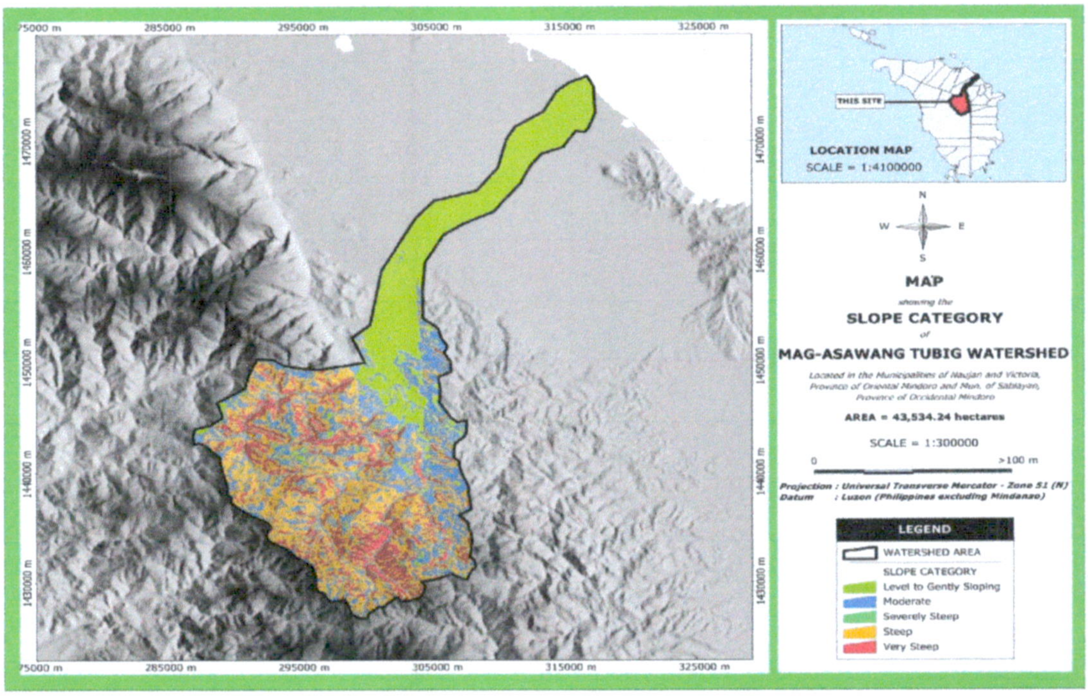


Source: NAMRIA, Digital Elevation Model (DEM) ASTER data

d. Slope

Slope plays vital role in infiltration in watershed area as against the water run-off. Infiltration is inversely related to run-off, the gentler the slope the higher is the infiltration and as the slope become steeper the less is the opportunity for a good infiltration and the more tendency for run-off (Parveen et. al. 2012). Five categories were used in the area to know the distribution of its slope, these are the following: 0-8 % (level to gentle slopes), (8-18%) gentle to moderate slopes, (18-30%) moderate to very steep slopes, (30-50%) very steep slopes and (above 50 %) severely steep. Figure 7 and Table 5 shows the distribution of slopes in the watershed area. Around 29,555.67 hectares had been classified in the area with below 30 percent slope.

Figure 7. Slope Map of Mag-asawang Tubig Watershed Area.



Source: NAMRIA, Digital Elevation Model (DEM) ASTER data

Table 5. Slope distribution in Mag-asawang Tubig Watershed area.

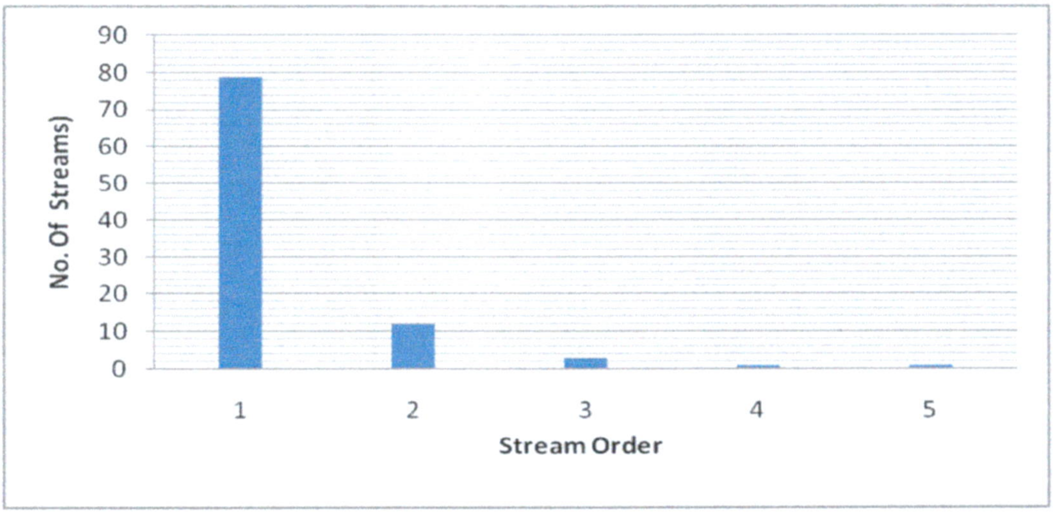
SUB- WATERSHED	0-8%	8-18%	18-30%	30-50%	above 50 %
MW-1(ALCATE)	2,219.31	765.56	232.39	18.08	None
MW-2(KISLUYAN)	1,311.50	1,026.48	372.64	95.75	None
MW-3(IBOLO)	1,049.30	2,810.23	4,419.09	1969.39	6.9
MW-4(AGLUBANG)	480.33	1,747.21	3,744.49	1715.3	10.07
MW-5(BURABOY)	480.58	1,329.95	824.27	195.1	None
MW-6	178.91	1,134.02	2,842.07	1760.23	15.15
MW-7	242.27	1,054.04	1,291.03	482.32	0.05
MW8	7,179.01	305.35	94.11	0	0
TOTAL	**13,141.21**	**9867.49**	**13820.909**	**6236.17**	**32.17**

3. **Channel Morphology**

a. Stream Order

The first step in the drainage basin analysis is the designation of the steam order. Horton (1945) first advocate this but Strahler (1952) scheme modified this ordering scheme. Following the set by Strahler (1952), Mag-asawang Tubig stream Ordering has been counted with five. It is noted that as the stream order increases the number of streams decreases (Figure 8).

Figure 8. Stream Order of Watershed Area



b. Stream Length

According to Strahler (1964) Horton's law of stream length support the theory that geometric similarity is preserved generally in watershed of increasing order. The length of the stream is from the drainage divide to the mouth of the river. Computed total stream length is 267.62 kilometers. Measured stream length of the watershed is shown in Table 6.

c. Mean Stream Length

Mean stream length is derived by dividing the total length of stream of an order by the segment in the order. Table 6 shows the computed mean stream length of this watershed is from 2.1 to 3.17. Sub-watersheds no. 6 has the low mean stream length while sub-watershed no. 6 has the longest with 3.17.

Table 6. Mean stream length of Mag-asawang Tubig Watershed

SUBWATERSHED	NO. OF STREAM	LENGTH OF STREAM (KM)	MEAN STREAM LENGTH
SW1 (ALCATE)	7	16.38	2.34
SW2 (KISLOYAN)	8	20.64	2.58
SW3 (IBOLO)	28	64.76	2.31
SW4 (AGLUBANG)	14	44.42	3.17
SW5 (BURABOY)	8	23. 84	2.98
SW6	17	35.69	2.10
SW7	12	16.69	1.39
SW8	2	45.20	3.00
TOTAL	96	267.20	19.87

4. **Drainage Texture of the watershed**

a. **Drainage density**

Drainage density is defined as the ratio between the total length of all the stream and area of watershed. This is the measurement of how the watershed is drained by stream channels. Factors that affect the drainage density are the climate and physical characteristics of the basin. Infiltration capacity of the soil and the rock type lies underneath affects the run-off in a drainage basin. Impermeable grounds put more surface water run-off that causes to have more streams in the watershed area. High drainage density in a river also has the indications of greater flood risks. Table 7 shows the index of the drainage density. Computed values of all drainage density of all sub-watersheds within Mag-asawang Tubig are less than 5 kilometers. This is indicating that there is lesser flood risk in the area.

Table 7. Index of Drainage Density Value

Range (km/square km)	Description
Less than 5	Low
5-13.7	Medium
13.7-155.3	High
7155.3	Very High

Source: ERDS-4B (2009).

b. **Stream density**.

Stream Density is the ratio of the number of streams and area of the watershed. This is also termed as stream frequency. This is correlated to drainage density, as such as the stream population increases drainage density also increases.

Permeability, infiltration capacity and relief of the watershed are important factors that affects the drainage density.

c. Length of the Overland flow

According to Horton (1932) the length of the overland flow is approximately equaling to half of the reciprocal of drainage density. It is the length of the river or ground surface before reaching the channels. This is an important variable in drainage basin development. Length of overland flow of the watershed is 0.89 kilometer. This means that there is a need for the surface water to travel 0.89 kilometer to get concentrated on the main channel.

Table 8 shows Computed value of drainage density, frequency and the length of the overland flow.

Table 8. Computed drainage texture of the watershed

SUB-WATERSHED	Drainage Density (Km/km^2)	Drainage Frequency (No/km^2)	Length of Overland Flow (Km)
SW 1(Alcate)	0.50	0.21	1.00
SW2(Kisluyan)	0.72	0.28	0.69
SW3(Ibolo)	0.63	0.27	0.79
SW4(Aglubang)	0.58	0.18	0.87
SW5(Buraboy)	0.84	0.28	0.59
SW6	0.60	0.29	0.83
SW7	0.54	0.39	0.92
SW8	0.55	0.30	0.80

Computed values of bifurcation and drainage density are both low for Mag-Asawang Tubig watershed area indicating that there are less structural disturbances within the said watershed.

C. Geology

1. Mineral Deposits

Mag-asawang Tubig lies within the area where mining exploration is very much active. Based on previous exploration by Mindex, the area is home to large deposits of Cobalt and Nickel, one of the largest in the Fareast.

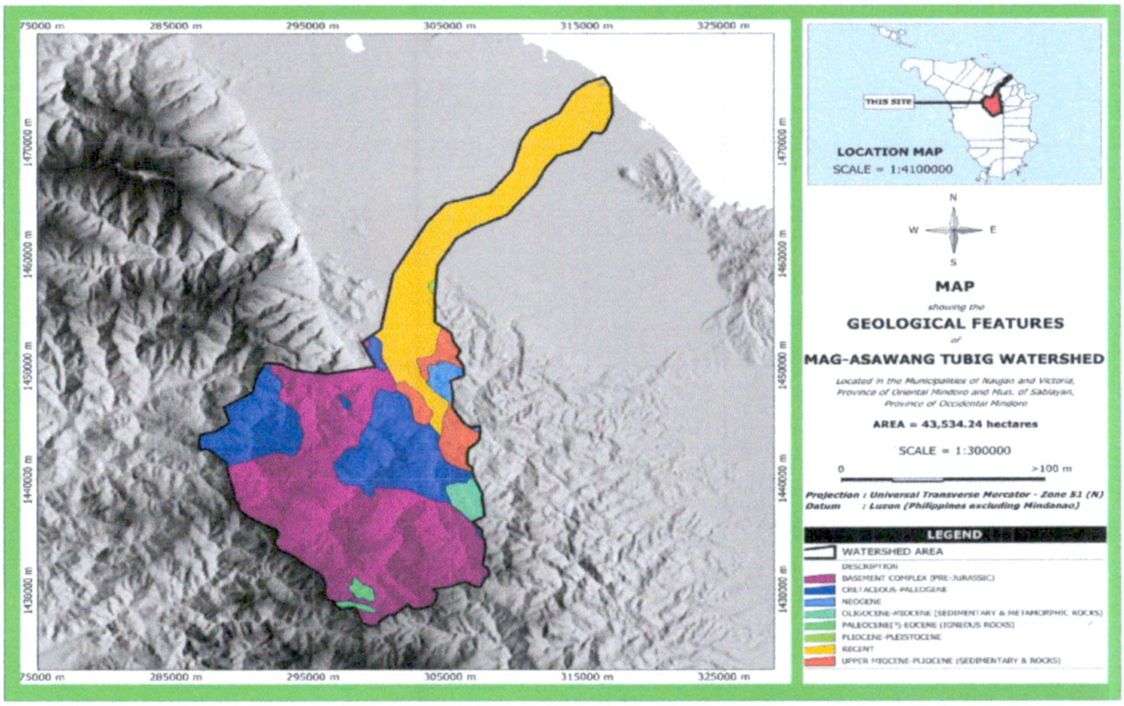
2. Geological Formation

There are seven soils and rock formation identified within Mag-asawang Tubig watershed area. These are Pre- Jurassic, Cretaceous-Paleocene, Neo-gen, Oligocene-Miocene (sedimentary and metamorphic rocks) Pliocene-Pleistocene, Recent and Miocene type of soil and rock formation (Figure 9). Majority of the area evolve from Pre-Jurassic to Jurassic era then rest from recent formation and Cretaceous-Paleogene era (Table 9).

Table 9. Geologic Formation in the Watershed Area

Period of Formation	Area (hectares)
1. Pre-Jurassic	20,645.18
2. Cretaceous-Paleocene	9,166.87
3. Neogene	617.92
4. Oligocene-Miocene (Sedimentary Formation	714.91
5. Paleocene- Eocene (Igneous)	374.95
6. Pliocene-Pleistocene	54.16
7. Recent	9,918.23

Figure 9. Geologic Map of Mag-asawang Tubig showing different rock formation



Source: NAMRIA, Digital Elevation Model (DEM) ASTER data

3. Lithology

Rocks deposits found in the area are alluvial deposits, Halcon metamorphosis and the ultramatic complex. Biggest part belongs to ultramatic complex which the nickel found embedded.

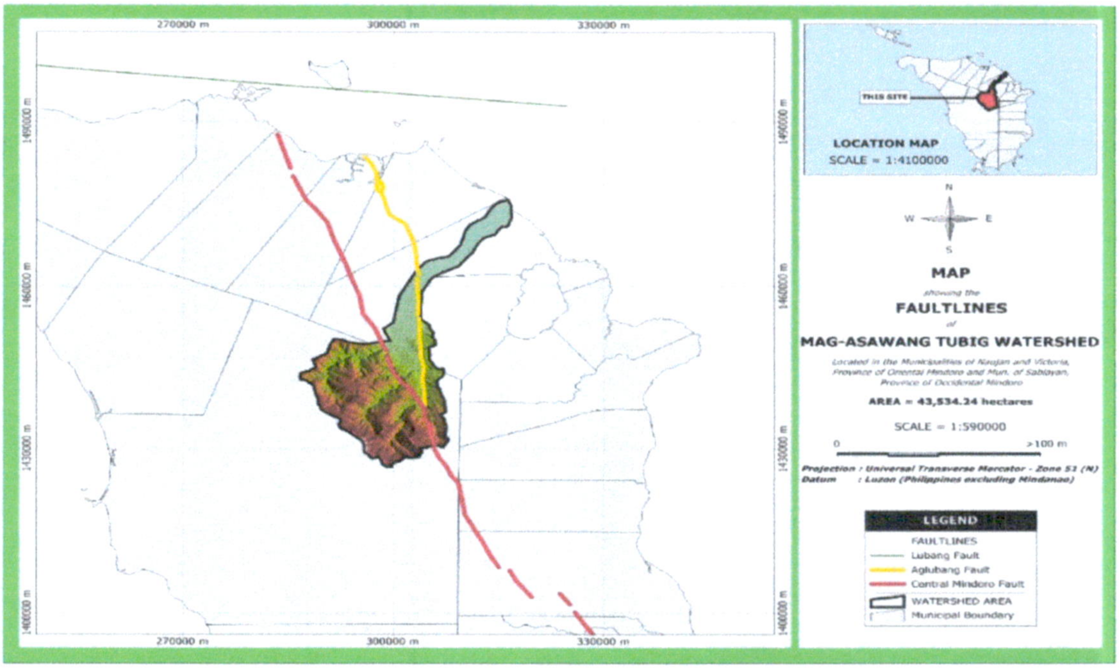
4. Composition

Four rocks deposits had been identified in Mag-asawang Tubig watershed area, these are silt-sand-gravel, green schist with mia schist, associated with Halcon Metamorphic and dunnite and pendolite associated with ultramatic complex.

5. Seismicity

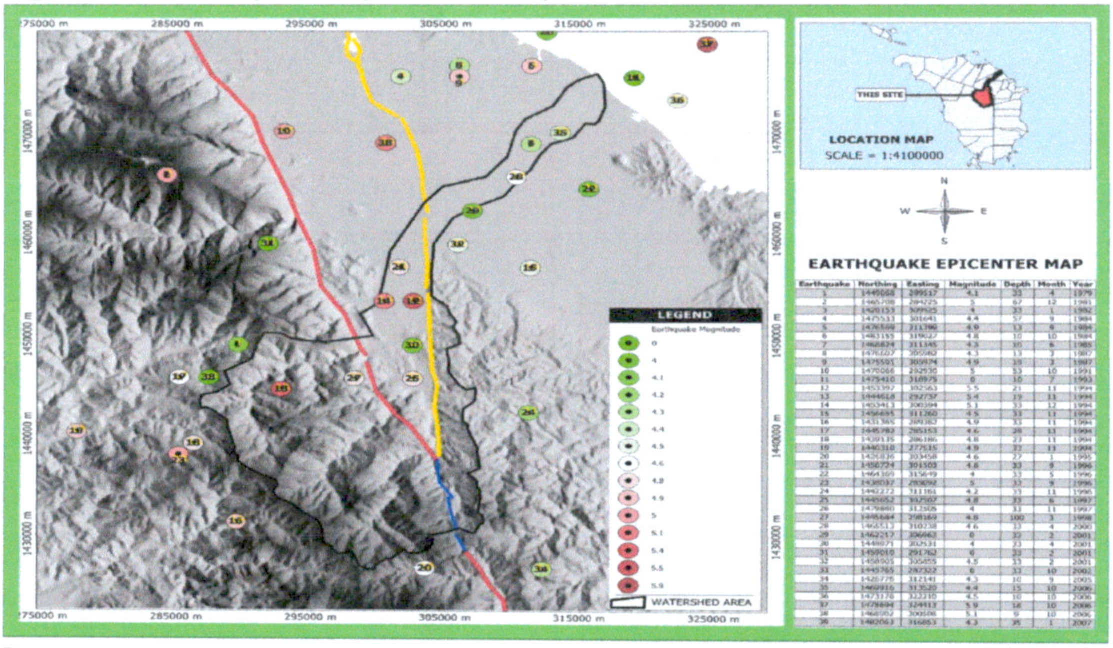
Figure 10 shows the two fault lines that pass through this watershed area. These are Lubang fault line, Aglubang faultline and Central Mindoro Faultline. Recorded three earthquakes in the area range from 5.4 and 5.9 intensity (Figure 11).

Figure 10. Map showing the fault lines inside the watershed area.



Source: NAMRIA, Digital Elevation Model (DEM) ASTER data

Figure 11. Earthquake epicenter map in the watershed area.

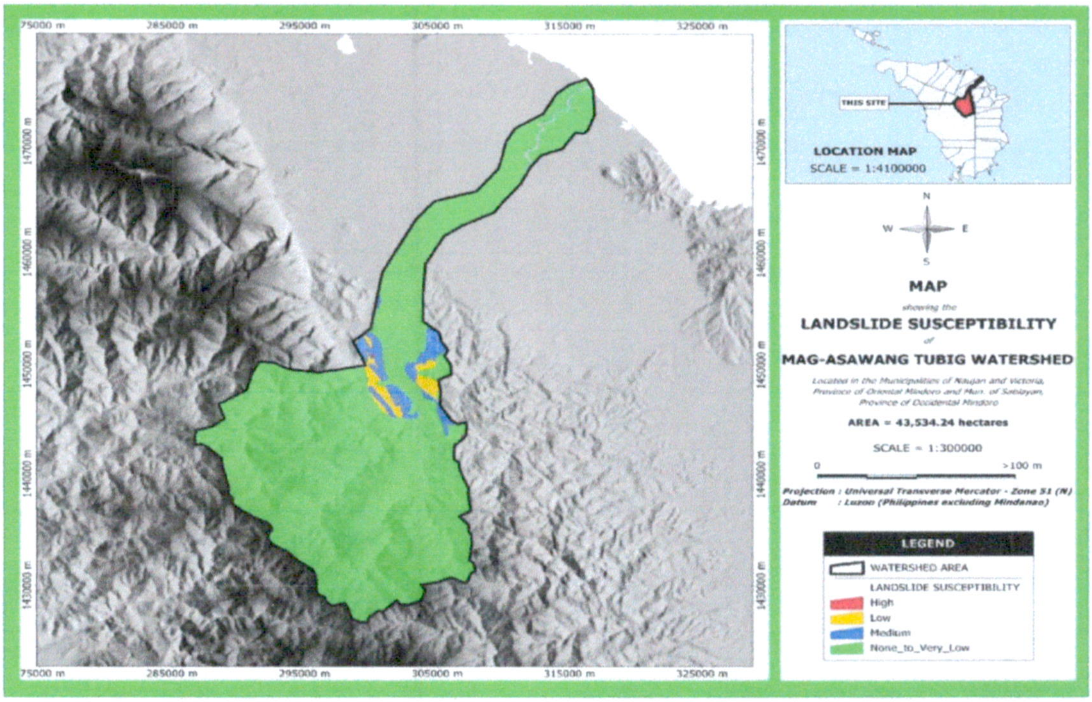


Source: NAMRIA, Digital Elevation Model (DEM) ASTER data

6. Geological Hazard

Figure 12 and Table 10 shows how the watershed is vulnerable to landslides. Vulnerability of the communities due to geological hazards had been identified in the area. These potential hazards are landslides (Figure 12), soil erosion (Figure 13a) and flooding (Figure 14). Figure13b shows of the area where erosion occurred caused by 1994 strong earthquake.

Figure 12. Map showing the landslide susceptibility of the watershed area.



Source: NAMRIA, Digital Elevation Model (DEM) ASTER data

Table 10. Distribution of landslide susceptibility of the watershed area

SUB-WATERSHED	None to very low	Low	Moderate	High
SW1(ALCATE)	2587.77	198.86	527.88	0.01
SW2(KISLUYAN)	1849.15	356.13	643.33	7.78
SW3(IBOLO)	9932.83	NONE	128.97	NONE
SW4(AGLUBANG)	2815.91	0.11	14.2	NONE
SW5(AGLUBANG)	7662.77	NONE	35.03	NONE
SW6	5928.67	NONE	NONE	NONE
SW7	3069.79	NONE	NONE	NONE
SW8	7578.48	123.24	366.7	5.34
TOTAL	41425.37	678.34	1716.11	13.13

Figure 13a. Soil Erosion Map of Mag-asawang Tubig Watershed

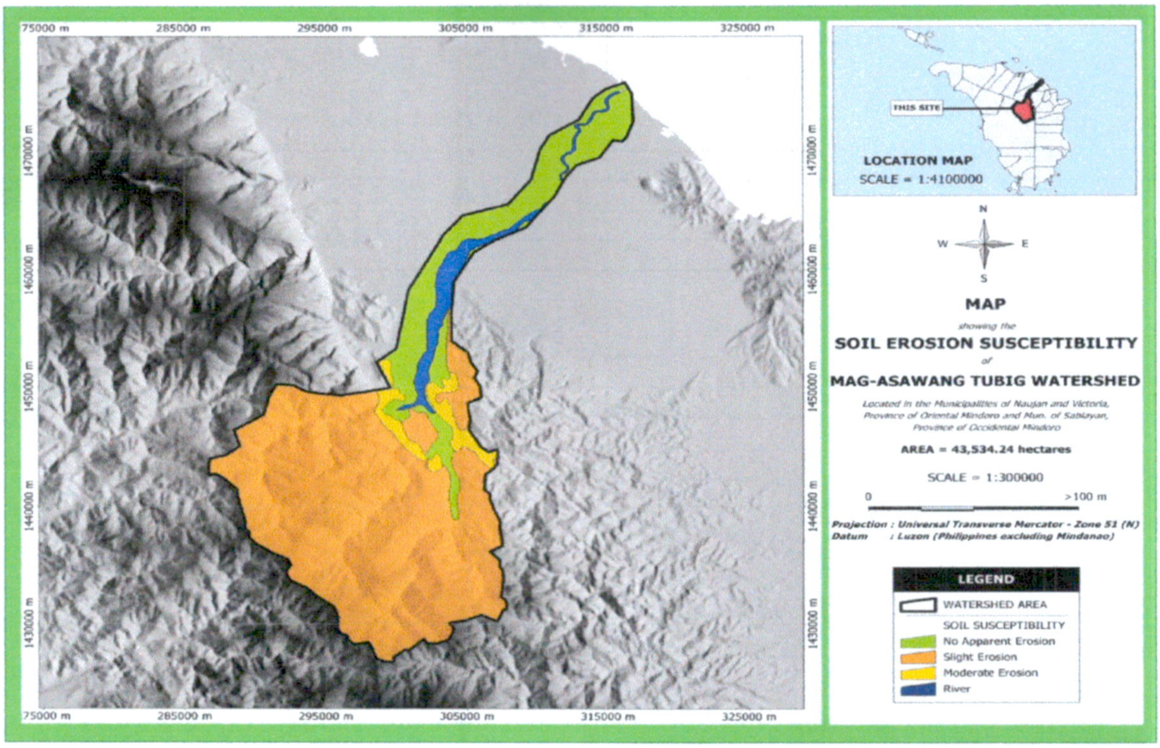
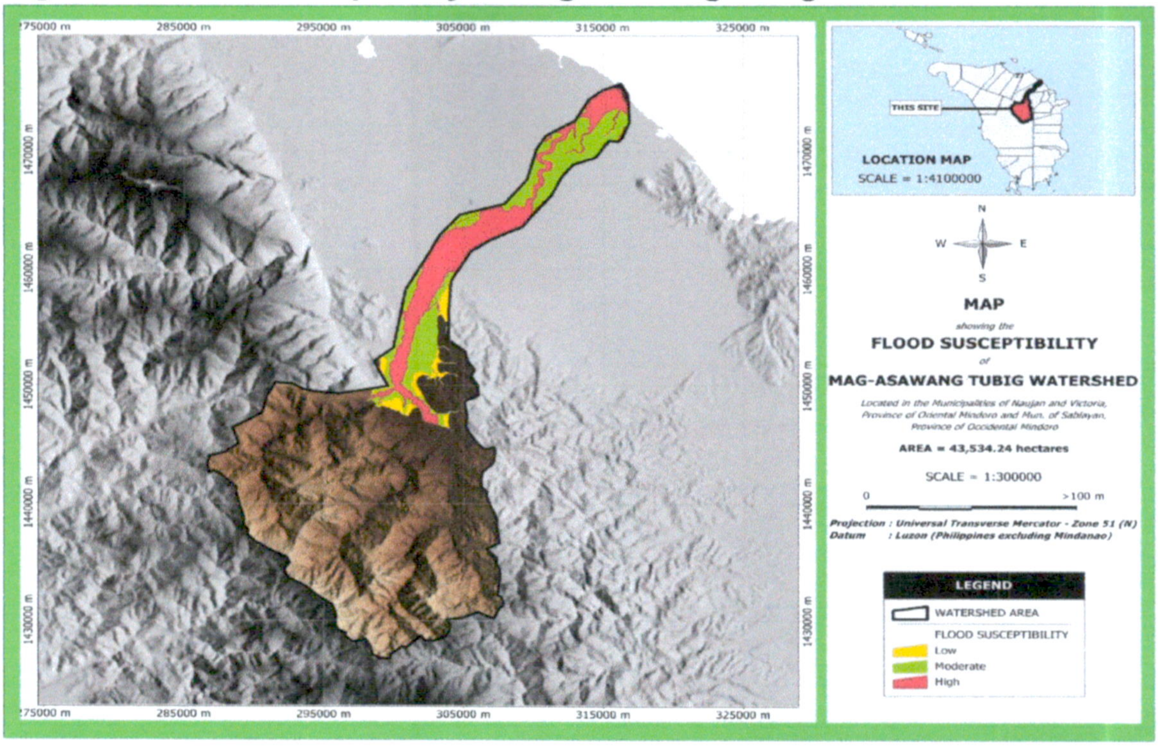


Figure 13b. Landslide caused by 1994 earthquake within the watershed area.

Source: ERDS-4B, 2009

Figure 14. Flood susceptibility of Mag-asawang Tubig Watershed



Source: NAMRIA, Digital Elevation Model (DEM) ASTER data

D. Soil

Osterkamp, 2008 defined Soils, as a product of natural hydrologic and geomorphic process is a layered mass of minerals and generally organic matter and rock fragments that differ from the parent material (rocks) from which it is derived in terms of morphology, physical and chemical characteristics, organism and organic content.

Based on the study conducted by ERDB (undated) in the mountainous area of the Mag-asawang Tubig- Bucayao river basin soil bulk density ranges from 0.37 to 1.89 gm/cc at the lower elevation, 0.65 to 2.35 gm/cc at mid-elevation and 0.90 to 1.88 gm/cc at the higher elevation. Soil porosity ranges from 29 to 87% at the lower elevation, 19 to 78% at the middle elevation and 34 to 73% at the higher elevation. Results of the chemical analysis of soil disclosed that the mountainous area of the Mag-asawang Tubig-Bucayao river basin has an OM content varying from 0.10 to 6.73% (lower elevation); 0.49 to 7.62% at mid-elevation; and 0.51 to 10.59% at the higher elevation. These generally reflect low to high organic matter content. The soil in the entire mountainous portion of the basin is generally acidic. Soil pH values ranged from extremely acidic (pH 3.6) to slightly acidic (pH 6.8) at the mid-elevation, and extremely acidic (pH 3.85) to neutral (pH 6.75) at the higher elevation (ERDS-4B, 2009).

Similarly, in the sample area in Kisluyan (Sub-watershed No. 2) results of the analysis conducted by Intex Resources Inc. reveals that the soil nutrient content in the entire mountainous area is generally low to high; nitrogen – 0.01 to 1.20%; phosphorous – 0.40 to 7.55 ppm; potassium (K) – 0.02 to 1.34 me/100gm; calcium (Ca) – 0.42 to 14.83 me/100gm; magnesium (Mg) – 0.22 to 18.57 me/100gm; and sodium (Na) – 0.03 to 2.67 me/100 gm. Soil depth ranges from 374.5 cm from the surface to the bedrock. Infiltration rates varies from 0.77 to 4.5 cm/hr in sandy clay loam; 0.1 to 1.0 cm/hr in clay; 0.25 to 1.5 cm/hr in clay loam and 0.03 to 0.3 cm/hr in silty clay.

Figure 15 and 16 shows the eight-soil type identified in Mag-asawang Tubig watershed area. Rough mountainous land dominated the soil type in the catchment basin having an area of 34,325.25 hectares. The entire catchment is classified by Bureau of Soil and Water Management as all belongs to mountain soil. Table 11 shows the physical and chemical characteristics of the soil of this watershed area in Kisluyan (SW2) while Figure 17 indicates the soil taxonomy/grouping of the watershed area.

Figure 15. Soil type in Mag-asawang Tubig Watershed

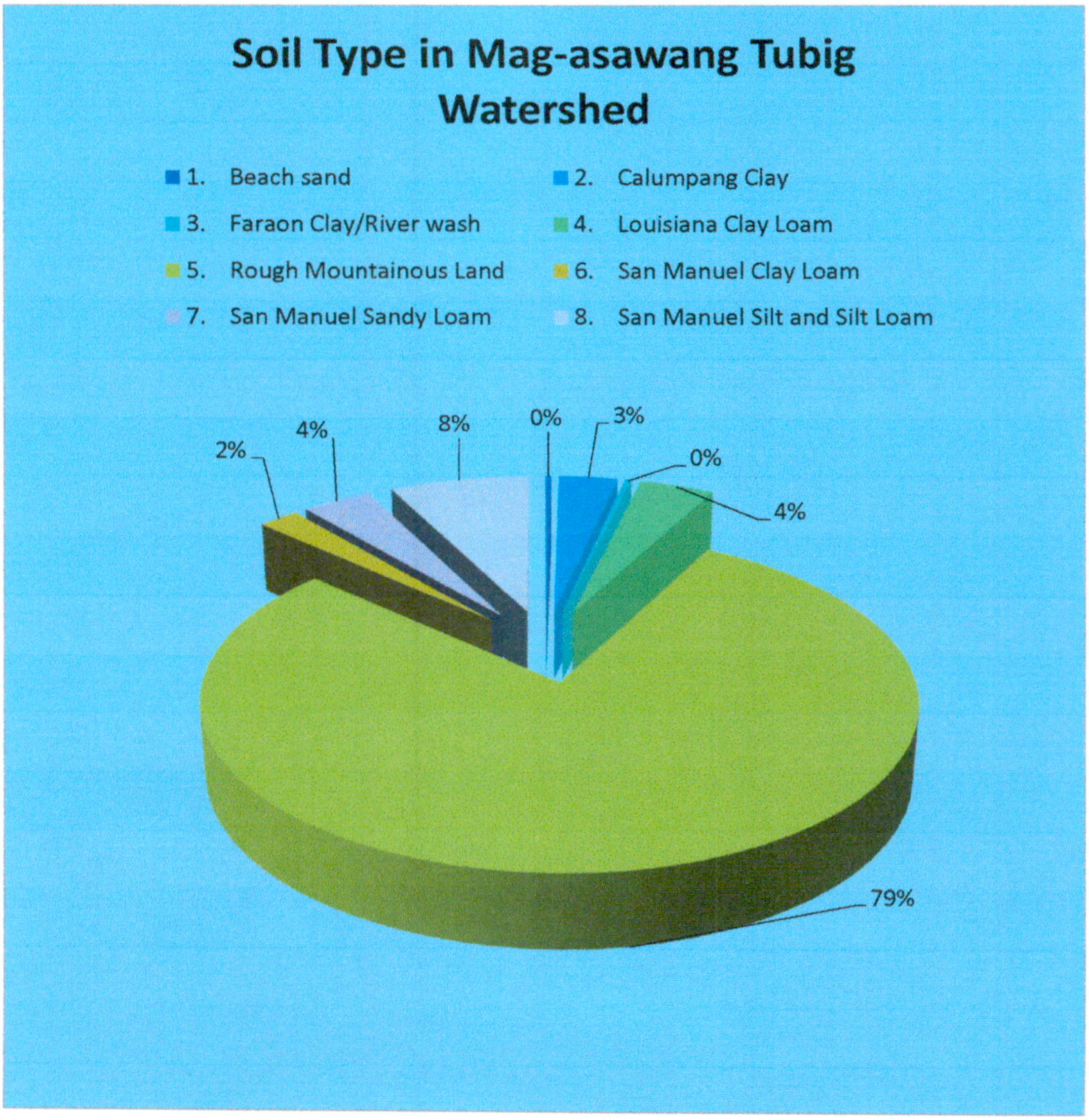
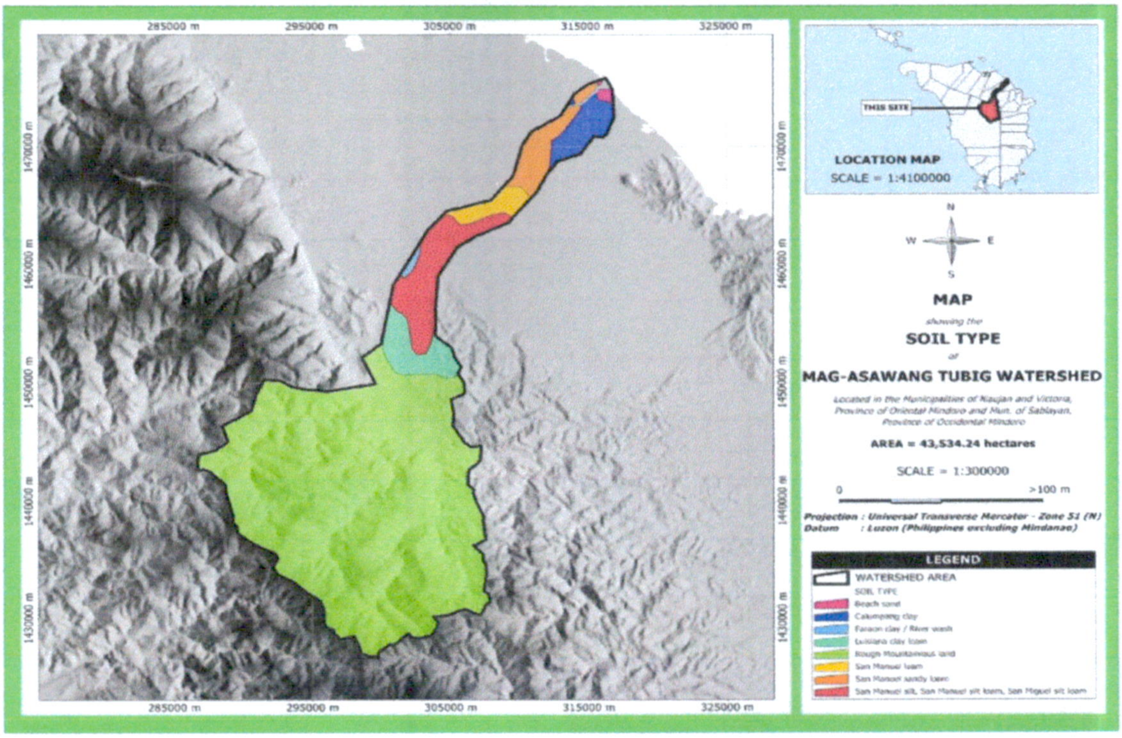
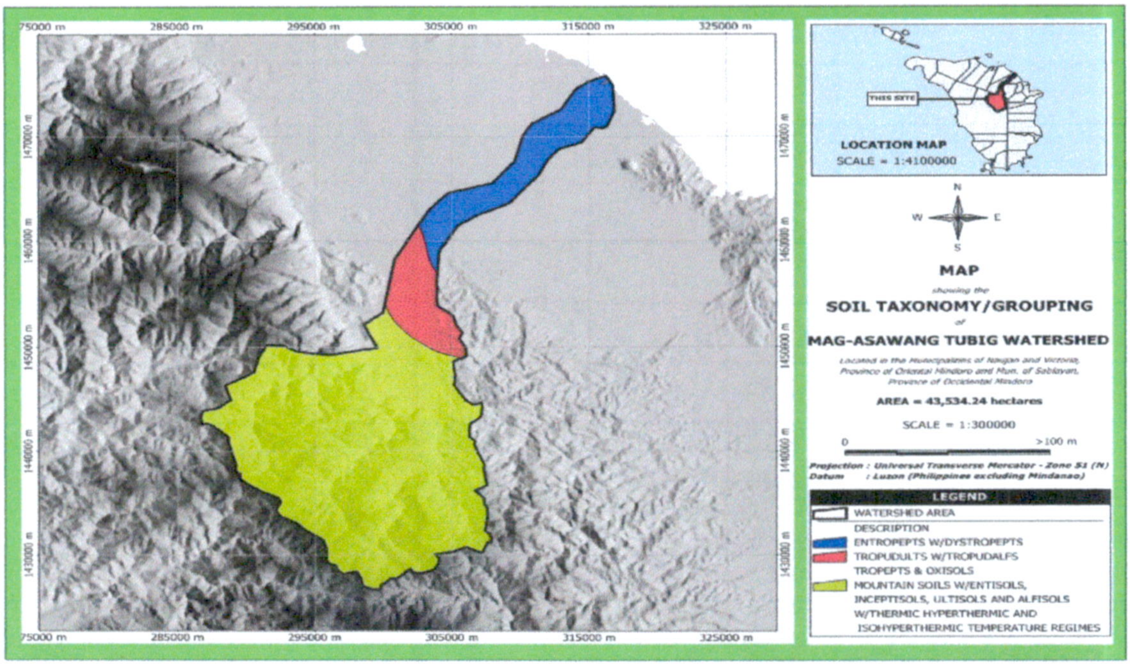


Figure16. Soil type map of Mag-asawang Tubig Watershed.



Source: NAMRIA, Digital Elevation Model (DEM) ASTER data

Figure 17. Soil taxonomy/grouping of Mag-asawang Tubig watershed area.



Source: NAMRIA, Digital Elevation Model (DEM) ASTER data

Table 11. Soil Characteristics from sample site in SW2(Kisloyan)

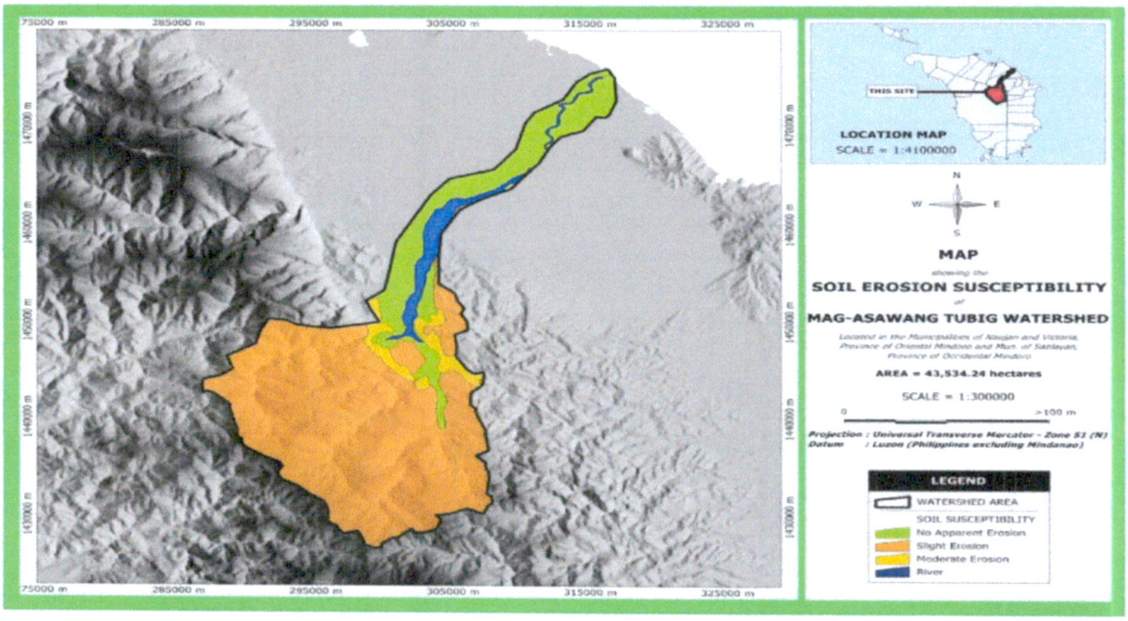
Soil	Lower Elevation		Middle Elevation		Higher Elevation	
Characteristics	Top Soil	Sub-Soil	Top Soil	Sub-Soil	Top Soil	Sub-Soil
OM (%)	3.46	1.53	3.57	2.45	6.07	2.68
Total N (%)	0.04	0.02	0.04	0.02	0.05	0.03
P(ppm)	0.8	Nil	0.5	0.3	0.04	0.3
K(ppm)	0.2	0.1	0.2	0.1	0.2	0.1
pH	5.9	6.4	5.5	6.2	5.3	6.2
Texture	Clay Loam	Clay	Clay Loam	Loamy Clay	Clay Loam	Loamy Clay
Soil Depth (m)	0.15	0.35	0.1	0.25	0.1	0.25
Bulk Density(g/cc)	1.15	1.25	1.08	1.12	1.02	1.08

Source: ERDS-4B, 2009

1. **Erosion Condition**

Figure 18 shows the erosion condition of Mag-asawang Tubig Watershed area. Three categories were used to identify its vulnerability to erosion. These are no apparent erosion, slight erosion and moderate erosion. Around 30,826.29 hectares or 88.36 percent of the area had been identified to have slight erosive condition (Table12).

Figure 18. Map of the watershed showing the soil erosion susceptibility



Source: NAMRIA, Digital Elevation Model (DEM) ASTER data

Table 12. Soil erosion prevailing in the area.

SUB-WATERSHED (MW)	No Apparent Erosion	Slight Erosion	Moderate Erosion
SW 1 (Alcate)	1205.52	954.70	229.29
SW 2 (Kisluyan)	449.91	1,386.70	896.29
SW 3 (Ibolo)	283.19	9,568.53	387.24
SW 4 (Aglubang)	356.68	2,417.69	55.74
SW 5 (Buraboy)	111.13	7,500.21	86.57
SW 6	none	5,928.67	None
SW 7	none	3,069.79	None
SW8	6,029.66	398.74	183.82
TOTAL	8,436.09	31,225.03	1,838.25

E. Land Classification/Legal Status of Land

The whole Mag-asawang Tubig watershed had been classified as forest land and agricultural land (Figure 20). Four tenurial instruments existed in the area. The biggest belongs to the Certificate of Ancestral Domain Claim (CADC), these are shown in Figure 19. As mentioned before watershed is a common property that's means a lot of people were utilizing the land resources therein thus conflicting management aroused (Kerr, 2007). Different group of people have their own belief, culture and tradition. Knowing that the area by virtue of CADC belongs to the Indigenous people called as Mangyan tribe. Experiences before by the DENR in implementing projects and programs encountered opposition from this Mangyan tribe. Importance lies in the aspect of what are the proper approaches should be used to prevent conflicts to halt or stop the project at all.

Figure 19. Tenurial Instrument inside the watershed area.

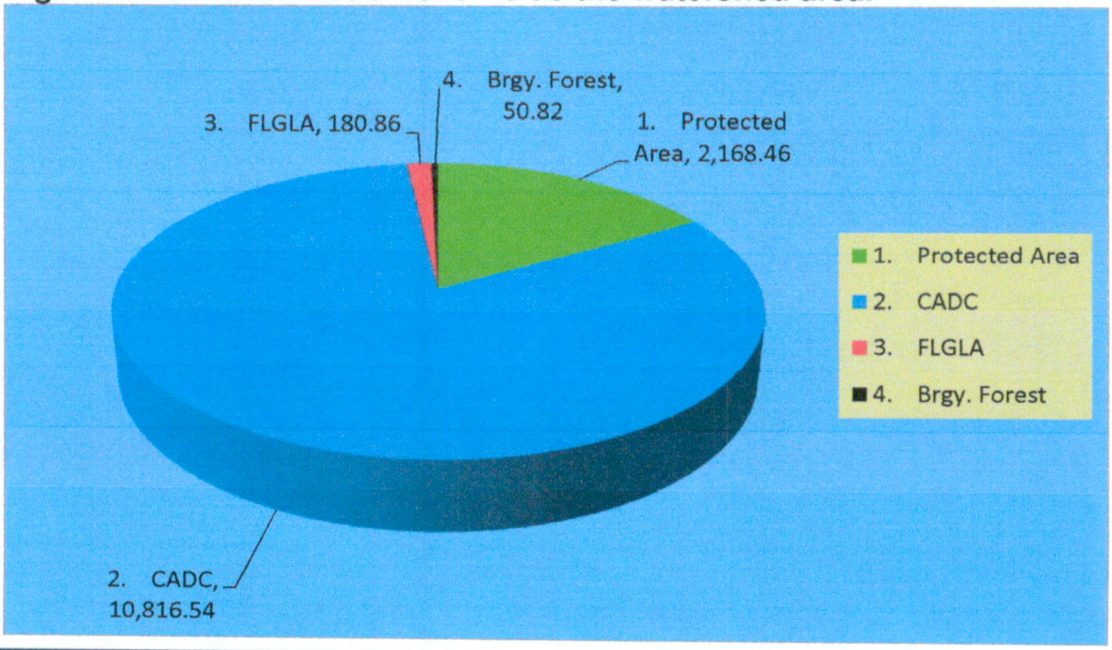
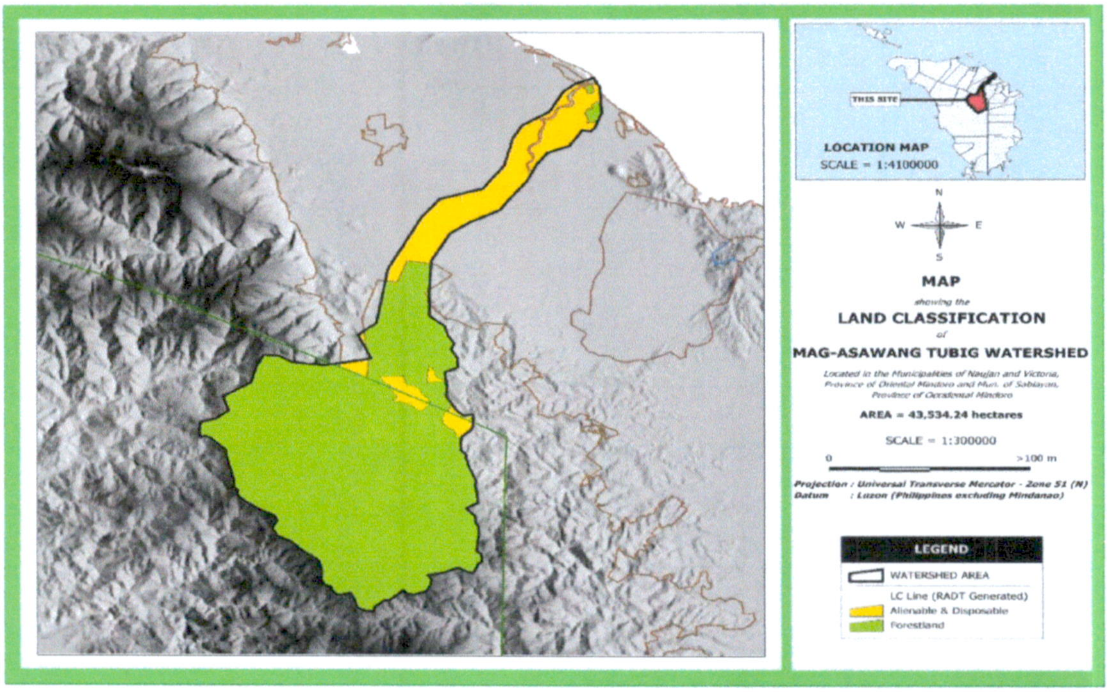


Figure 20. Land Classification Map of Mag-asawang Tubig Watershed area.

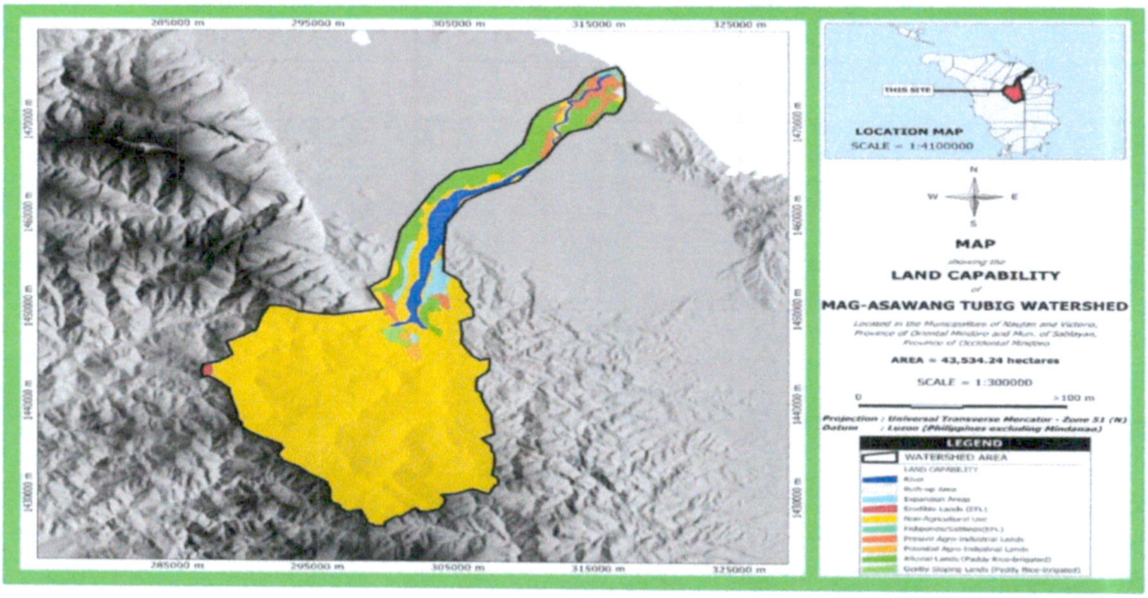


Source: NAMRIA, Digital Elevation Model (DEM) ASTER data

F. Land Capability

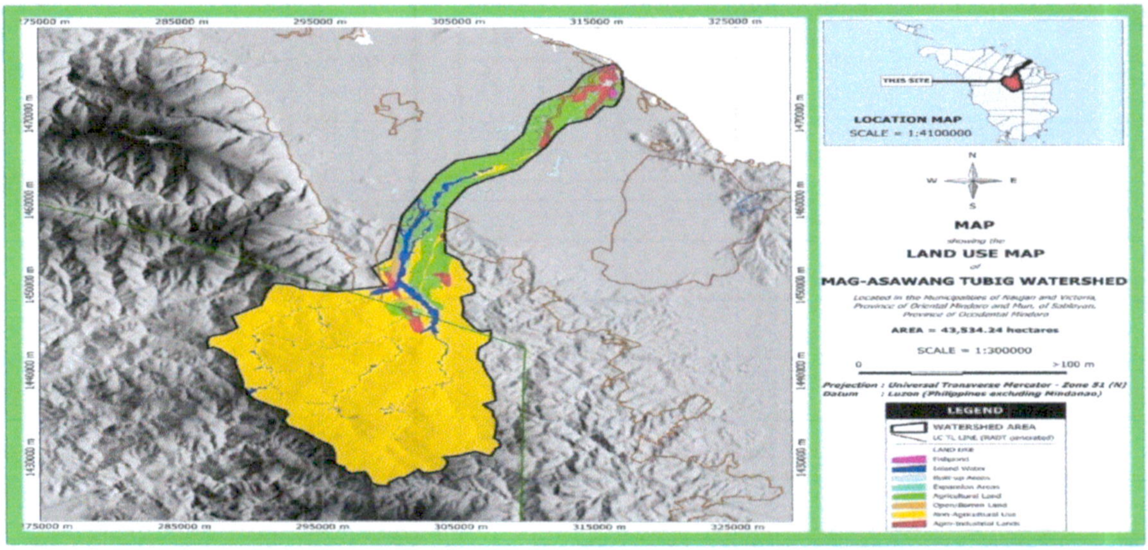
In general, most of the area of Mag-asawang Tubig watershed is not suitable for agricultural purposes as shown in the map (Figure 21). This portion is best devoted for forest trees and its association.

Figure 21. Land Capability Map the watershed area



Source: NAMRIA, Digital Elevation Model (DEM) ASTER data

Figure 22. Land use map Mag-asawang Tubig Watershed area.



Source: NAMRIA, Digital Elevation Model (DEM) ASTER data

G. Land-use

Figure 22 and Table 13 shows the type of land use found existing in the watershed area. The biggest area is occupied by non-agricultural use a total of 32,708.35 hectares followed by land devoted for agricultural purposes covering an area of 5,631.75 hectares.

Table 13. Land-use of Mag-asawang Tubig watershed

LAND-USE	AREA(HAS)
BUILT-UP	809.03
INLAND WATER	2,014.83
OPEN/BARREN LAND	251.13
AGRICULTURAL LAND	5,631.75
EXPANSION LAND	78.21
AGRICULTURAL LAND	1,008.48
NON-AGRICULTURAL USE	32,708.35
AGRO-INDUSTRIAL LANDS	908.69
FISHPOND	123.77
TOTAL	43,534.24

H. Climate

1. Rainfall

Mag-asawang Tubig Watershed falls under Climatic Type III of Corona Classification (Figure 23). This means that there there is no distinct dry season but with a very pronounced maximum rainfall from May to January (Figure 11). The graph 59-year average annual rainfall (1960-2018) recorded in the

PAGASA station in Calapan City, Oriental Mindoro is shown in Figure 24. Based on record of PAGASA, the highest recorded annual rainfall was about 3,280 mm in 2008 while the lowest was about 1,045 mm in the year of 1968.

Figure 25 illustrated the average monthly rainfall recorded from 1960-2018 in the Mag-asawang Tubig Watershed area with the highest average monthly rainfall occurred during the month of October and the lowest one is during the month of February.

Figure 23. Climatic Map under the Corona Classification of Mag-asawang Tubig Watershed

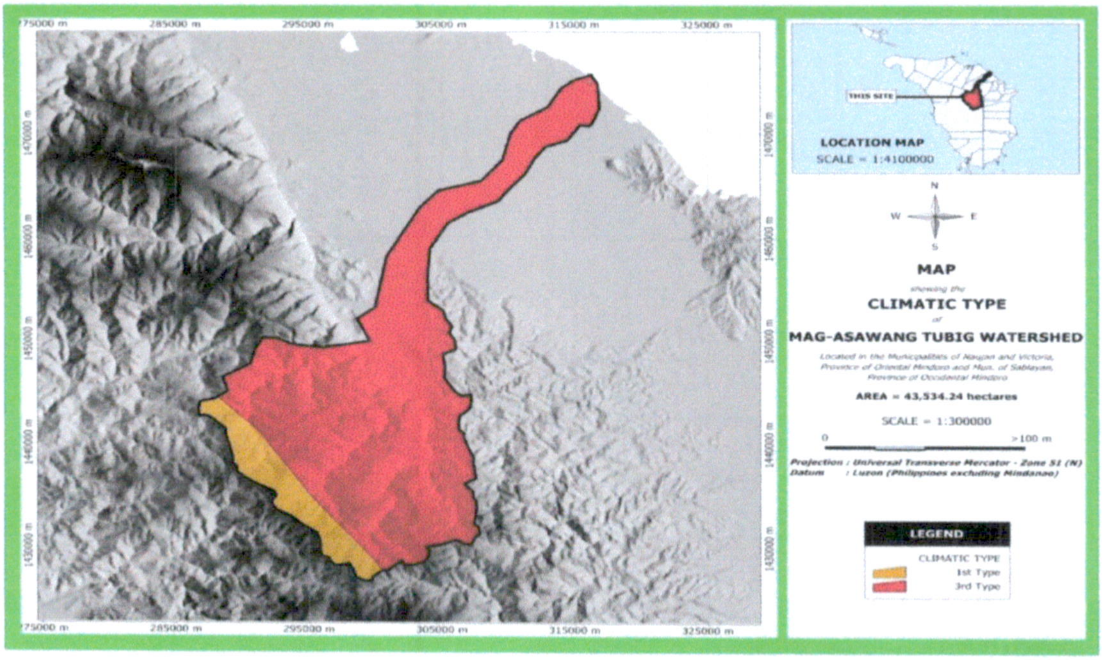
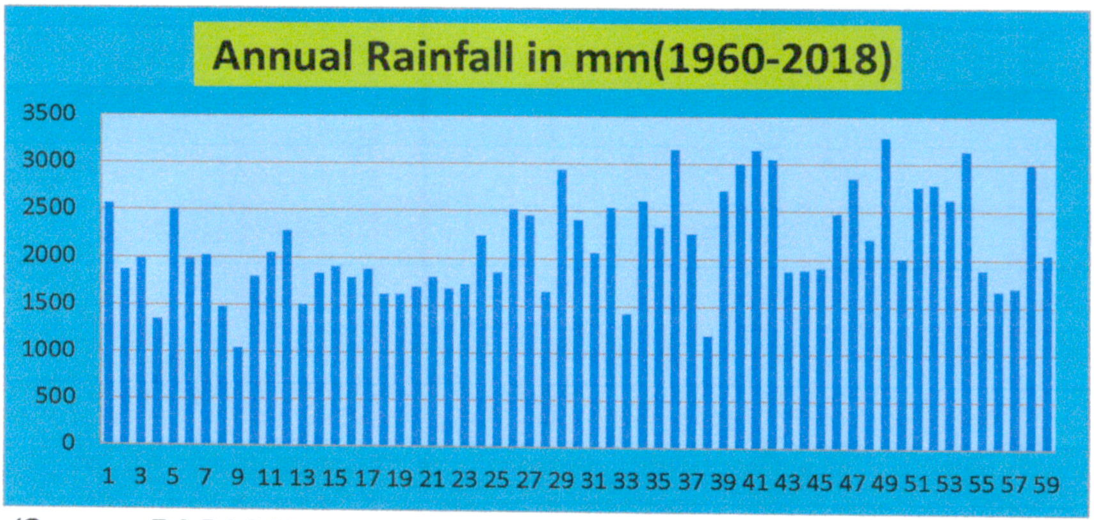
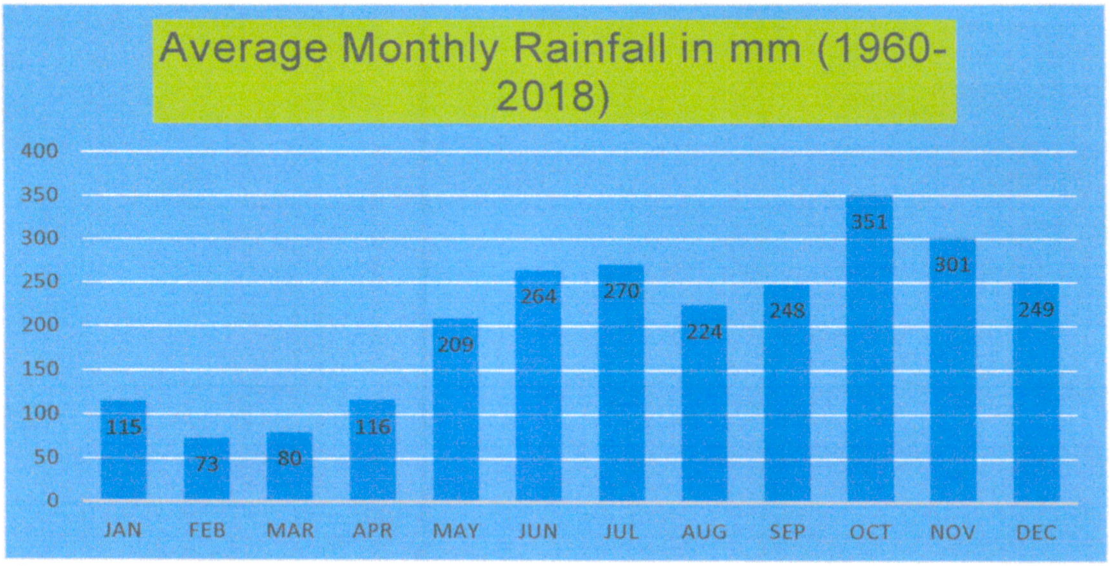


Figure 24. Annual Rainfall of Mag-asawang Tubig Watershed



(Source: PAGASA)

Figure 25. Average Monthly Rainfall of Mag-asawang Tubig River Watershed

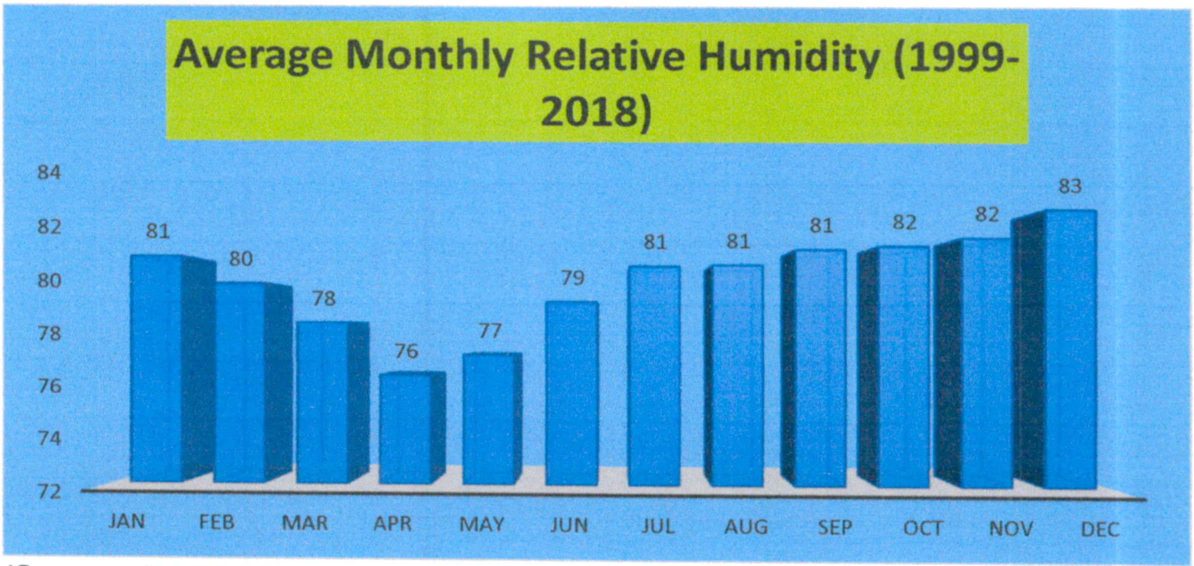


(Source: PAGASA)

2. Relative Humidity

With respect to relative humidity the records show that the highest relative humidity occurred in the month of December while the lowest is on the month of April (Figure 26).

Figure 26. Average Monthly Relative Humidity of Mag-asawang Tubig Watershed

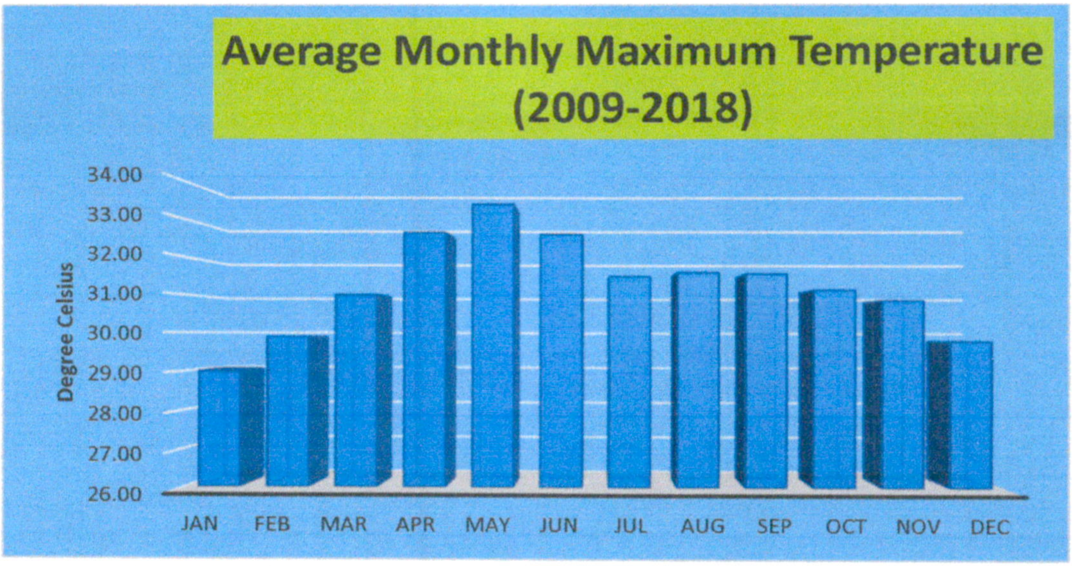


(Source: PAGASA)

3. Temperature

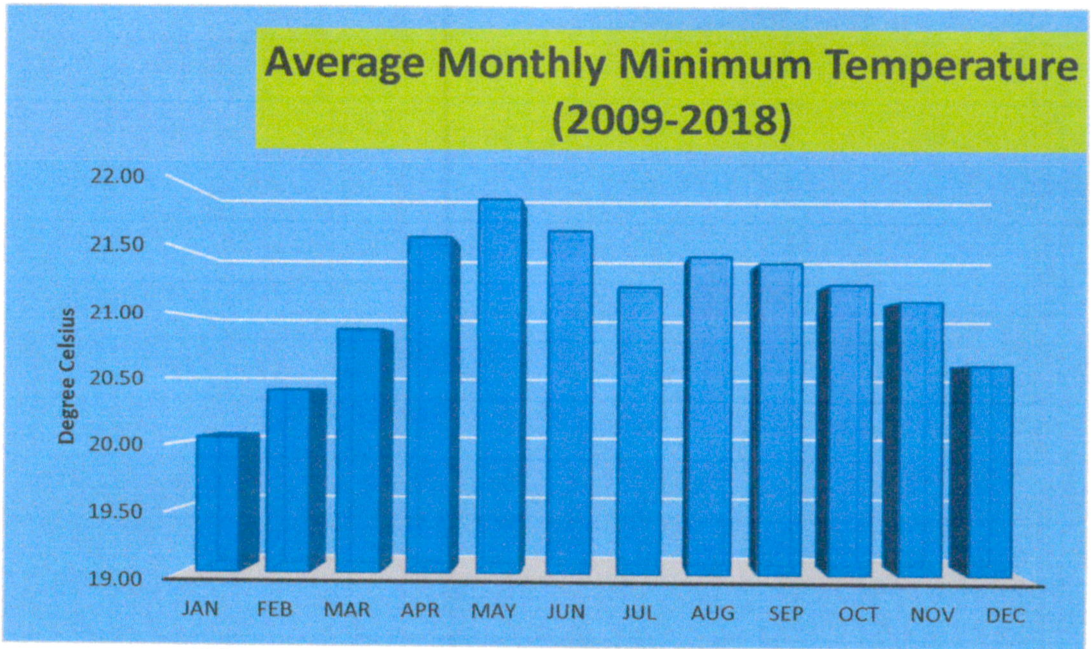
Recorded highest maximum temperature from 2009 to 2018 shows that this occurred in the months of April to June (Figure 27). With respect to the minimum temperature, this extends from the months of December to February (Figure 28).

Figure 27. Average Monthly Maximum Temperature of Mag-asawang Tubig Watershed



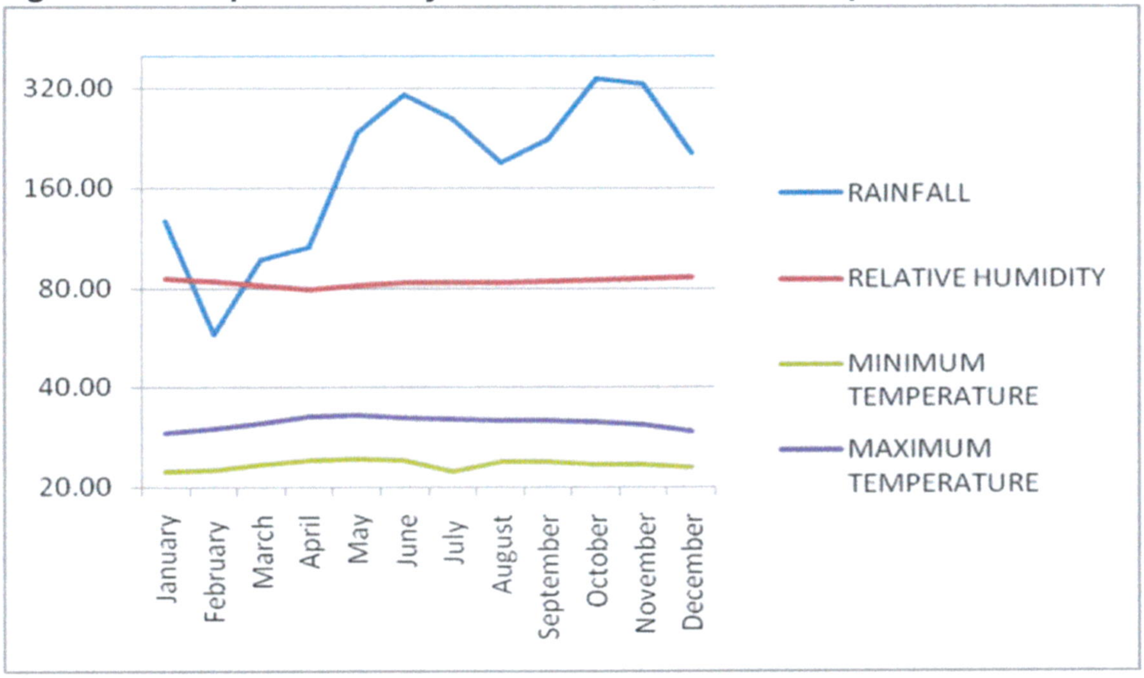
(Source: PAGASA)

Figure 28. Average Monthly Minimum Temperature of Mag-asawang Tubig



Watershed (Source: PAGASA)

Figure 29. Comparative analysis of Rainfall, RH and temperature



Oyewole et al, (2014) conducted a study on the relationship between relative humidity and rainfall in Nigeria to analyze the climate variability in Lagos, Port-Harcourt and Calabar. Based on the data of the study made it was showed a long rainy season that begins in March and lasts to the end of July, having a peak period in June or July. This is the period when there is a thick cloud and excessively wet. The relative humidity recorded an average value hardly below 82 % across the observation stations. The results of this study showed that there is a direct relationship between rainfall and relative humidity throughout the months of the year. Relative humidity increases as rainfall increases.

In the case of the rainfall and relative humidity in the vicinities of the Mag-asawang Tubig Watershed there is the similarity in this study. Figure 29 shows that when the relative humidity decreases the rainfall amount also decreases but as the relative humidity increases the rainfall or the occurrence of rain becomes frequent.

With respect to the relationship of temperature and relative humidity it was observed that as the temperature increases the relative humidity decreases. Relative humidity changes when temperatures changed. Because warm air can hold more water vapor than cool air, relative humidity falls when the temperature rises if no moisture is added to the air.

This is important to know that good cover of forest vegetation is needed in order to have a good supply of water. Forests vegetation cover plays a vital role in determining rainfall because a good forest vegetation generate a large-scale water vapor.

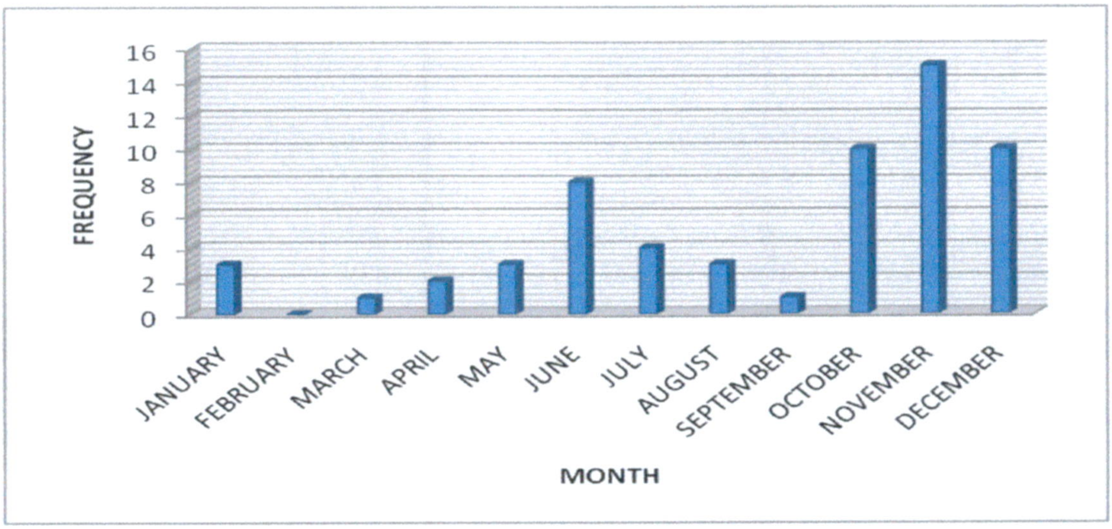
4. Wind Direction

Four times wind directions shifted in a year in the area, first is the Northeast monsoon occurred during the months of August up to December then continued up to March. Second shift is during the month of April where the wind moves to east to northeast. By the month of May and June wind blows from the southeast then by October move to the east.

5. Typhoon Frequency

Figure 30 shows how the province of Oriental Mindoro is often visited by typhoon for the past few years. Typhoon frequently occurred in this province from October to December of every year. June is also the month where typhoon is also frequent. Months of February and September are the time wherein less typhoon visited the province.

Figure 30. Typhoon Frequency in Oriental Mindoro



Source: DOST-PAGASA, Quezon City

I. Flora and Fauna

Among the common species that can be found in the Mag-asawang Tubig Watershed and the adjacent area are those trees belonging to the family of Anacardiaceae, Annonaceae, Apocynaceae, Dipterocarpaceae, Euphorbiaceae, Lauraceae, Melastomataceae, Myrtaceae and Moraceae (Table 14, Table 15 and Table 17). These distributions indicated how the watershed still possess endemism and diversity (Arsenio et. al. 2011). Other species are non-timber forest products and understory that includes, bamboo, palms, rattan and vines. But the continuous timber poaching and illegal logging reduced the large trees found inside the watershed. In the upper portion of Mag-asawang Tubig Watershed, brushlands and shrublands are also observed existing especially in the area of abandoned clearing. Canthophyllum exelsum, Ficus nota and Trema orientalis are the notable species of plants existing in the brushland area.

Grasses found inside the watershed are Imperata cylindrica, Bidens pilosa, Chromolaena odorata. Imperata cylindrica dominated the grass cover of this ecosystem.

In Mag-asawang Tubig Watershed area faunal species identified are bats, birds, rats and shrunk. List of these species is found below in Table 18.

Table 14. Enumeration of plant species found in Mag-asawang Tubig watershed

Species Name	Family Name	Class	Ecological Status/ Category/ Remarks
Mangifera longipes	Anacardiaceae	Tree	Lowland primary and secondary forest; up to 400m altitude widely distributed
Buchanania microphylla	Anacardiaceae	Tree	Secondary forest at low altitude
Buchanania arborescens	Anacardiaceae	Tree	Lowland forest and secondary forest; Widely distributed
Buchanania arborescens	Anacardiaceae	Tree	Lowland forest and secondary forest; Widely distributed
Polyalthia barnesii	Annonaceae	Tree	small tree widely distributed
Polyalthia glauca	Annonaceae	Tree	Common
Polyalthia glauca	Annonaceae	Tree	Common
Mitrephora reflexa	Annonaceae	Tree	Common
Alstonia macrophylla	Apocynaceae	Tree	Open and primary forest: widely distributed
Alstonia macrophylla	Apocynaceae	Tree	Open and primary forest: widely distributed
Alstonia macrophylla	Apocynaceae	Tree	Open and primary forest: widely distributed

Alstonia macrophylla	Apocynaceae	Tree	Open and primary forest: widely distributed
Alyxia concatenata	Apocynaceae	Tree	Common
Calamus mindorensis	Palmae	Rattan	Endemic
Spatiphyllum commutatum	Araceae	Herb	Common
Agathis philippinensis	Araucariaceae	Tree	*Vulnerable ; DENR DAO No 2007-1; IUCN Plant List 2006
Pinanga philippinensis	Arecaceae	Palm	Endemic
Pinanga insignis	Palmae	Palm	Endemic
Asplenium haenkei	Aspleniaceae	Fern	Common
Asplenium haenkei	Aspleniaceae	Fern	Common
Blechnum orientale	Blechnaceae	Fern	Common
Canarium asperum var.asperum	Burseráceae	Free	Common
Dracaena angustifolia	Convallariceae	Shrub	Common
Dracaena angustifolia	Convallariceae	Shrub	Common
Scleria scrobiculata	Cyperaceae	Sedge	Common
Scleria scrobiculata	Cyperaceae	Sedge	Common
Dioscorea divaricara	Dioscoreaceae	Vine	Common
Shorea polysperma	Dipterocarpaceae	Tree	*Vulnerable species; Critically Endangered; DENR ADMINISTRATIVE ORDER No 2007-1; IUCN Plant List 2006
Shorea polysperma	Dipterocarpaceae	Tree	*Vulnerable species; Critically Endangered; DENR ADMINISTRATIVE ORDER No 2007-1; IUCN Plant List 2006

Shorea polysperma	Dipterocarpaceae	Tree	*Vulnerable species; Critically Endangered; DENR ADMINISTRATIVE ORDER No 2007-1; IUCN Plant List 2006
Shorea polysperma	Dipterocarpaceae	Tree	*Vulnerable species; Critically Endangered; DENR ADMINISTRATIVE ORDER No 2007-1; IUCN Plant List 2006
Shorea polysperma	Dipterocarpaceae	Tree	*Vulnerable species; Critically Endangered; DENR ADMINISTRATIVE ORDER No 2007-1; IUCN Plant List 2006
Shorea polysperma	Dipterocarpaceae	Tree	*Vulnerable species; Critically Endangered; DENR ADMINISTRATIVE ORDER No 2007-1; IUCN Plant List 2006
Elaeocarpus mindorensis	Elaeocarpaceae	Tree	Endemic
Trigonostemon longipes	Euphorbiaceae	Tree	Common
Glochidion trichophorum	Euphorbiaceae	Tree	Endemic
Breynia cernua	Euphorbiaceae	Tree	Common
Breynia viti-ideae	Euphorbiaceae	Tree	Common
Breynia cernua	Euphorbiaceae	Tree	Common
Antidesma subcordatum	Euphorbiaceae	Tree	Endemic

Flagellaria indica	Flagellariaceae	Vine	Common
Flagellaria indica	Flagellariaceae	Vine	Common
Dicranopteris curanii	Gleicheniaceae	Fern	Common
Litsea fulva	Lauraceae	Tree	Common
Litsea fulva	Lauraceae	Tree	Common
Litsea fulva	Lauraceae	Tree	Common
Litsea philippinensis	Lauraceae	Tree	Common
Neolitsca vidalii	Lauraceae	Tree	Common
Neolitsea villosa	Lauraceae	Tree	Common
Litsea sebeifera	Lauraceae	Tree	Common
Fagraea auriculata ssp.auriculata	Loganiaceae	Tree	Common
Taenitis luzonica	Lomariopsidaceae	Fern	Common
Astronia williamsii	Melastomateceae	Tree	Endemic
Astronia cumingiana	Melastomateceae	Tree	Endemic
Melastoma setosa	Melastomateceae	Shrub	Common
Melastoma malabarichum	Melastomateceae	Shrub	Common
Aphanamixis polystachya	Meliaceae	Tree	Common
Ficus congesta	Moraceae	tree	Common
Ficus ruficaulis	Moraceae	tree	Common
Syzygium merritianum	Myrtaceae	tree	Common
Syzygium oleinum	Myrtaceae	tree	Common
Acmena acumnatissima	Myrtaceae	tree	Common
Syzygium mindorense	Myrtaceae	tree	Endemic
Syzygium mindorense	Myrtaceae	tree	Endemic
Pandanus gracilis	Pandanaceae	pandan	Common
Pandanus gracilis	Pandanaceae	pandan	Common
Frecynetia sphaerocephala	Pandanaceae	vine	Common

Padanus gracilis	Pandanaceae	pandan	Common
Pandanus gracilis	Pandanaceae	pandan	Common
Pandanus ensifolia	Pandanaceae	pandan	Common
Frecynetia sphaerocephala	Pandanaceae	pandan	Common
Alphitonia philippinensis	Phamnaceae	tree	Common
Alphitonia philippinensis	Phamnaceae	tree	Common
Piper inaequalis	Piperaceae	vine	Common
Piper merillii	Piperaceae	vine	Common
Dinochloa acutiflora	Poaceae	bamboo	Common
Dinochloa acutiflora	Poaceae/Gramineae	bamboo	Common
Dinochloa luconiae	Poaceae/Gramineae	bamboo	Common
Dinacholoa cutiflora	Poaceae/Gramineae	bamboo	Common
Dinochloa luconiae	Poaceae/Gramineae	bamboo	Common
Dinochloa luconiae	Poaceae/Gramineae	bamboo	Common
Podocarpus polystachyus	Podocarpaceae	tree	Common
Alphitonia philippinensis	Rhamnaceae	tree	Common
Alphitonia philippinensis	Rhamnaceae	tree	Common
Alphitonia philippinensis	Rhamnaceae	tree	Common
Prunus arborea var. arborea	Rosaceae	tree	Common
Prunus arborea var. arborea	Rosaceae	tree	Common
Lasianthus stipularis	Rubiaceae	shrub	Common
Mussaenda magallanensis	Rubiaceae	shrub	Common
Mussaenda magallanensis	Rubiaceae	shrub	Common
Mussaenda magallanensis	Rubiaceae	shrub	Common

Gardenia merrilii	Rubiaceae	shrub	Common
Mussaenda anisophylla	Rubiaceae	shrub	Common
Neonauclea reticulata	Rubiaceae	tree	Endemic
Lasianthus stipularis	Rubiaceae	shrub	Common
Palaquium obovatum	Sapotaceae	tree	Common
Pterocymbium tinctorium	Sterculiaceae	tree	Common
Ternstroemia gymnanthera	Theaceae	tree	Common
Gordonia sablayana	Theaceae	tree	Common
Leucocyke mindorensis	Urticaceae	tree	Endemic

(Source: ERDS-4B, 2009)

Table 15. Flora species found in the adjacent Pula River Watershed (Plot No. 1)

Local Name	Common Name	Scientific Name	Family
1. Agas	Malaikmo	Celtis philippinensis	Umaceae
2. Taguile	Tanguile	Shorea polysperma	Dipterocarpaceae
3. Agupanga	Malugai	Pometia pinnata	Sapindaceae
4. Manggachapoy	Manggachapoy	Vatica manggachapoi	Dipterocarpaceae
5. Sala		Mallutos tiliifolius	Euphorbiaceae
6. Bugnay	Bugnay	Antidesma bunius	Euphorbiaceae
7. Kamagong	Kamagong	Diospyrus philippinensis	Euphorbiaceae
8. Amugis	Amugis	Koorsiodendron pinnatum	Anacardiaceae
9. Oramo			
10. Fagtanda			
11. Duguan	Dugu-an	Myristica philipensis	Myristicaceae
12. Lawaan pula	Lawaang pula	Shorea negrosensis	Dipterocarpaceae
13. Banayan		Ficus magnoliifolia	Moraceae

14. Ibuyu malayung		Litsea sp.	Lauraceae
15. Almuyo		Ficus melinocarpa	Moraceae
16. Talakius tama		Engelhardtia sp.	Lauraceae
17. Pagsahingen	Pagsahingen	Canarium asperum	Dipterocarpaceae
18. Amilig		Macaranga bicolor	Euphorbiaceae
19. Mayawi			
21. Fasi		Elaeocarpus sp.	Elaeocarpaceae
22. Nato	Nato	Lygodium japonicum	Schizeaceae
23. Tabuo		Elaeocarpus sphaericus	Elaeocarpaceae
24. Bunglas	Patalsik	Decaspermum fruticosum	Myrtaceae
25. Da		Canarium luzonicum	Burseraceae
26. Faglambung		Clerodendrum elliptifollium	Verbenaceae
27. Alungkoy		Syzygium sp.	Myrtaceae
28. Baguinwa		Semicarpus cuneiformis	Anacardiaceae
29. Anangi	Piling liitan	Canarium luzonicum	Burseraceae
30. Lawaan puti	Lawaang puti	Shorea contorta	Dipterocarpaceae
31. Kalantas	Kalantas	Toona calantas	Meliaceae
32. Tamisan		Memecylon paniculatum	Melastomataceae
33. Almangug		Blumeodendron cumingii	Euphorbiaceae
34. Banasi		Antidesma cumingii	Euphorbiaceae
35. Namiasan		Ficus pubinuruis	Moraceae
36. Ige tama		Garcinia vidalii	Clusiaceae
37. Udalo		Daedalea ambigua	Polyporaceae
38. Bagidarug		Garcinia dulcis	Clusiaceae
39. Sigbiya			
40. Anglitap		Sterculia rubigonosa	Sterculiaceae
41. Maruroy	Alamaciga	Agathis philippinensis	Auracariaceae
42. Banilad	Banilad	Trichadenia philippinensis	Flacourtiaceae

(Source: CENRO Socorro, 2018)

Table 16. Flora species found in the adjacent Pula River Watershed (Plot No. 2)

Local Name	Common Name	Scientific Name	Family
1. Gitta	Dita	Alstonia sholaris	Apocenaceae
2. Lawaan puti	Lawaan puti	Shorea contorta	Dipterocarpaceae
3. Sialud	Talakatak	Castanopsis sp.	Fagaceae
4. Giho	Giho	Shorea guiso	Dipterocarpaceae
5. Kalumpit	Kalumpit	Terminalia microcarpa	Combretaceae
6. Tanguile	Tanguile	Shorea polysperma	Dipterocarpaceae
7. Bunglas	Patalsik	Decaspermus fruticusum	Myrtaceae
8. Bagidarug	Taklang-anak	Garcinia dulcis	Clusiaceae
9. Aranag		Archidendron scutiferum	Fabaceae
10. Agupanga	Malugai	Pometia pinnata	Sapindaceae
11. Nato	Nato	Cryptocarya ampla	Lauraceae
12. Maruroy	Almaciga	Agathis philipensis	Aurocariaceae
13. Lawaan pula	Lawaan pula	Shorea negrosensis	Dipterocarpaceae
14. Lamiyo	Lamiyo	Dracontamelon edule	Anacardiaceae
15. Dao	Dao	Dracontamelon dao	Anacardiaceae
16. Amaluwin		Gonystylus macrophyllus	Thymelaeaceae
17. Alungkoy		Syzygium sp.	Myrtaceae
18. Banilad	Banilad	Trichadenia philippinensis	Flacourtiaceae
19. Amugis	Amugis	Koordersiodenron pinnatum	Anacardiaceae
20. Kalantas	Kalantas	Toona calantas	Meliaceae
21. Udalo		Daedalea ambigua	Polyporaceae
22. Batino	Batino	Alstonia macrophylla	Apocynaceae
23. Kinay			
24. Sigbiya			
25. Kabarok			
26. Ibuyo malayung		Litsea sp.	Lauraceae
27. Sala		Mallotus tiliifolius	Euphorbiaceae
28. Anangi	Piling-liitan	Canarium luzonicum	Burseraceae
29. Anglo			
30. Sablayan			
31. Anglitap		Sterculia rubigosa	Sterculiaceae
32. Baginwa	Ligas	Semicarpus cuneiformis	Anacardiaceae

33. Laguwan		Gymnacramthera farquhariana	Myristicaceae
34. Balikat		Tabernaemontana subglobusa	Apocynaceae
35. Maytarasa		Litsea sp.	Lauraceae
36. Da		Canarium luzonicum	Burseraceae
37. Anuklong		Aglaia sp.	Meliaceae
38. Baliti		Ficus baliti	Moraceae
39. Bayog	Bayok	Pterospermum diversafolium	Sterculiaceae
40. Sangbawan		Sideroxylon sp.	Sapotaceae
41. Ayo sablayan			
42. Anglo			
43. Araganay		Crataxylum summatranum	Clusiaceae
44. Balinono tina		Lepisanthes rubigonosa	Spidaceae
45. Libso			
46. Manal		Syzygium sp.	Myrtaceae
47. Talakius tama		Engelhardtia sp.	Loranthaceae
48. Almangog		Blumeodenron cumingii	Euphorbiaceae
49. Igad daul		Pouteria macrantum	Sapotaceae
50. Balatino			
51. Linab		Garcinia sp.	Clusiaceae
52. Bagidarug		Garcinia dulcis	Clusiaceae
53. Tabangay			
54. Tino			
55. Banayan		Ficus magnoliifolia	Moraceae
56. Binroy			

(Source: CENRO Socorro, 2018)

Table 17. List of faunal species identified in the area

Species	Common Name	Status
BATS		
Cynopterisbrachyotis		Endemic
Pteropusleucopterus	Flying fox	Endemic
Macroglossuslogochilus	Long-tongued fruit bat	
Rossetusamplexicaudatus	Rosette fruit bat	
Ptenochinusjagori		Endemic
BIRDS		
Laniuscristatus	Brown shrike	Migratory
Dicrurus sp.	Drongo	
SKUNK		
Sphenomorphusjagori	Jagor's Sphenomorphus	Endemic
RAT		
Rattuseveretti	Everett's rat	Luzon endemic

(Source: Intex)

J. Land use and Land Capability

In general, most of the area of Mag-asawang Tubig watershed is not suitable for agricultural purposes as shown in the map (Figure 31). This portion is best devoted for forest trees (Figure 32).

Figure 33 shows the type of land capability found existing in the watershed area. These are forest land with a total of 31,533.55 hectares followed by land devoted for agricultural purposes covering an area of 6,473.38 hectares, inland water and fishpond to name a few (Figure 34).

Figure 31. Land-use of Mag-asawang Tubig Watershed

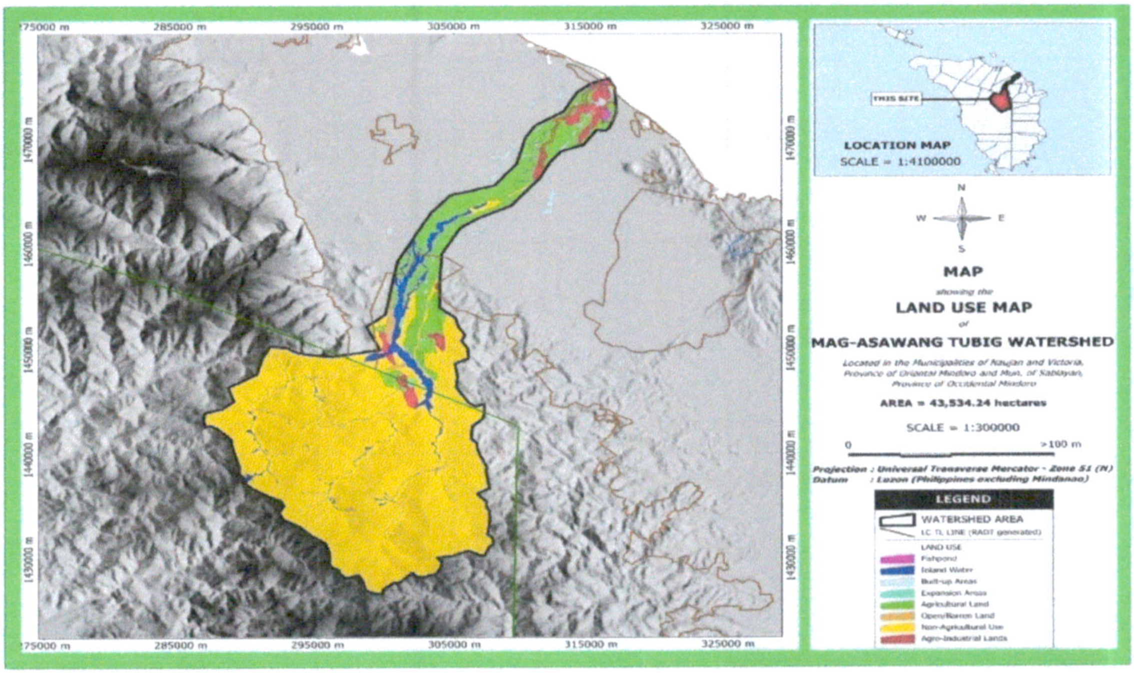


Figure 32. Land Cover Map of Mag-asawang Tubig Watershed

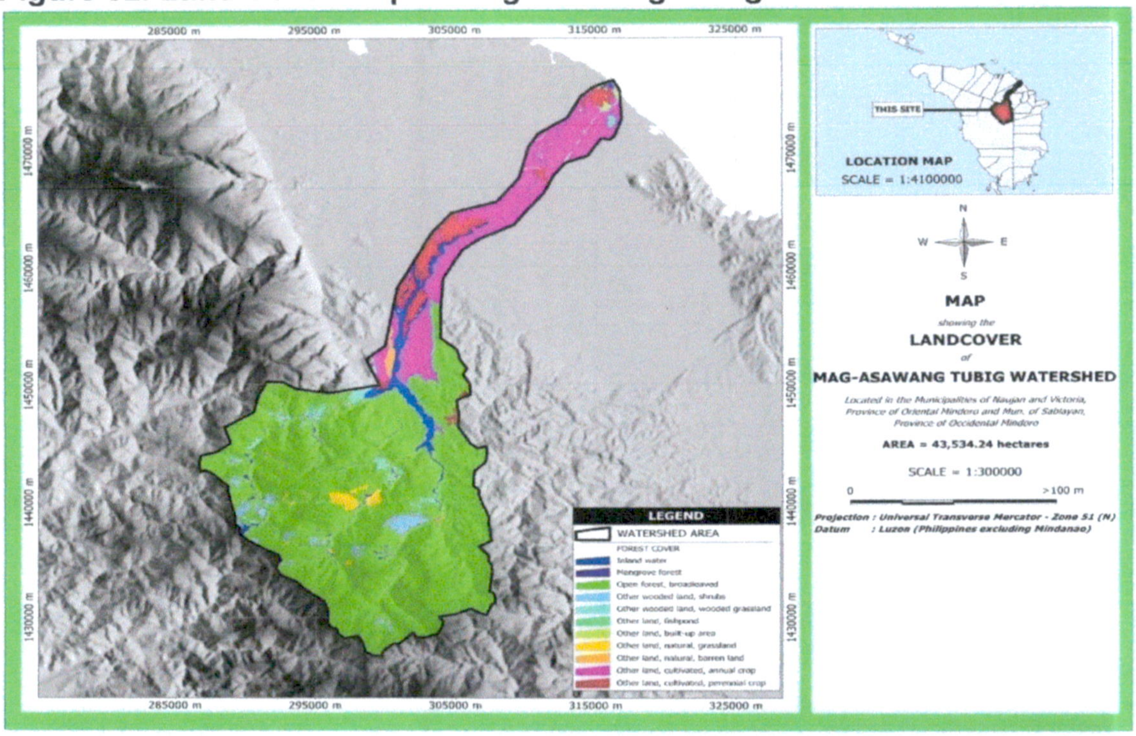


Figure 33. Land Capability Map of Mag-asawang Tubig Watershed

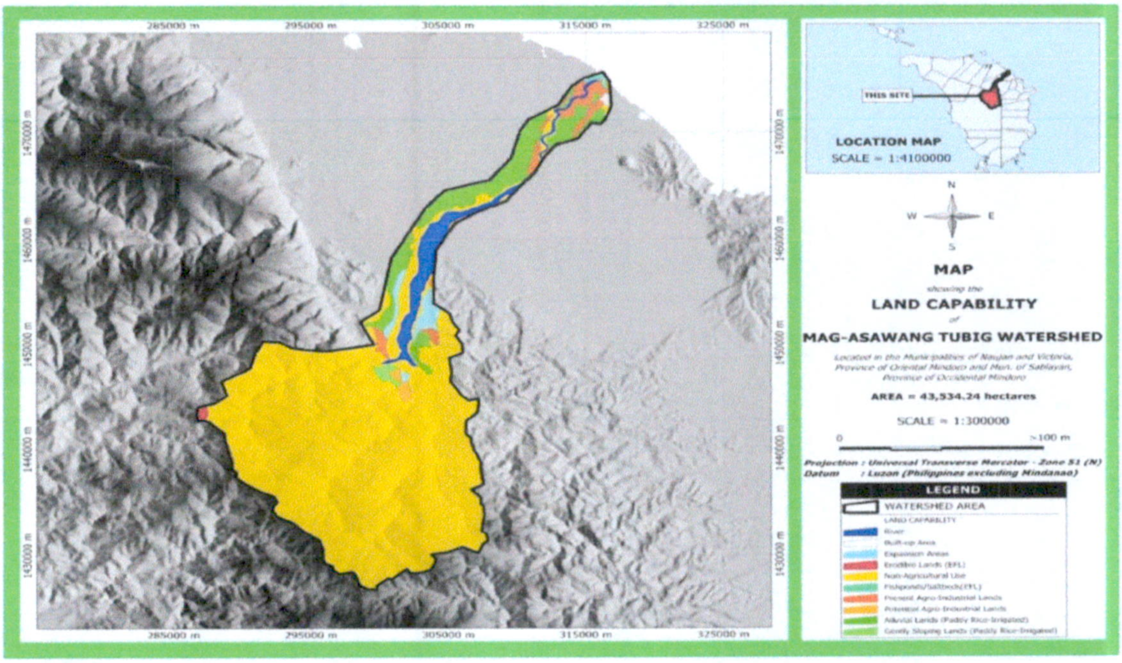
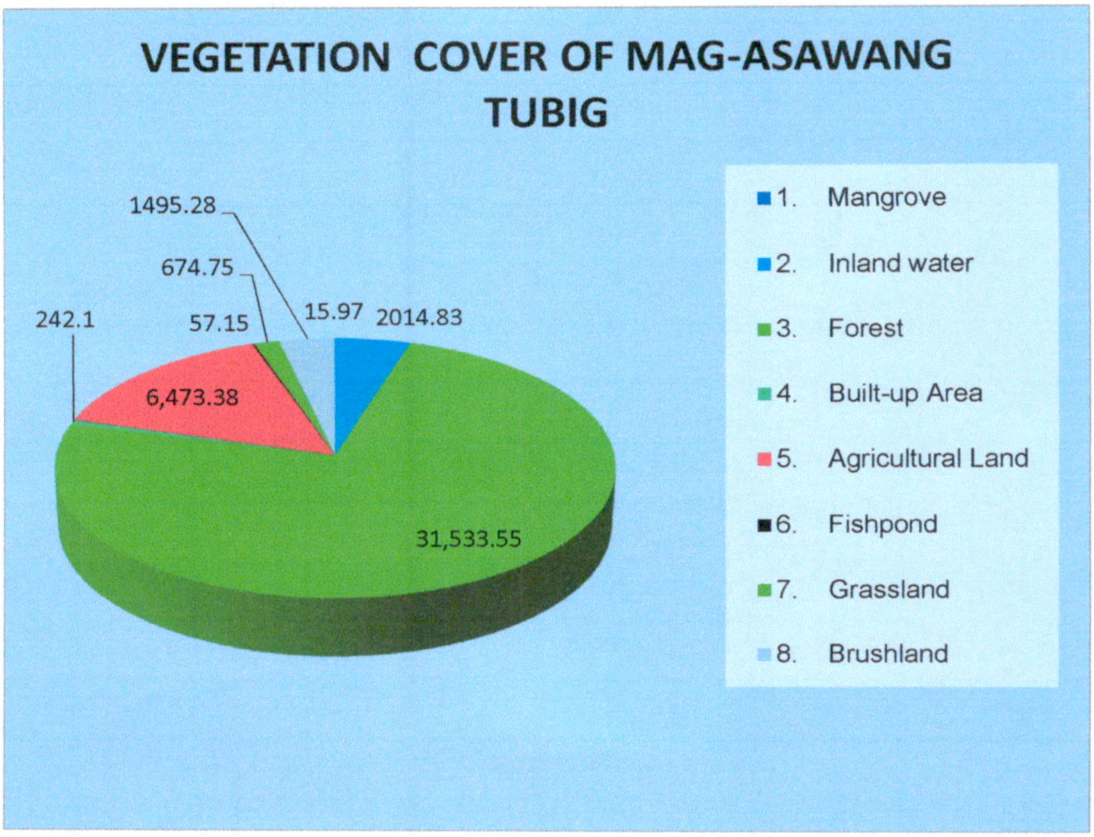


Figure 34. Vegetation cover of Mag-asawang Tubig Watershed



K. Hydrology and Water Quality

Mag-asawangTubig had been subdivided into seven (7) sub-watershed areas. The total length of these streams is 267.20 kilometers (Table 4). This watershed area has the longest basin length of all the rivers in Naujan having a total 101.22 kilometers distance that traverses from San Andres flowing downward to Estrella bay. Mag-asawangTubig water is classified by DENR as Class C Category which means that it is both conducive for recreational, industrial and aquatic uses. Figure 35 shows the drainage pattern of the watershed area. While Table 18 shows the physical characteristics of Mag-asawang Tubig river system. Accordingly, the main channel of the Mag-asawang tubig upper portion is braided and while going downward it became meandering. Bedloads of sediments of this river is attributed to the eroded soil occurred during the strong earthquate that struck the province of Oriental Mindoro in November 15, 1994. Up to the present day these sediments are being carried by the rainfall downpour. As a result, the riverbeds become full with bedloads causing the water to overflow and as a consequence flooded the lower valley of Naujan and Victoria.

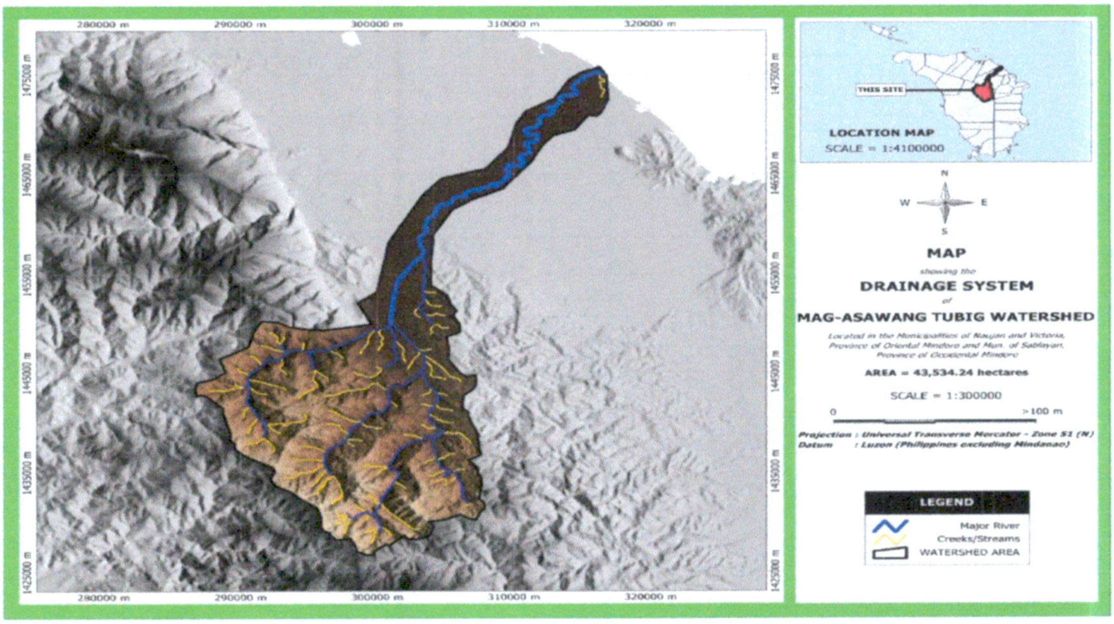
This watershed is a mountainous area as such, has a very difficult groundwater sources but the sub-watersheds in the area had several streams and creeks that are possible sources of water respectively in the lowland portion.

Table 18. River system physical characteristics of Mag-asawang Tubig Channel

River	Pattern	Slope (%)	Bed Load	Streambank vegetation	Streambank Gradients (%)
Mag-asawang Tubig Main Channel	Meandering And Breaded	0.42	Stones, rocks, Sand silt, and clay	Grasses, Brushes Coconut, seasonal crops	0-5
Aglubang River	Denditric	5.60	Stones, rocks and sand	Generally Secondary forest	30-100
Ibolo	Dendritic		Stones, rocks and sand	Generally Secondary forest	30-80

Source: DENR-ERDB, Undated

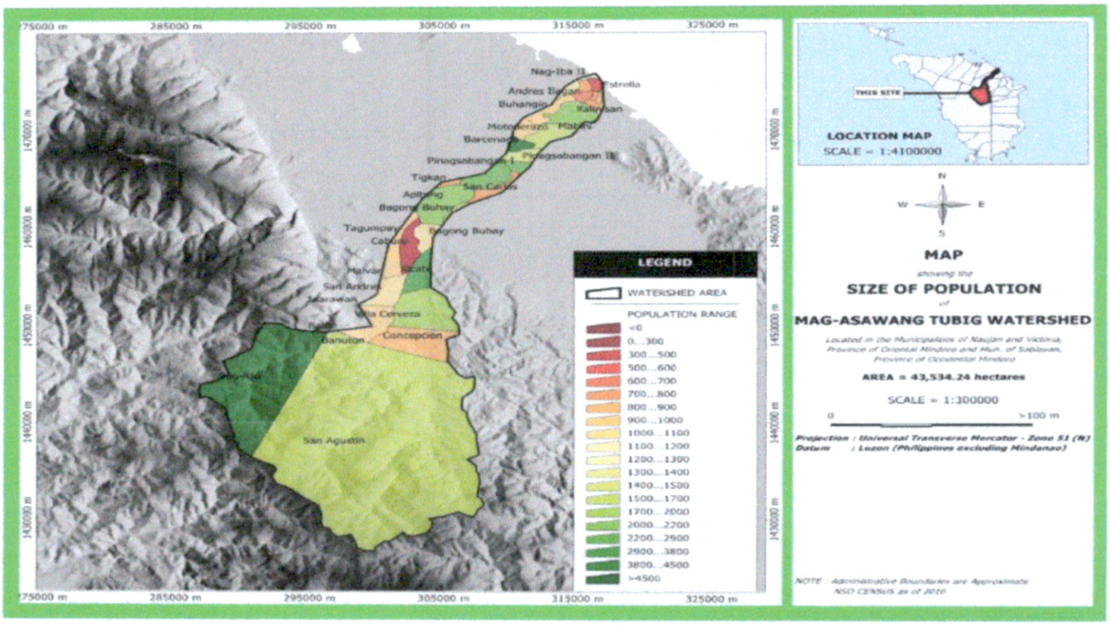
Figure 35. Map showing the drainage Pattern of the watershed area



L. Socio-institutional Characteristics

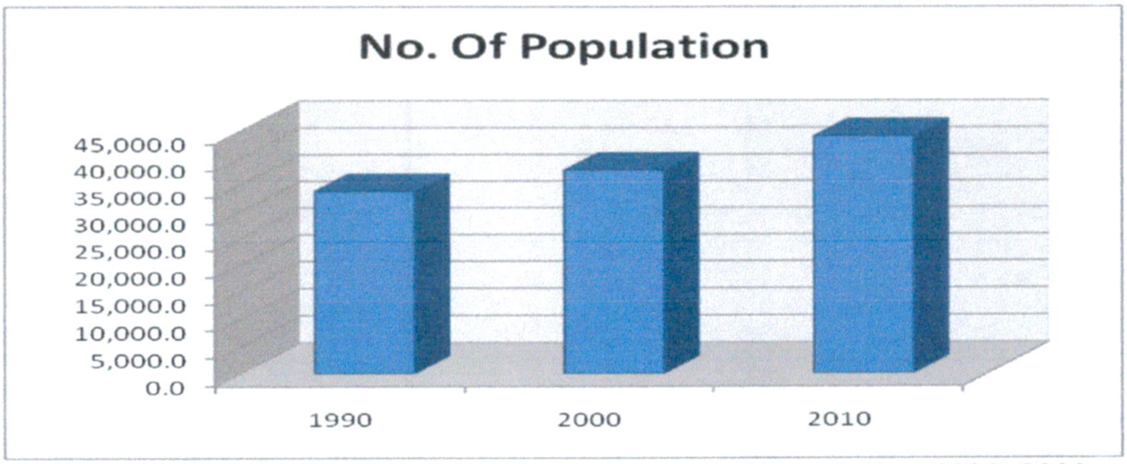
Based on the census of 2010 population inside in the Mag-asawang Tubig watershed is estimated to be around 44,471 individuals distributed in 27 number of barangays from the Municipalities of Sablayan, Occidental Mindoro (2), Naujan (22) and Victoria (3), Oriental Mindoro (Figure 36). Figure 37 shows the trends of increase of populations inside the watershed area. Most of these populations inside the watershed are located in the Municipality of Naujan. The population density in the watershed is computed as 0.98 person per hectare.

Figure 36. Population Map of the watershed area.



Source: Philippine Statistics Authority Census of Population 2010.

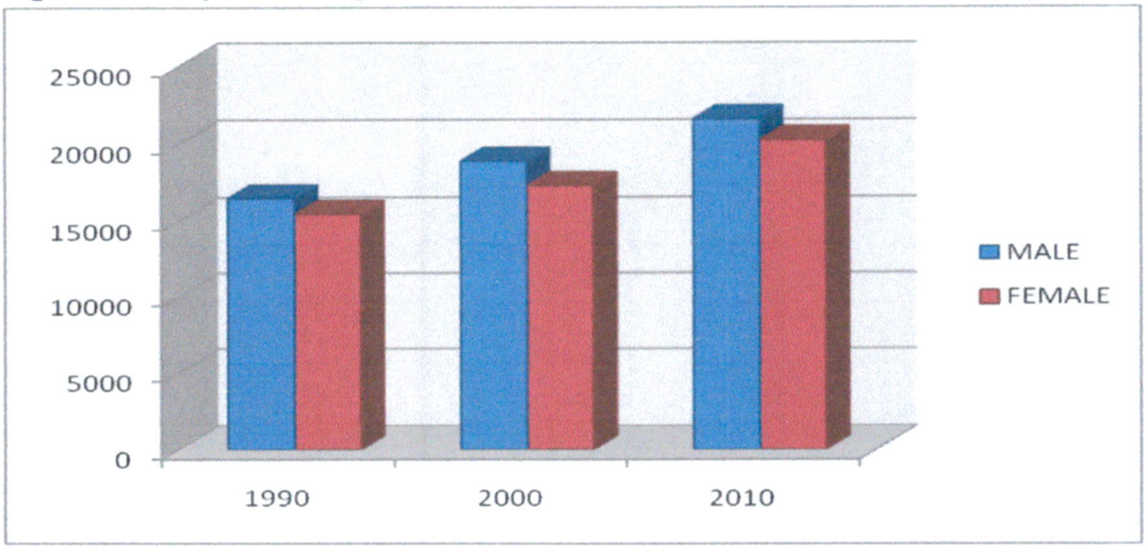
Figure 37. Census of Population in Mag-asawang Tubig watershed



Source: Philippine Statistics Authority Census of Population 1990, 2000, 2010

In 1990, 2000 and 2010 NSO Census of Populations, number of males is higher than female in terms of number (Figure 38).

Figure 38. Population by Sex

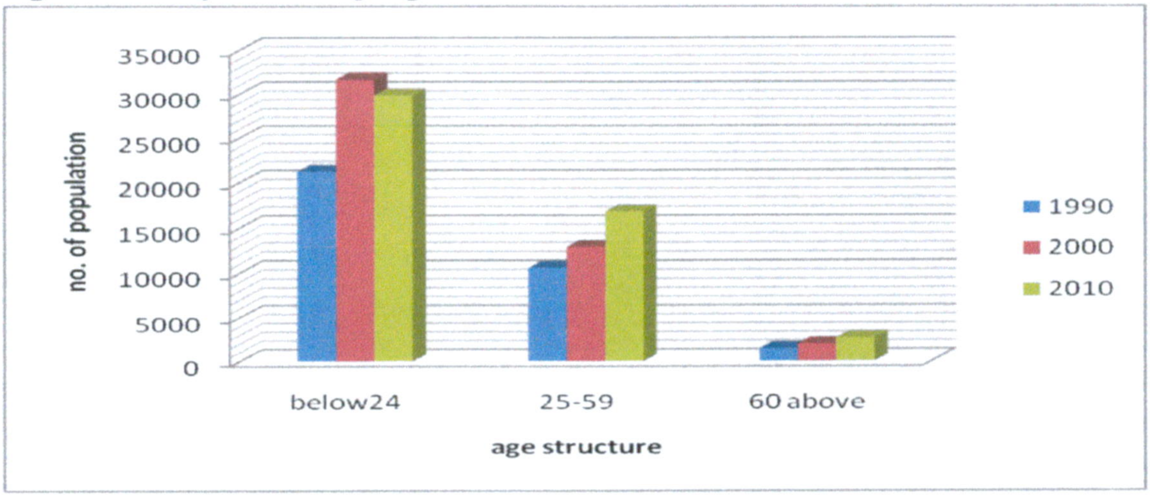


Source: Philippine Statistics Authority Census of Population 1990, 2000, 2010

1. Age Structure

Bulk of the population falls in the age structure of 24 years and below. In this age bracket, young age in the area belongs with. While for the household population 60 and above it is quite interesting to note that in this age bracket, number of populations decreases (Figure 39).

Figure 39. Population by Age Structure

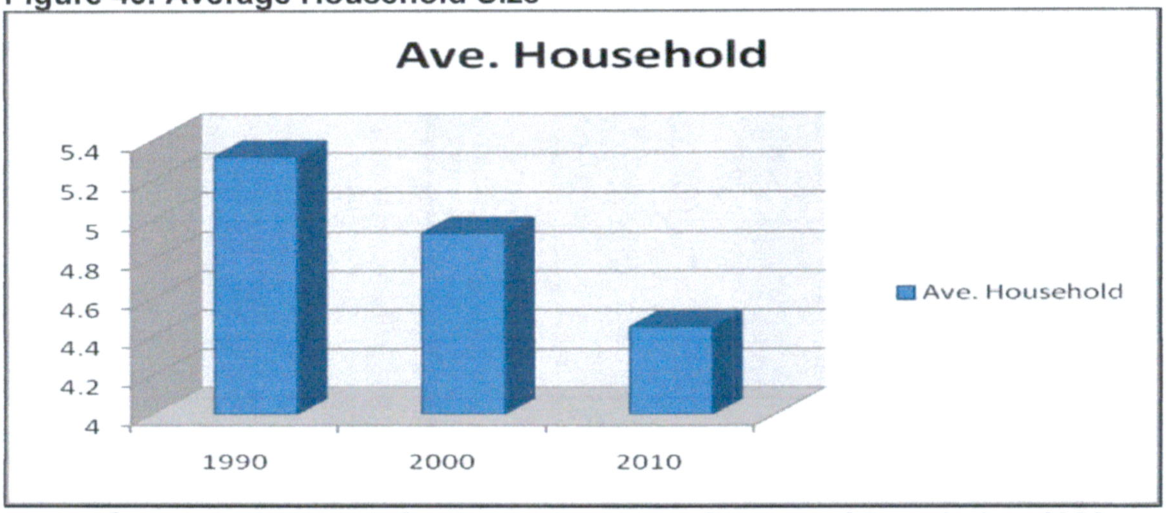


Source: Philippine Statistics Authority Census of Population 1990, 2000, 2010

2. **Household/Family Size**

In 2010, the recorded total households present in the watershed area has a total of 9842. These households have a corresponding 44,471 number of individuals (Annex 7). Average household size in the watershed is 4.60 person per household (Figure 40).

Figure 40. Average Household Size



Source: Philippine Statistics Authority Census of Population 1990, 2000, 2010

3. **Livelihood and Income/Profile/Sources**

Majority of the people in the area derived their income from agriculture although there are few who also derived income from other sources such as the services sector but still bulk of them sources their income from agriculture sector.

4. **Sectoral Production**

Agricultural sector has the biggest production in the area especially from palay or rice. While Lanzones, Coconut and Rambutan, Durian are the most common tropical fruits harvested in the area thus considering the province as the fruit basket of Southern Tagalog.

5. **Employment Pattern and Projection**

While development and modernization of adjacent towns and provinces are in fast pace trends as noted in the provinces of Batangas and Laguna, projection of the employment for the next ten years indicates that the residents in the area will still be deriving their income and livelihood from the agriculture sector production.

6. **Social, Educational, and Medical Services**

a. Education

All barangays in the watershed area has elementary school while there are secondary schools strategically located. This give the residents of an equal access and opportunity in education.

Mindoro State College of Agriculture and Technology located at Brgy. Alcate, Victoria, Oriental Mindoro is biggest school giving tertiary school in the area and adjacent municipalities.

More females than males had attained higher levels of education as majority of those with academic degrees were females (formerly NSO now PSA).

b. Health

Medical services are provided by Municipal Hospitals in the town proper. Barangay Health Workers assisted the residents in delivering basic health services in the locality. Some private hospitals are also available in the town proper of Victoria, Oriental Mindoro.

c. Social Services

Municipal Social Welfare and Development Office is the leading unit of local government in providing basic social services to the community. This unit of the local government give care, protection and empowered the socially, economically and physically disadvantage sectors in the municipality.

Leading morbidity in the area are pneumonia respiratory infection and parasitism. There is also a high incidence of diseases like cardio-diseases that are considered diseases of the lifestyle.

7. **Transportation and Communication**

a. Transportations

The watershed area is accessible by means of land transport vehicle through the Barangay road network but upon reaching the upland area, man-made trail is the only available way to reach the inner watershed area.

b. Communications

Modernization had brought communications in the area through the cellular phone where there are signals but in the inner most of the watershed area, signal is not available hence no available communication.

8. **Tourism and Recreation**

a. Tourism

The watershed area still possesses its natural lust and beauty though no man-made structure for tourism purposes is present still the area is ideal for nature lover. There are several tourist spots in the area both developed and under develop.

b. Recreation

Natural river system is the available recreation in the watershed area. Pristine water from the mountain drain to this river.

9. **Religious Sectors, Political, and Social Organization**

a. Religious

Based on the 2010 record of Philippine Statistics Office, Roman Catholic has the biggest members in terms of followers and the rest are members of another religious sect such as Iglesia ni Cristo, Protestant and Aglipay to name a few.

b. Social Organization

The social organization existing in the area is through kinship and family ties, a norms and tradition of the Filipino people.

c. Political Subdivision

Political subdivision in the area is through barangay boundaries and municipal boundaries but the sudden increase in population now further subdivided the barangay into more sitio electing their Purok leaders through appointment. This way will help the local government administration to properly manage the public at the barangay level.

d. Citizen Participation

The local barangay officials are the leading group that provided direction and leading the communities in the area whenever there are issues and concern that needed to be disseminated to the residents in the watershed area.

e. Ancestral Domain Claims

There are portions of the watershed that falls within the CADC area. The Alangan tribe of Mangyan indigenous group of the province of Oriental Mindoro is the dominant residents occupying the said CADC area inside the watershed. Approximately this is around 10,816.54 hectares.

10. Behavioral and Cultural Patterns

Since the population in the watershed area are combinations of different migrants and mangyan folks, each one of these group practice their traditional life and culture unique to them. The issues being common to them is the operation of mining company in the watershed area. Opposition for this mining project had crossed religious, cultural and political group thus up to now approval and actual operation did not push for the moment.

Vulnerability Assessment Report

I. Methodology in Vulnerability Assessment and Hazard Analysis

The site selected is a predetermined area and one of the targets to be accomplished for this year in the aspect of watershed study anchored on the river basin program of the DENR. This is part of the river basin in the province of Oriental Mindoro whose function is vital to agriculture, knowing this province as the food basket of Southern Tagalog. Mag-asawang Tubig Watershed is located part of the province of Occidental Mindoro and Oriental Mindoro and one of the vital sources of water of the towns of Victoria and Naujan.

Rapid internet searching was made to collect information on available articles and literatures about vulnerability assessment. Previous characterization study of Mag-asawang Tubig Watershed served as one of the guiding papers in completing this research.

Secondary data from different government agencies were collected as well as available profile, forest land-use plan and comprehensive last use plan were requested from the Municipalities Naujan and Victoria for this study of vulnerability assessment of this watershed. Climatic data were requested from PAGASA office in Quezon City while the demographic information came from the Office of the Regional Director of Philippine Statistics Authority based in Calapan City, Oriental Mindoro.

Geospatial analysis was made by using the GIS tools. Different watershed attributes were overlaid and combined to produce the needed mapping information and analysis relevant to the vulnerability assessment study of Magasawang Tubig Watershed.

All these data collected were synthesized and interpolated. The guidelines prepared by Ecosystem Research and Development Bureau (ERDB) was utilized as the guiding tools for the scaling of factors to produce and determine the vulnerability assessment of this watershed from the natural and anthropogenic activities.

II. Results and Discussion

A. Hazard Identification and Critical Factor Analysis

DOST-PAGASA (2018) presented climate change projection for the Philippines was modified by using the IPCC set of scenarios representing the cumulative concentration of GHGs It is now designated as Representative Concentration Pathways (RCP) with names that is based on the energy accumulated by GHGs in our atmosphere. Climate change experiences in the Philippines such as the temperature is warming registered an average rate of 0.10 Celsius increase per decade. Based on PAGASA projections our average mean temperature may further increase at the rate of 0.9^{0}Celsius-1.9^{0}Celsius (assumptions of RPC 4.5 moderate emission scenario) within the 2036-2065 period and for the year 2070- 2099 could further increase from 1.3^{0}Celsius-2.5^{0}Celsius (RPC 4.5) to 2.5^{0}Celsius-4.1^{0}Celsius (RCP 8.5) following the baseline used on temperature from 1971-2000.

While changes for the projected rainfall both for annual and seasonal rainfall for many parts of the country had been noted also. These rainfall increases and decreases exceeding the 40 percent of the historical values from 1971 to 2000 (Table 19) baseline period.

On the part of the tropical cyclone hitting the country, there was a slight decrease in number for the past 65 years however the typhoon with higher intensity (exceeding the 170 km/hour) increases. This scenario will be a dominant in the future climate conditions of our country.

As mention earlier based on the study of Oyewole, 2014, relative humidity increases as rainfall increases. Relationship of temperature and relative humidity was observed that as the temperature increases the relative humidity decreases. Then there is changes in relative humidity when temperatures changed. That's due to the fact that warm air can hold more water vapor than cool air, thus when the relative humidity falls because the temperature rises hence no moisture is added to the air.

Table 19. CLIRAM of the total rainfall (In mm) for the province of Oriental Mindoro (baseline period 1971-2000)

OBSERVED (1971-2000)			
DJF	MAM	JJA	SON
260.30	269.30	894.30	791.20

(Source: DOST PAGASA, 2018)

The new approach for the climate projection for the Philippines is based on the principle of Climate Information Risk Analysis Matrix (CLIRAM) tool. This tool provides the projected changes for climate data such rainfall and temperature. Table 20 shows the province of Oriental Mindoro projected changes for the month of slight reduces for the month of June, July and August under RCP 4.5 9upper bound for the period 2036 to 2065. While for the RCP

8.5 (upper bound) all the rainfall amount increases. In this context projected flooding in the Province of Oriental Mindoro particularly Naujan and Victoria may also increase for the mid-21st century. Thus, the role of the LGU's will have to adapt several strategies to lessen the impacts of flooding.

Table 20. CLIRAM of the Projected seasonal change in total rainfall in millimeters in the mid-21st century (2036-2065) for the province of Oriental Mindoro

Projected (2036-2065)									
Scenario	Range	DJF(December-January-February)		MAM(March-April-May)		JJA(June-July-August)		SON(September-October-November)	
		Percent Change	Projected Value	Percent Change	Projected Value	Percent Change	Projected Value	Percent Change	Projected Value
Moderate Emission RCP 4.5	Lower Bound	0.0	260.2	3.6	279.1	-24.9	671.2	-17.3	654.6
	Median	10.8	288.5	5.6	284.3	-18.8	726.2	-7.7	729.9
	Upper Bound	31.9	343.3	12.3	302.5	-0.4	890.8	5.2	832.3
High Emission RCP 8.5	Lower Bound	-2.7	253.3	-9.5	243.7	-27.2	650.7	-13.9	681.2
	Median	13.9	296.6	5.7	284.6	-12.9	778.9	-5.8	737.5
	Upper Bound	27.9	332.8	9.2	294.1	9.5	979.6	4.9	829.8

From the result of the characterization of the Mag-asawang Tubig watershed it has been assessed that the most hazardous events commonly occurring in the downstream communities of Mag-asawang Tubig is the flooding (Figure 41). Based on the gathered information from the Office of the Oriental Mindoro PDDRMO which recorded the flooding incidents from 2005 to 2018 damages to agriculture and infrastructure amounted to billions of pesos (Table 21).

Flooding is a type of phenomena many countries in the world seriously attended with outmost perseverance and dedication. In tropical countries like the Philippines floods are commonly caused by heavy rainfall where the magnitude may bring flash floods but it is only caused by nature what about the contribution of human activities. In other parts of the world the threshold level is 100mm per day but the Philippines particularly in Oriental Mindoro is higher than the worldwide than usual average threshold.

All of these disasters were disastrous that for today worth to remember with. To look back not only to remember but how we can analyze to avoid these scenarios and put readiness to avoid further losses to human lives and properties. Accolades should be given to the DENR for initializing the conduct of Vulnerability assessment of Mag-asawang Tubig watershed.

Floods are natural hazards; however, this is not caused by nature but by human activities as well (Mohammed et al. 2017). Several studies on the impact of flooding was reviewed, one of these is the research made by Eguaroje et. al. in 2015 on the Flood Vulnerability Assessment of Ibadan City, Oyo State, Nigeria. In this study it was found out that flood harm the city without returning any benefits to the communities, hence we could say that flood is a destructive factor that need to be watched upon with the objective of preparing the proper coping mechanisms to avoid destruction to people's lives and properties.

There are three critical factors identified as the cause of the flooding in the vicinities of the downstream communities of Mag-asawang Tubig watershed. These are the following;

a. Physiography

The location of the communities in the downstream of Mag-asawang Tubig watershed especially those that are near the riverbank are very prone to flooding (Figure 42). These areas that identified prone to flooding are the catch basin of water coming from the upstream of Mag-asawang Tubig. Thus, the tendency of the water which overflows the riverbank of the river channel of Mag-asawang Tubig watershed that traversed the area going to the Estrella Bay located the Municipality of Naujan, Oriental Mindoro. Worse is that the flood water is further aggravated by the overflow of water from the Caturian River as narrated by the staff of Naujan MDRRMO.

Figure 41. Flood Susceptibility Map of Mag-asawang Tubig Watershed

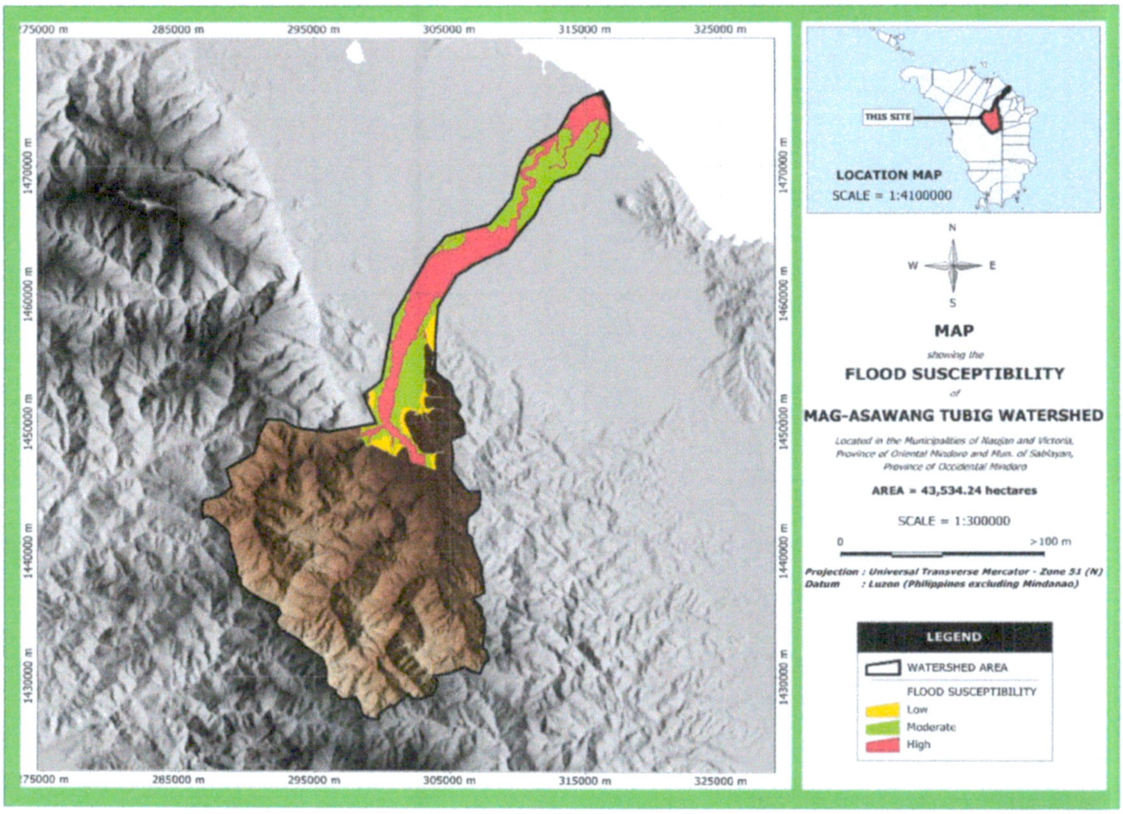
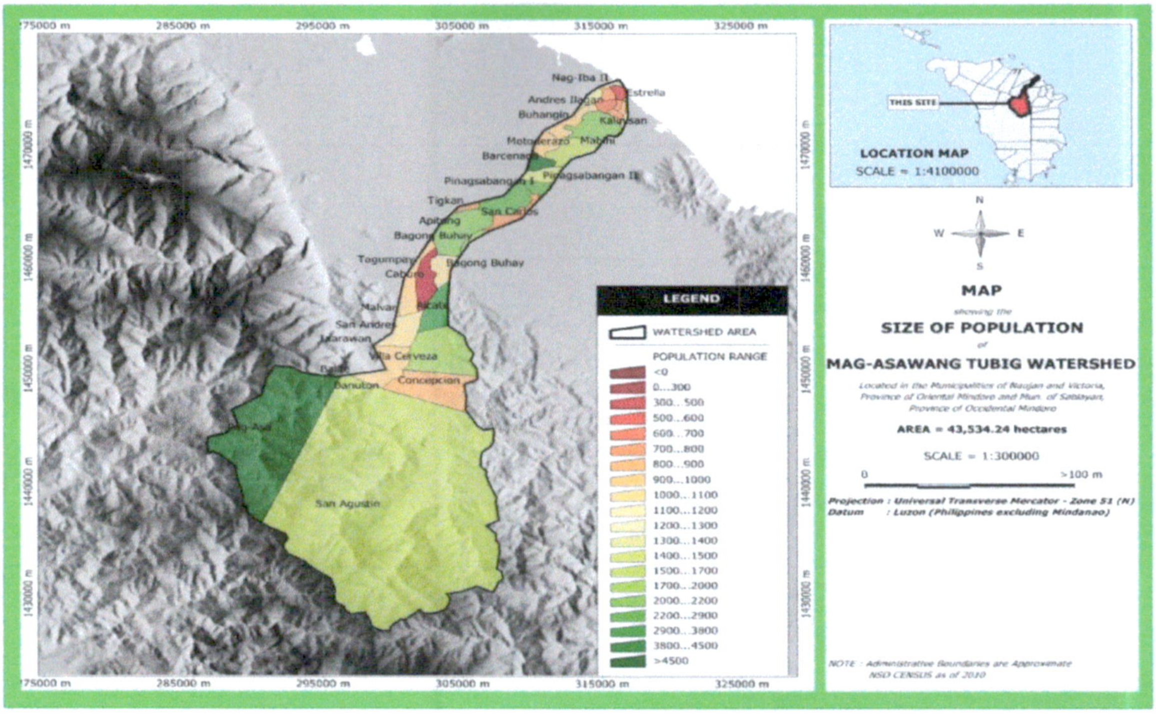


Figure 42. Location of the downstream communities of Mag-asawang Tubig Watershed



b. River and Channel Aggradation

The water moving downward to the lowland communities of Mag-asawang Tubig watershed came from the mountainous portion thus the sudden movement of water moving downward caused the sediments to be deposited to the riverbeds.

One of the contributory factors for the higher sediment's deposits in the riverbeds of Mag-asawang Tubig river channel is the major earthquake that hit the province of Oriental Mindoro in November 15, 1994. Many loose soils and boulders were transported downward every time the area is hit by heavy rainfall. Previous deep of the river of Mag-asawang Tubig is no longer the same as before due to the accumulations of bedloads of sediments thus the water moving downward overflows the riverbank causing flooding to the lower valley where the water settled at lowest point in the area.

Heavy depositions of sediments were caused by the Aglubang and Ibolo rivers of Mag-asawang Tubig watershed occurred after the earthquake in 1994. This incidence redefines the river geometry thus bifurcation or branching of rivers occurred. The frequent overflowing of river channel due to flood inundation was caused by reduced channel capacity.

c) Heavy rainfall

Another contributory factor to the occurrences of flooding in the downstream communities of Mag-asawang tubig watershed is the heavy rainfall. Mindoro being a typhoon belt province which frequently visited by typhoon is no longer new to the residents in the area. From the world threshold of 100 mm daily rainfall, Oriental Mindoro's average daily exceeded that point thus causing flooding to the lower valley. Uptrends amount of rainfall from 1960-2017 indicated the continues risk to flooding of many communities in the downstream of Mag-asawang Tubig watershed. This is shown on the records of the Oriental Mindoro PDRRMO where the occurrence of typhoons had caused a lot of flooding in many areas in the Province, Victoria and Naujan are no exemption. Though there are times that even there is no typhoon heavy downpour occurred that caused flooding, most of the times it was noted that heavy rainfall was brought by the passing of typhoon in the province. This depth of rainfall can cause tremendous volume of runoff and therefore can trigger flooding in the low-lying areas. By its location, storms frequently pass near or within the island of Mindoro which increases the probability of flooding occurrence. As discussed in earlier section of the report, most of the reported high flood damages occurred during the passage of typhoons in the area.

Table 21. Disaster that hit Oriental Mindoro

Type of Disaster	Date Occurred	Location	No. of Dead/ Injured/Affected Persons/Families	Estimated Damages ('000 Pesos
Flashflood	Dec. 6-7, 2005	163 Brgys, Calapan, Naujan, Victoria, Socorro, Pola, Pinamalayan & Baco	Dead - 2 Affected Families 30,420 Affected Persons 155,274	325,450.00
Flashflood - Typhoon Quedan and continuous heavy rains	December 17 and 27, 2005	141 barangays (Baco, San Teodoro, Puerto Galera, Naujan, Victoria, Calapan City, Pinamalayan, Bansud, Bongabong, Roxas, Mansalay & Bulalacao	Dead - 1 Affected Families 52,414 Affected Persons 133,190	Infrastructure damage PhP158.98 Agricultural losses PhP166.47
Typhoon Caloy Dead -8 Php	Typhoon Caloy	All munipalities	Dead -8 Php 2,624.81 Injured - 30 Affected	Php 2,624.81

2,624.81 Injured - 30 Affected Families 81,860 Affected Persons 407,750			Families 81,860 Affected Persons 407,750	
Typhoon "Reming".	November 30-December 1, 2006	244 barangays in Calapan City, Baco, Gloria, Naujan,	3 dead 36,776 families or 163,213 persons were affected. A 13,458 Damaged Houses.	Infrastructure damages PhP25.3 Agricultural damages PhP296.1 million.
Typhoon Seniang	December 6-15, 2006	Farmers of Baco, Bansud, Bongabong, Calapan City, Gloria, Mansalay, Pinamalayan, Roxas and Victoria		PhP139, 214,281.00
Typhoon Feria	June 24, 2009	76 brgys. (Calapan) Pinamalayan, Pola Bansud, Naujan & Socorro)	2,744 families and 13,565 individuals affected	Agricultural Damages PhP30,074,500.00 Infrastructure Damages PhP6, 250.00.
Flashflood	Jan. 17-18,2010	61 brgys. (Baco, Naujan, Calapan, and Victoria)	Dead - 2 Injured - 346 Affected Families 5,876	Php 72,140.00
Flooding Incident.	February 7, 2011	A total of 13 flooded municipalities and	2 dead 329 farmers affected, 6 houses damage	Agriculutural Damages - PhP1, 477,321.00
- "Flashflood" .	March 26 and 28, 2012	A total of 88 barangays from Baco, Calapan, Naujan, Pola, and Vitoria were affected.	1,835 farmers affected.	Infrastructure damages PhP44.01 agricultural damages PhP16.7 million

Typhoon "Ofel"	October 25, 2012	Baco, Puerto Galera, Calapan City, Victoria, Pola, Bansud, Bongabong, Roxas, Mansalay, Gloria, Bulalacao, and Pinamalayan	5 death and 34 injured. 29,504 families or 73,031 individuals affected. 4,240 damaged houses. 13,026 families/person were rescued and evacuated.	Infrastructure damages PhP89.4 agricultural damages PhP774.1 million
Typhoon "Yolanda"	November 8-9, 2013	14 municipalities and 1 city	4 injured, 11, 547 families, 45,280 individuals rescued and evacuated. Totally damaged houses 439, Partially Damaged Houses 1, 029	Agriculture Damages-2,912,000.00. Electrical Facilities-2,000,000.00 Infrastructure - 25,448,100.00
Typhoon "Glenda".	July 14-16, 2014	Calapan City and Naujan	1 dead, 62 totally damaged houses, 97 partially damage	Agricultural damages: 1,520,611.00
Typhoon "Ruby"	December 8, 2014	15 municipalities	1 dead 2 injured	Agricultural damages PhP29, 299, 845, 98.00. infrastructure damages PhP6,500,000.00
- "Flashfloods" cause of heavy rains	December 23-27, 2014	12 barangays namely: Antipolo, Bayani, Andrialuna, Pinagsabangan II, San Carlos, Apitong, Sampaguita, Gamao, Nag-iba I, Tigkan, Sta. Isabel and Sto. Niño.	95 persons were affected	Agricultural Damages 3,787,180.00; 171.35 hectares affected

Flashflood" due to continuous heavy rain.	December 31, 2014-January 5, 2015	9 barangays in municipality of Victoria.	171 farmers affected. A total of 334 totally and partially affected	Agricultural damages 6.2 million
"Flashflood" heavy "Rain Shower" that caused "Magasawang Tubig River" Overflow at Barangay Alcate, Municipality of Victoria.	January 1, 2015	Barangay Alcate, Victoria	185 population were affected and evacuated.	Estimated cost was 6,221,595.00
Typhoon "Nona"	December 14-15,2015	Calapan City, Naujan, Victoria, Socorro, Pola, Pinamalayan, Gloria, Baco, San Teodoro, Pto. Galera	Casualty 13 dead and 401 injured 95,651 families and 422,495 individuals displaced in 396 designated evacuation centers from 384 affected barangays Totally damaged houses: 30,064 Partially damaged houses: 46,478	Agriculture w/coconut 3,587,800,809.30 Infrastructure: 1,620,313,230.10 Environment: 7,400,000.00 Power: 290,622,177.12
Typhoon Nina		Calapan City, Baco, Naujan, Victoria, Socorro	Totally Damage Houses 3,702 Partially Damage Houses 12, 906 Education Sector: 37 totally damage classroom 261 partially damage houses Damages:	Infrastructure: (Damages) National Road (9,565,000.00) Agriculture Damages: 104,121,000.00 Provincial Road 1,549,000.000

				Education Sector - 24,006,370.00 damage houses 78,497,944.79
Typhoon Usman	December 30, 2018	Calapan City, Baco, Naujan, Victoria, Socorro, Pinamalayan, Gloria, Bansud and Bongabong	Totally Damaged House: 336 Partially damaged house: 446 Affected families: 37,468 or 98,440 165 flooded Barangay	Agricultural Damages: 314,137,313.25 Infrastructure damages; 1,669,733,688.84

(Source: Oriental Mindoro PDRRMO)

B. Adaptive Capacity Components

1. Hazard in Relations to Community

From 2005 up to 2018 eight flashfloods occurred in the province of Oriental Mindoro. All of these also hit the Municipalities of Victoria and Naujan. These flashfloods were caused by few days of continues rainfall thus resulted to the heavy discharge of water from the upstream of Mag-asawang Tubig watershed to the river channel traversing Victoria and Naujan downward to Estrella bay. Those communities with low point valley were mostly affected near the riverbank of Mag-asawang Tubig watershed.

While Typhoon Quedan, Reming and Caloy passed the area in 2005 and 2006. These typhoons brought large volume of water that considerably damaged in the vicinities of Victoria and Naujan. Regular were occurrences of typhoon on the succeeding years up to 2018 repeatedly damaged different communities in the downstream of Mag-asawang Tubig watershed. One of these is the typhoon Nona that hit the northern part of Oriental Mindoro In December 14 and 15, 2015. During this time not only, the floods affected many properties but also felled many big trees that existed in the area for centuries.

2. Impacts of Hazards to Communities

Displacement, anxiety, trauma and stress are the most common effect of the disasters in the area affected by calamities particularly flooding. In the vicinities of Mag-asawang Tubig watershed floods affected the residences of the stakeholders especially when the river overflows in the lower valley portion. Damages to properties and agricultural crops were also experienced by the residents in the flood prone areas of this watershed. Based on views gathered from the communities inside the watershed their perceptions on flood intensity varies from normal, manageable and to an extreme as disastrous. These perceptions are explained below, to wit:

a. Normal – the community perceived that flood is a natural event and they were already familiar with it because it happened every year during rainy seasons. Flooding is not an unusual event to them.

b. Manageable – they accepted that flood occurrence is a natural recurring event and they still can manage it. It affected their normal life as it caused various problems such as lack of clean water to drink and difficulty to work in their farms. In this level, people preferred to stay in their flooded houses rather than go to evacuation centers and higher areas. People with two storey houses or in some elevated areas continued their daily activities.

c. Unmanageable – people considered that they find it difficult to deal with the flood anymore because the level is already too high and it caused great problems to their family. Flood caused serious damage to their properties, agricultural crops and some infrastructures within the community.

d. Disastrous – uncontrollable flood and respondents preferred to evacuate themselves in higher and safer places. If they have the means, they intend to look for better area to live.

3. Coping Mechanisms

According to the residents in the area flood occurrence is a natural phenomenon that they were used to experience for many years since they live in the community to where they stay today. They have no other choice but to be always ready and alert when the typhoon and rainy season of the year came. Communities in the vicinities of Mag-asawang Tubig from the Municipalities of Naujan and Victoria, Oriental Mindoro employed various strategies to cope and adapt themselves to flooding. Most of the common strategies employed by these people are the following:

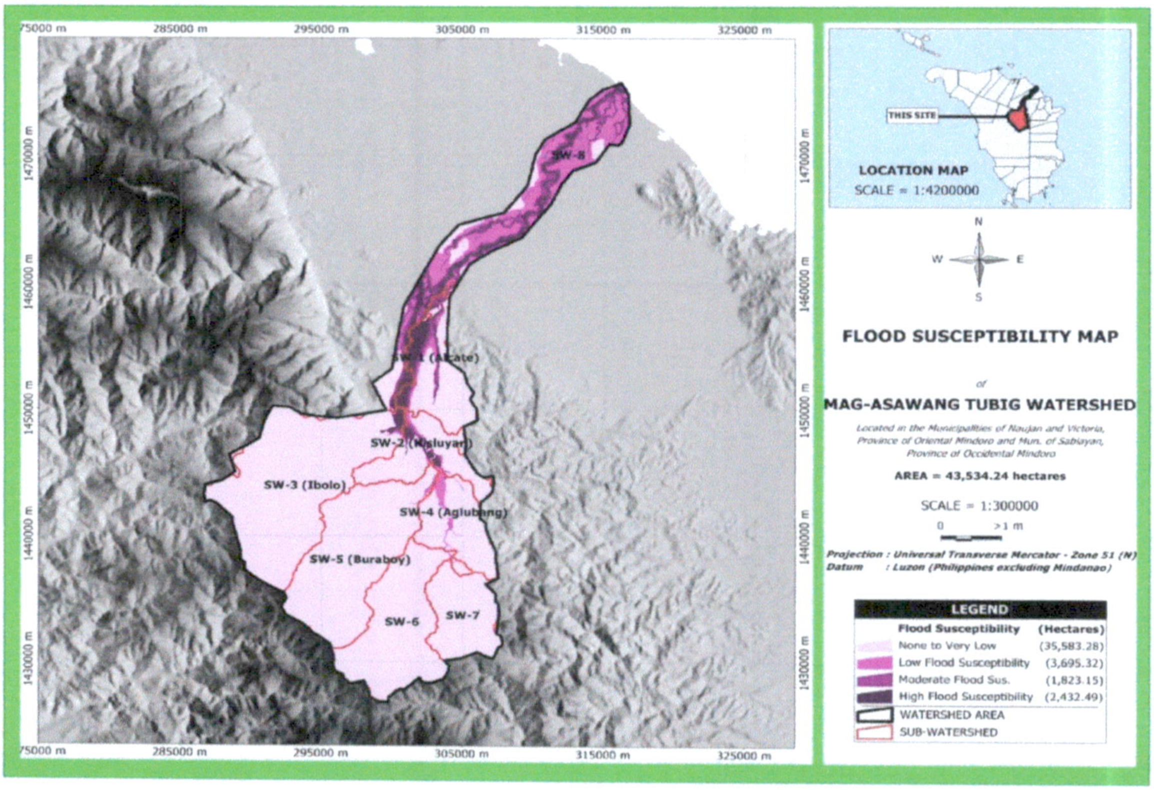
a. Storing of furniture and other valuables in higher places (covered with
plastics) when rainy season comes;

b. Making of banca from banana trunk and bamboo raft for evacuation and means of transport during time of high-water level;
c. Storing a ladder;
d. Checking of water level in the river during heavy rains and typhoons;
e. Cleaning of canals;
f. Building a house with more than one floor;
g. Abandonment of field constantly flooded;
h. Adjusting rice planting so it will be harvestable by November;
i. Dredging of the river

4. Adaptive Capacity Assessment

Based on the assessment using the guidelines for scaling up of factors from ERDB the communities inside the watershed had been assessed with a high adaptive capacity because of their experiences with the flooding incidence in the area occurred during the previous years they have adjusted to cope up with the magnitude of flooding in their communities. Figure 43 shows the new flood susceptibility map after overlaying the assessment on the adaptive of the communities inside the watershed area. Support of the LGU's concern help a lot the residents in the downstream communities of Mag-asawang Tubig Watershed to be resilient to flooding.

Figure 43. New Flood Susceptibility Map of Mag-asawang Tubig watershed



5. **Gender and Development (GAD)**

From the result of the census of population conducted in 1990, 2000 and 2010 male populations outnumber the number of female populations. However recent observations in the communities inside the Mag-asawang Tubig watershed those that were left in the house were mostly women. This is true in the sense that most male being head of the family work in the rice field or in the nearby places while they are waiting for the harvest season. This means that those staying in the house during the daytime are women. If the flooding will happen during the day women are the one who will bear the responsibility of taking care of the family. The situation will be different in the coping mechanism since male and female has differences in responsibilities. Due to this factor the female has more difficulty in the recovery after the flood since they are the one taking care the family. Physically, women are not that strong as men hence they are needing help. With this analogy it is important to strengthen the readiness of the women through the capacity building program for women. The role of the LGU on this aspect will be needed as they are the one having the resources dealing the Gender and Development at the local level.

III. Summary and Conclusion

Based on the study of *Oyewole* et al, (2014) relationship of climatic factors are indicators of changing climatic conditions in any locality. That study is also supplemented by the Inter-governmental Panel on Climate Change were scenarios were illustrated that increase of temperature and rainfall may probably increase given the present environmental condition of Southeast Asia, the Philippines included. That scenario is now quietly experienced by many of us last summer. Hottest climate was even feeling by us here in the province of Oriental Mindoro. There was the delay of the onset of the rainy season and worst that may have possible impact to increase possible downpour of rainfall in the province.

Pervasive impacts of climate change may result to intensify flooding, droughts and landslide causing soil erosion thereby losing soil fertility. As a consequence, vulnerable areas may further aggravate by losing agricultural productions thus affecting human food security. When it comes to coping mechanisms, several issues must address upon on the broad issues of climate change. Take a look at the case of this study area, the Mag-asawang Tubig Watershed which covers the Municipalities of Naujan and Victoria in the province of Oriental Mindoro.

Repeated occurrences of strong floods in the vicinities of Victoria and Naujan brought by heavy rainfall and the strong typhoon became tremendous and alarming. As such flooding causes disasters and brought problems to the communities living in the lowland valley in these municipalities. Serious steps must be undertaken by the government to come up with a workable and realistic solutions that can help ease out the devastations brought up by these phenomena.

The present state of the Mag-asawang Tubig Watershed particularly the forestland area are the remnants of the old logging companies that operated in the area way back during the flourishing of timber harvesting in the province of Oriental Mindoro. After the logging companies abandoned their concession areas, local residents including the minorities utilized the site for slash and burn cultivation. Previous cover of this bountiful forest is now covered with shrubs and grasses.

Knowing the impact of the loss of forest cover of Mag-asawang Tubig Watershed, projects such as the National Greening Program was implemented but when the funds for this project diminished and the project was terminated the enthusiasm for the sustainability effort also ended. Loss of forest cover contributed to global warming or climate change, as a matter of fact several flooding struck affected the low-lying barangays within the lowland communities of Mag-asawang Tubig Watershed. Destructions of agricultural crops and infrastructures recorded amounted to billion pesos.

Assessment of vulnerability of Mag-asawang Tubig Watershed indicates that this area is mostly affected by flooding hazard. The adaptive capacity of the communities in the municipalities covering this watershed revealed the readiness to risk and disasters of the stakeholders. But continued anthropogenic activities such as illegal cutting of trees and opening of forest areas in steep slope may lead to further exposure of Mag-asawang Tubig Watershed to climatic extremes and even though there are several coping mechanisms adopted.

Cognizant of the probable dilemma faced by the stakeholders of this watershed additional mitigating measures must be laid out and continues practice to come up with the right protection needed (Khan, 2012). We must think of what are the other possible consequences if they are to continue neglecting the protection and conservation of this watershed. Once again it is interesting to note that adaptive capacity or readiness of the stakeholders must be assured to cope up with the climate change happening today where contributions of Mag-asawang Tubig Watershed continuous destruction become also part of this event.

In addition to this, the adaptive capacity to cope up with the identified vulnerabilities of the stakeholders must be institutionalized. In this aspect, the local government unit should provide enough funds and efforts to assure the readiness of the communities located in the vulnerable areas to lessen the damages to lives and properties.

Given the profile of the Mag-asawang Tubig watershed as a result of keen analysis using different information derived, Integrated Watershed Management Plan can now be prepared.

IV. Recommendations

Getting the idea from the research of Lemieux et. al (2012) adaptive measures should be taken into considerations especially in the risk reduction and management brought by the climate extreme and variability's such as flooding, assessment of readiness of the communities as well as the capacity to respond to the situation must be exercise by the government particularly the LGU concern. Monitoring and evaluation should be conducted also to determine on whether the adaptation is successful or eliminated or reduced the effects of vulnerabilities to the people themselves.

Knowing the possibilities of an effective protection and conservation of Mag-asawang Tubig watershed. Policies and implementations plan and programs must gear up towards the readiness and preparedness of the communities within the vicinities of the watershed particularly those living in the flood prone areas.

From the result of the consultations with the stakeholders during the characterization phase of Mag-asawang Tubig Watershed, the following are the recommendations towards the capacitation of the stakeholders inside the watershed:

A. Mitigation Measures

1. Planting of trees in the open and denuded area to prevent flooding.
2. Construction of dike to prevent overflowing of river.
3. Protection of riverbank through the construction of gabion and planting of bamboos along the riverbank.
4. Construction of the foot bridge to allow the people to cross the river even there is flood.
5. Dredging of the riverbeds to remove the bedloads of sediments hampering the flow of water.
6. Intensify the conduct of Information, Education and Communication campaign to help increase awareness of the need to protect Mag-asawang Tubig Watershed.
7. Erection of flood gauge in the vicinities of Villacerveza, Victoria, Oriental Mindoro to warn the downstream communities of water level that may cause flooding in the river of Magasawang Tubig watershed traversing Victoria and Naujan.

B. Policy Recommendations

Policy is something that guides the implementation and management of the Mag-asawang Tubig Watershed. Relative to this, the following are the recommended policies:

1. Policy that strengthen the collaboration effort of the LGU and the DENR, and other sectors of society with interest in this ecosystem in managing the Mag-asawang Tubig Watershed.

2. Policy that adhere to the principles of the sustainable management of whatever resources the Mag-asawang Tubig Watershed poses.
3. Policy that further intensified the forest protection and law enforcement rules and regulations by allowing the LGU's to adopt the DENR laws on forest conservation and development and be an important partner in battling the poaching and illegal cutting of trees inside the Mag-asawang Tubig Watershed and vicinities.

4. Policy that will effectively enhanced community participation through an intensified effort and information drive.

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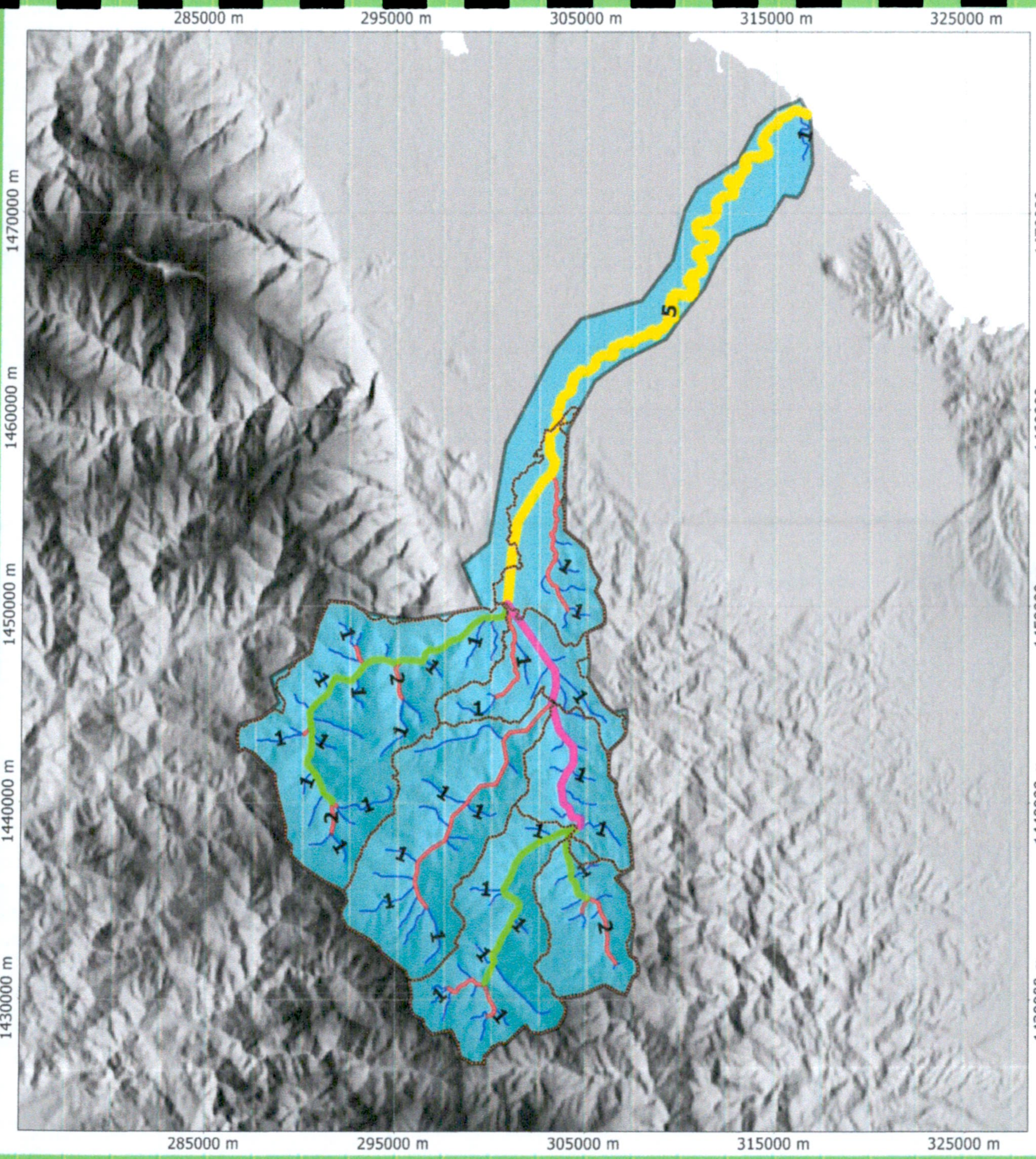


MAP

showing the

BIFURCATION

of

MAG-ASAWANG TUBIG WATERSHED

Located in the Municipalities of Naujan and Victoria, Province of Oriental Mindoro and Mun. of Sablayan, Province of Occidental Mindoro

AREA = 43,534.24 hectares

SCALE = 1:300000

0 >100 m

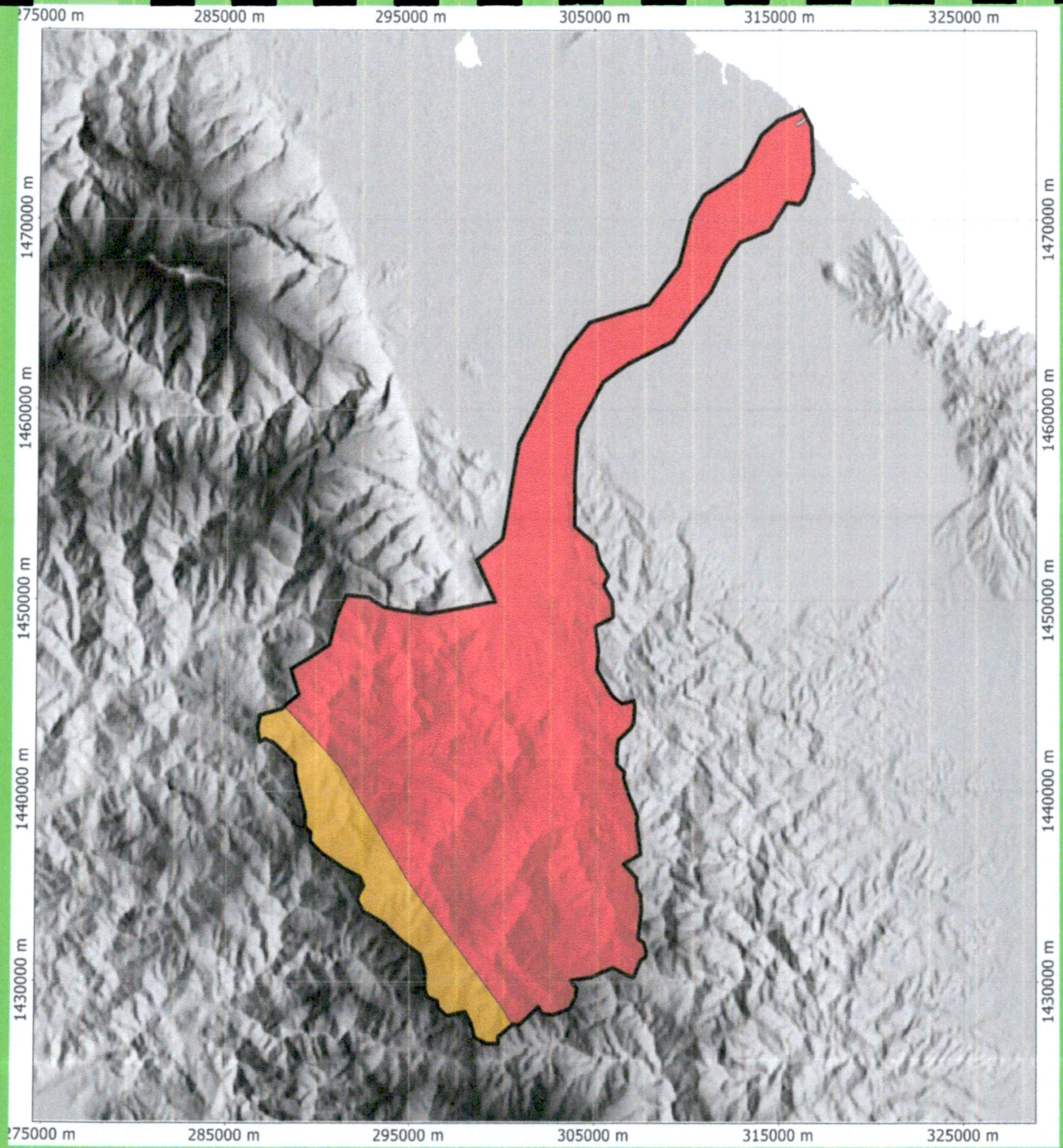
Projection : Universal Transverse Mercator - Zone 51 (N)
Datum : Luzon (Philippines excluding Mindanao)

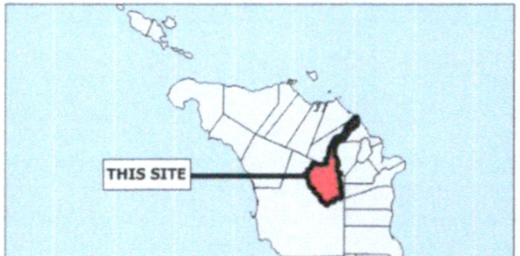
LEGEND

Creeks/Streams
1
2

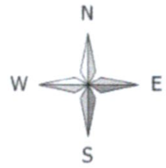
Major Streams
3
4
5

Micro-Watershed Boundary (MW)
WATERSHED BOUNDARY





LOCATION MAP
SCALE = 1:4100000



MAP

showing the

CLIMATIC TYPE

of

MAG-ASAWANG TUBIG WATERSHED

Located in the Municipalities of Naujan and Victoria, Province of Oriental Mindoro and Mun. of Sablayan, Province of Occidental Mindoro

AREA = 43,534.24 hectares

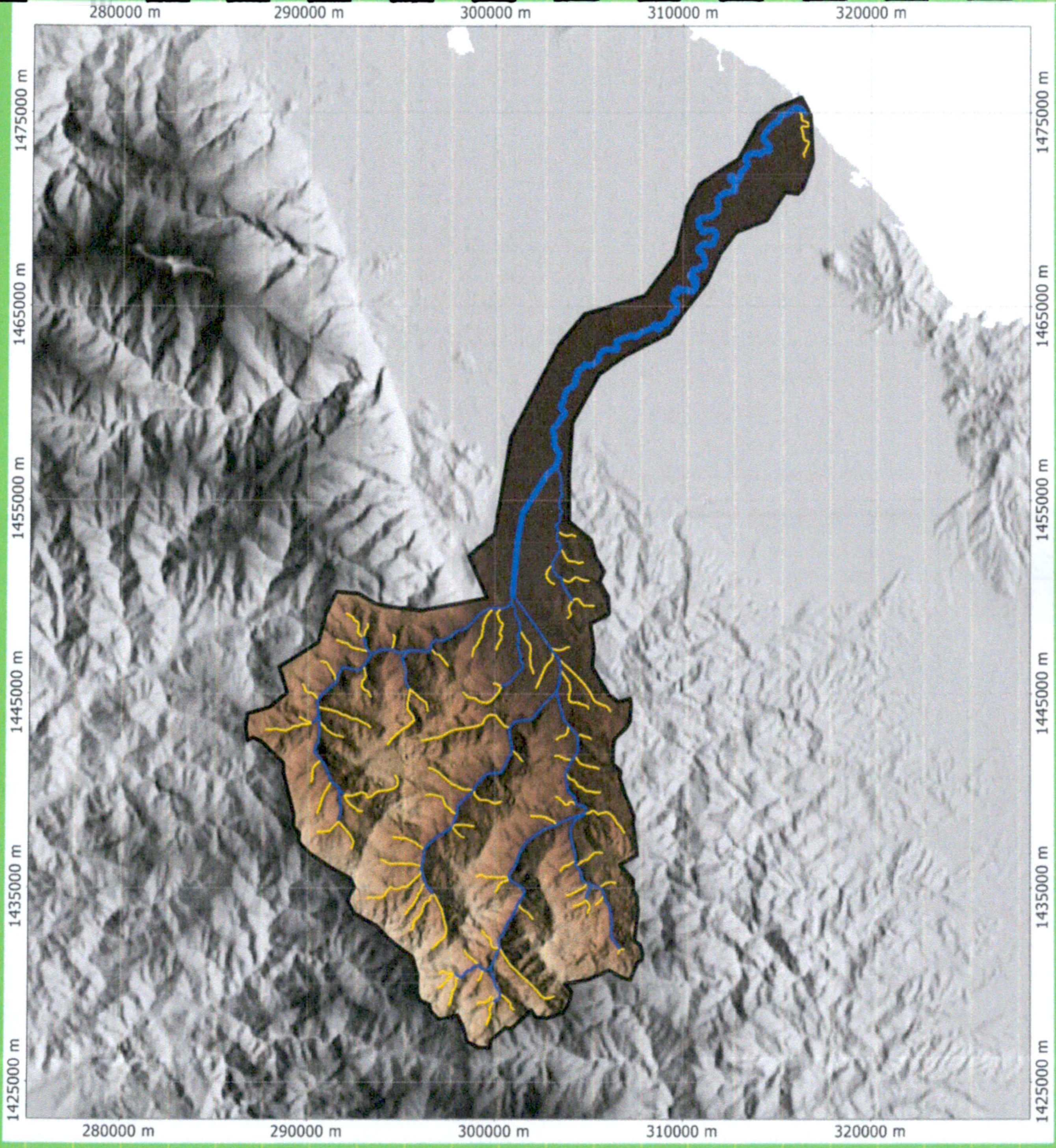
SCALE = 1:300000

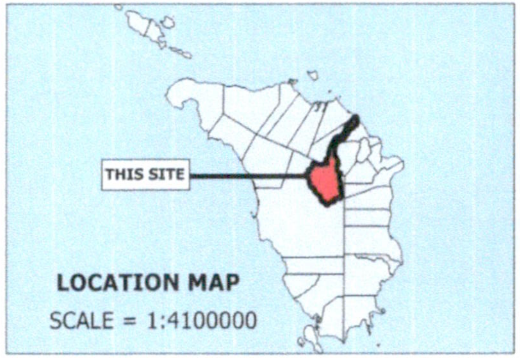
0 >100 m

Projection : Universal Transverse Mercator - Zone 51 (N)
Datum : Luzon (Philippines excluding Mindanao)

LEGEND

CLIMATIC TYPE
1st Type
3rd Type





LOCATION MAP

SCALE = 1:4100000

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MAP

showing the

DRAINAGE SYSTEM

of

MAG-ASAWANG TUBIG WATERSHED

Located in the Municipalities of Naujan and Victoria, Province of Oriental Mindoro and Mun. of Sablayan, Province of Occidental Mindoro

AREA = 43,534.24 hectares

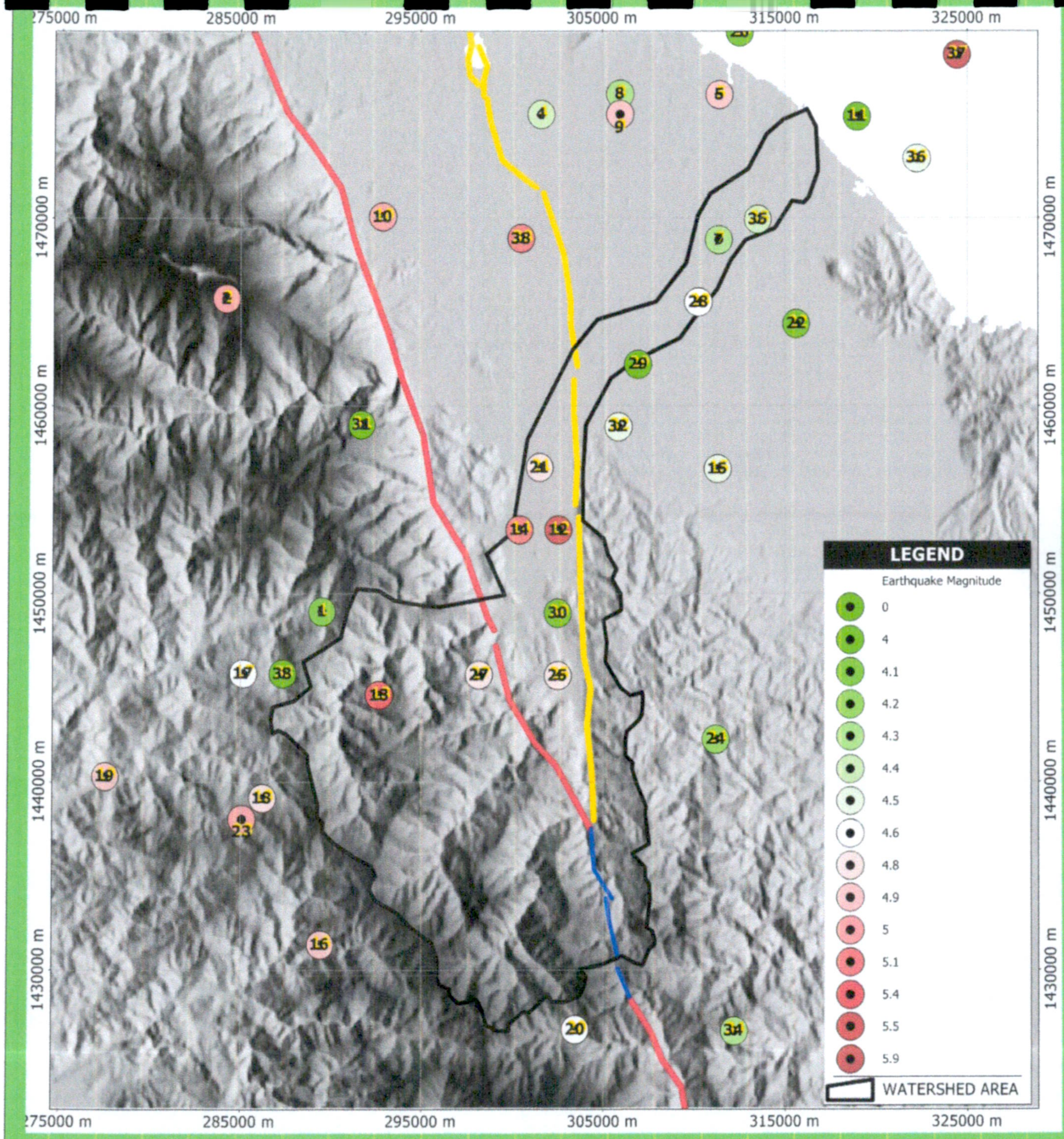
SCALE = 1:300000

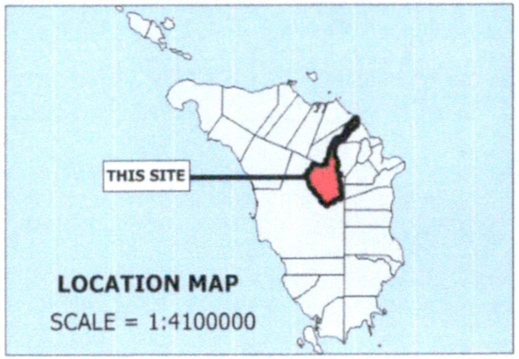
0 >100 m

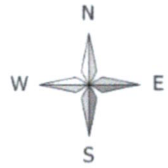
Projection : Universal Transverse Mercator - Zone 51 (N)
Datum : Luzon (Philippines excluding Mindanao)

LEGEND

Major River
Creeks/Streams
WATERSHED AREA

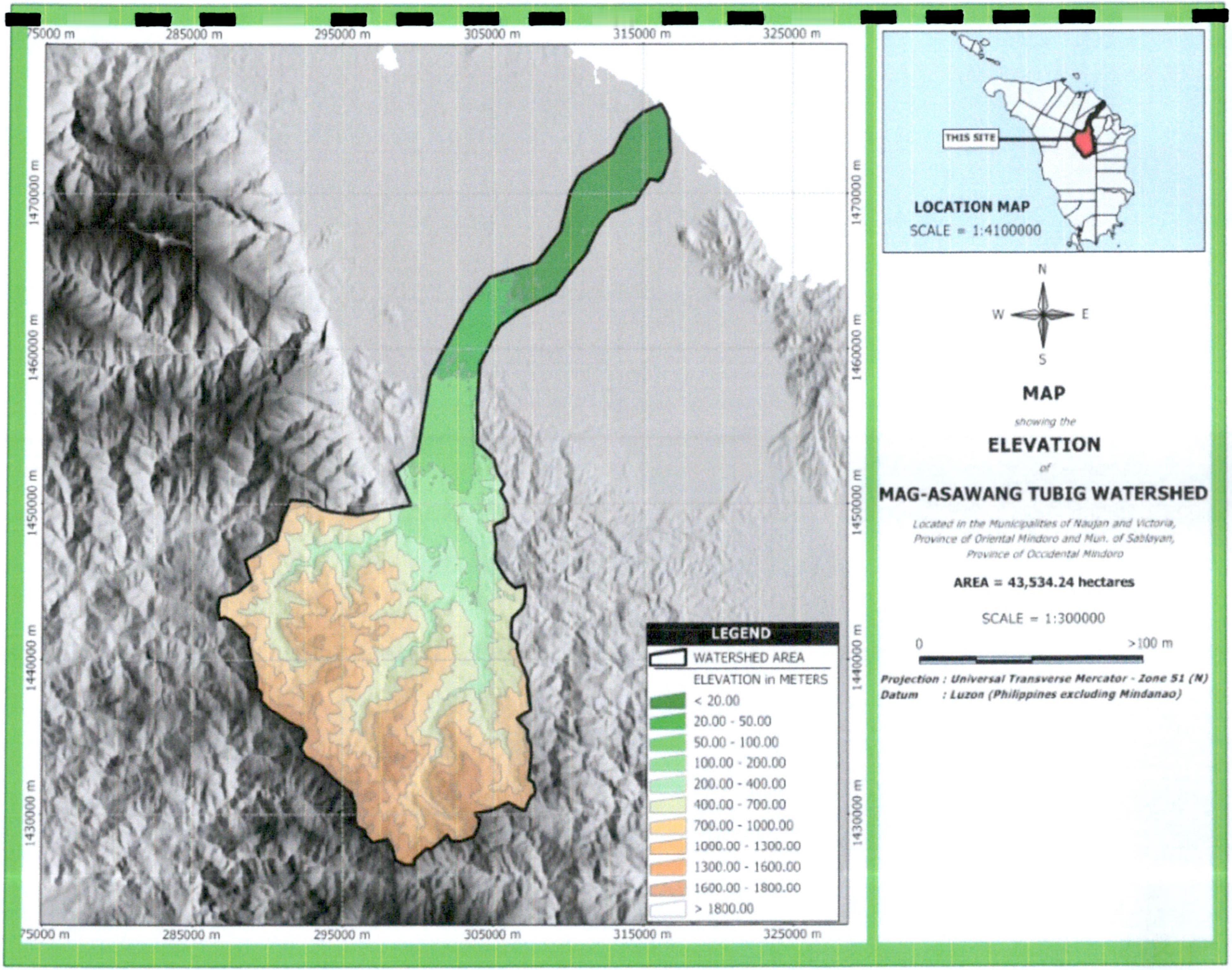


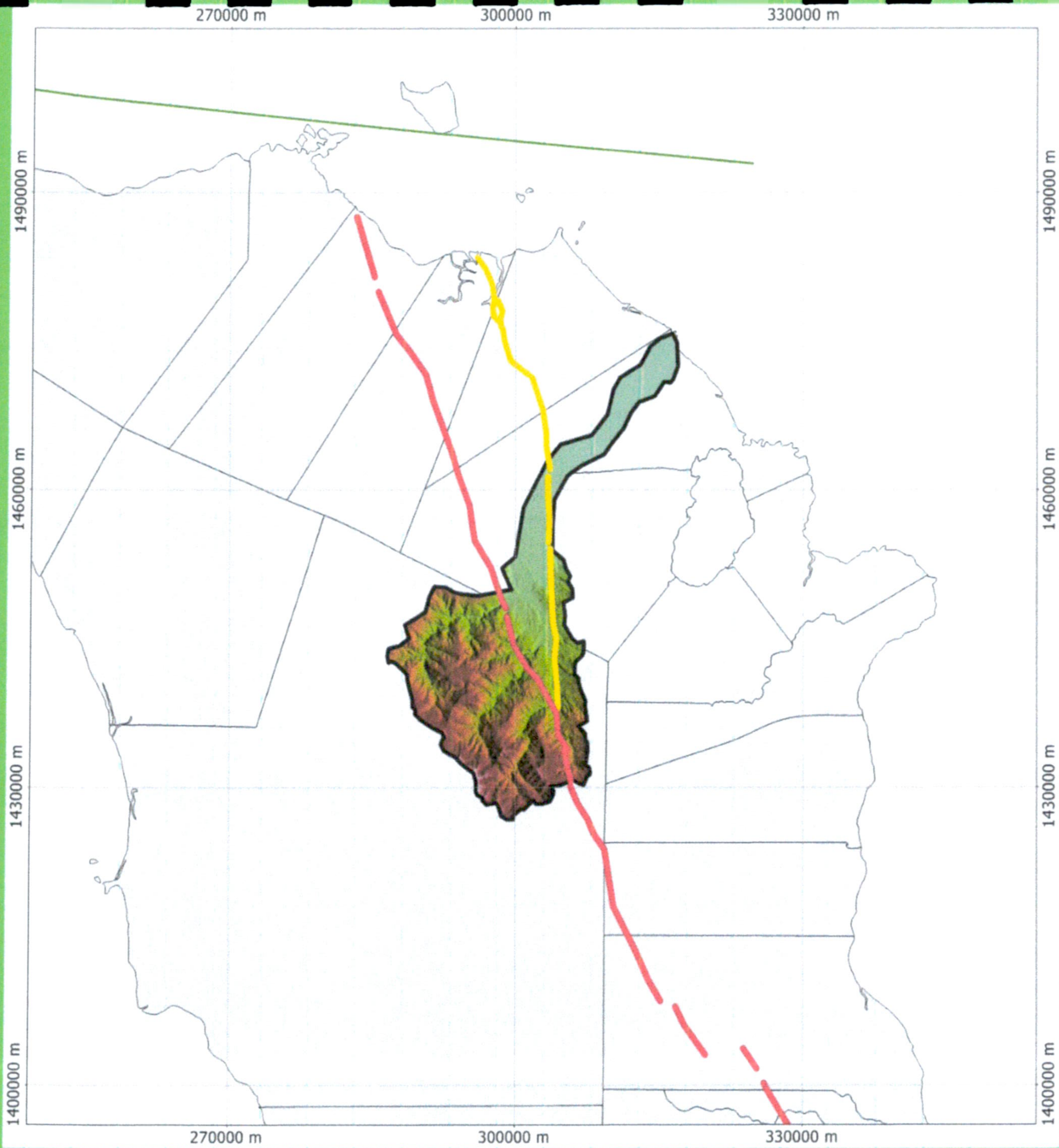


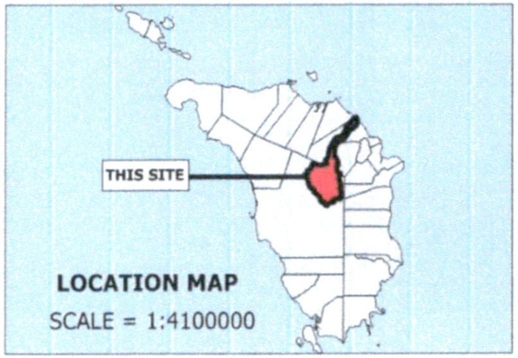


EARTHQUAKE EPICENTER MAP

Earthquake	Northing	Easting	Magnitude	Depth	Month	Year
1	1449068	289517	4.1	33	4	1979
2	1465708	284225	5	67	12	1981
3	1420153	309925	4	33	1	1982
4	1475533	301641	4.4	57	9	1984
5	1476569	311399	4.9	13	9	1984
6	1483155	319027	4.8	10	10	1984
7	1468824	311345	4.3	10	6	1985
8	1476607	305982	4.3	13	3	1987
9	1475501	305974	4.9	19	3	1987
10	1470066	292930	5	53	10	1991
11	1475410	318975	0	10	7	1993
12	1453397	302563	5.5	21	11	1994
13	1444618	292737	5.4	19	11	1994
14	1453413	300394	5.1	33	12	1994
15	1456655	311260	4.5	33	11	1994
16	1431365	289382	4.9	33	11	1994
17	1445782	285153	4.6	28	11	1994
18	1439135	286186	4.8	23	11	1994
19	1440310	277515	4.9	33	11	1994
20	1426836	303458	4.6	27	1	1995
21	1456724	301503	4.8	33	9	1996
22	1464369	315649	4	33	5	1996
23	1438037	285092	5	33	9	1996
24	1442272	311161	4.2	33	11	1996
25	1445652	302507	4.8	33	6	1997
26	1479880	312505	4	33	11	1997
27	1445684	298169	4.8	100	3	1998
28	1465513	310238	4.6	33	4	2000
29	1462217	306963	0	33	2	2001
30	1448971	302531	4	33	4	2001
31	1459010	291762	0	33	2	2001
32	1458905	305855	4.5	33	2	2001
33	1445765	287322	0	33	10	2002
34	1426776	312141	4.3	10	9	2005
35	1469916	313520	4.4	15	10	2006
36	1473176	322210	4.5	10	10	2006
37	1478694	324413	5.9	18	10	2006
38	1468902	300508	5.1	9	10	2006
39	1482063	316853	4.3	35	1	2007


75000 m
285000 m
295000 m
305000 m
315000 m
325000 m
1470000 m
1460000 m
1450000 m
1440000 m
1430000 m
LEGEND
WATERSHED AREA
ELEVATION in METERS
< 20.00
20.00 - 50.00
50.00 - 100.00
100.00 - 200.00
200.00 - 400.00
400.00 - 700.00
700.00 - 1000.00
1000.00 - 1300.00
1300.00 - 1600.00
1600.00 - 1800.00
> 1800.00
THIS SITE
LOCATION MAP
SCALE = 1:4100000
N
W
E
S
MAP
showing the
ELEVATION
of
MAG-ASAWANG TUBIG WATERSHED
Located in the Municipalities of Naujan and Victoria,
Province of Oriental Mindoro and Mun. of Sablayan,
Province of Occidental Mindoro
AREA = 43,534.24 hectares
SCALE = 1:300000
0
>100 m
Projection : Universal Transverse Mercator - Zone 51 (N)
Datum : Luzon (Philippines excluding Mindanao)





LOCATION MAP
SCALE = 1:4100000

N
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MAP

showing the

FAULTLINES

of

MAG-ASAWANG TUBIG WATERSHED

Located in the Municipalities of Naujan and Victoria,
Province of Oriental Mindoro and Mun. of Sablayan,
Province of Occidental Mindoro

AREA = 43,534.24 hectares

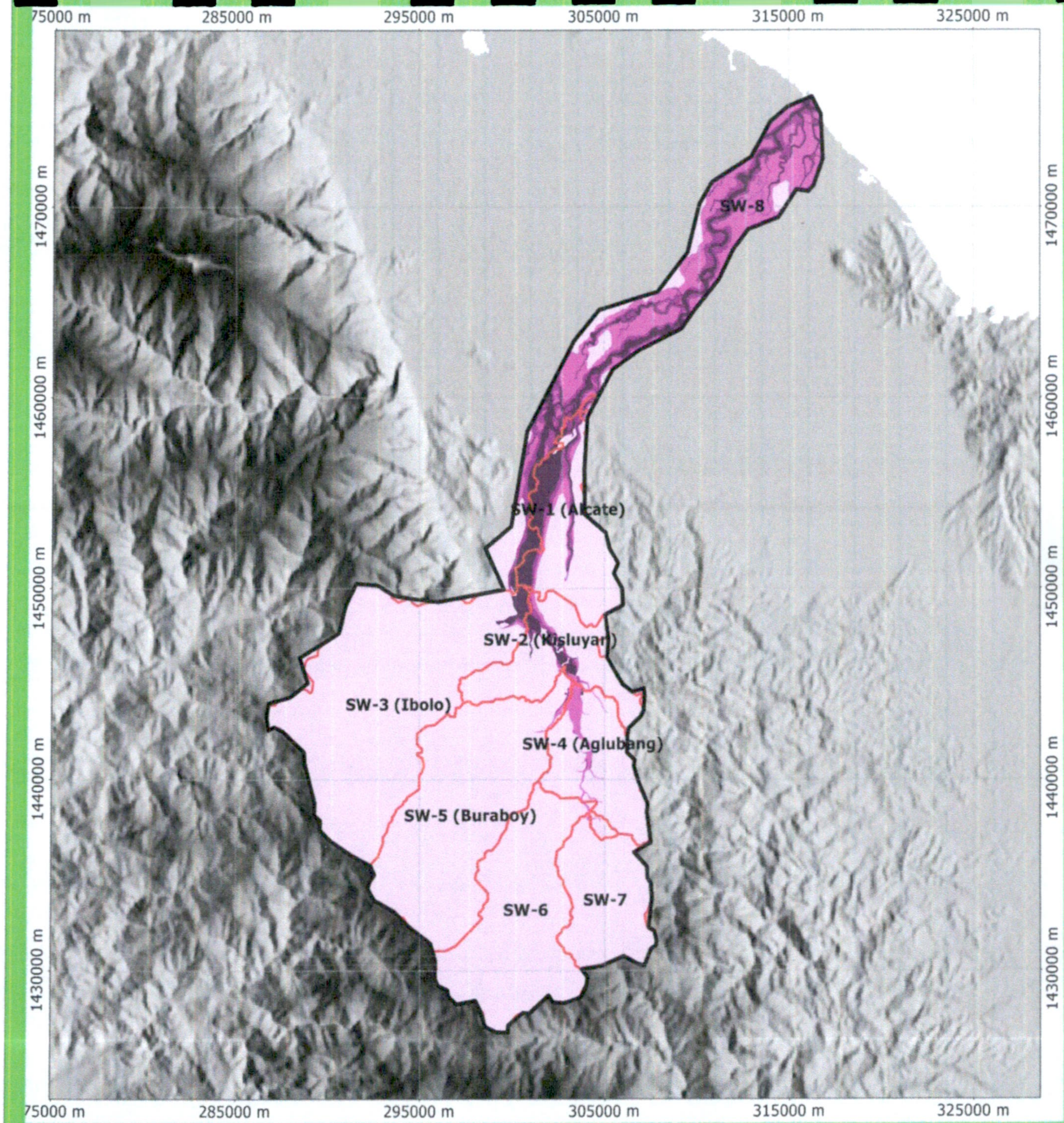
SCALE = 1:590000

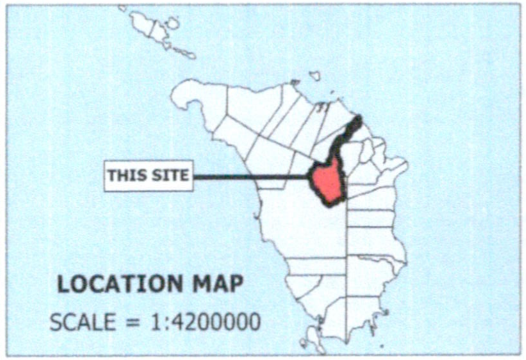
0 >100 m

Projection : Universal Transverse Mercator - Zone 51 (N)
Datum : Luzon (Philippines excluding Mindanao)

LEGEND

FAULTLINES
- Lubang Fault
- Aglubang Fault
- Central Mindoro Fault
- WATERSHED AREA
- Municipal Boundary





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FLOOD SUSCEPTIBILITY MAP

of

MAG-ASAWANG TUBIG WATERSHED

Located in the Municipalities of Naujan and Victoria, Province of Oriental Mindoro and Mun. of Sablayan, Province of Occidental Mindoro

AREA = 43,534.24 hectares

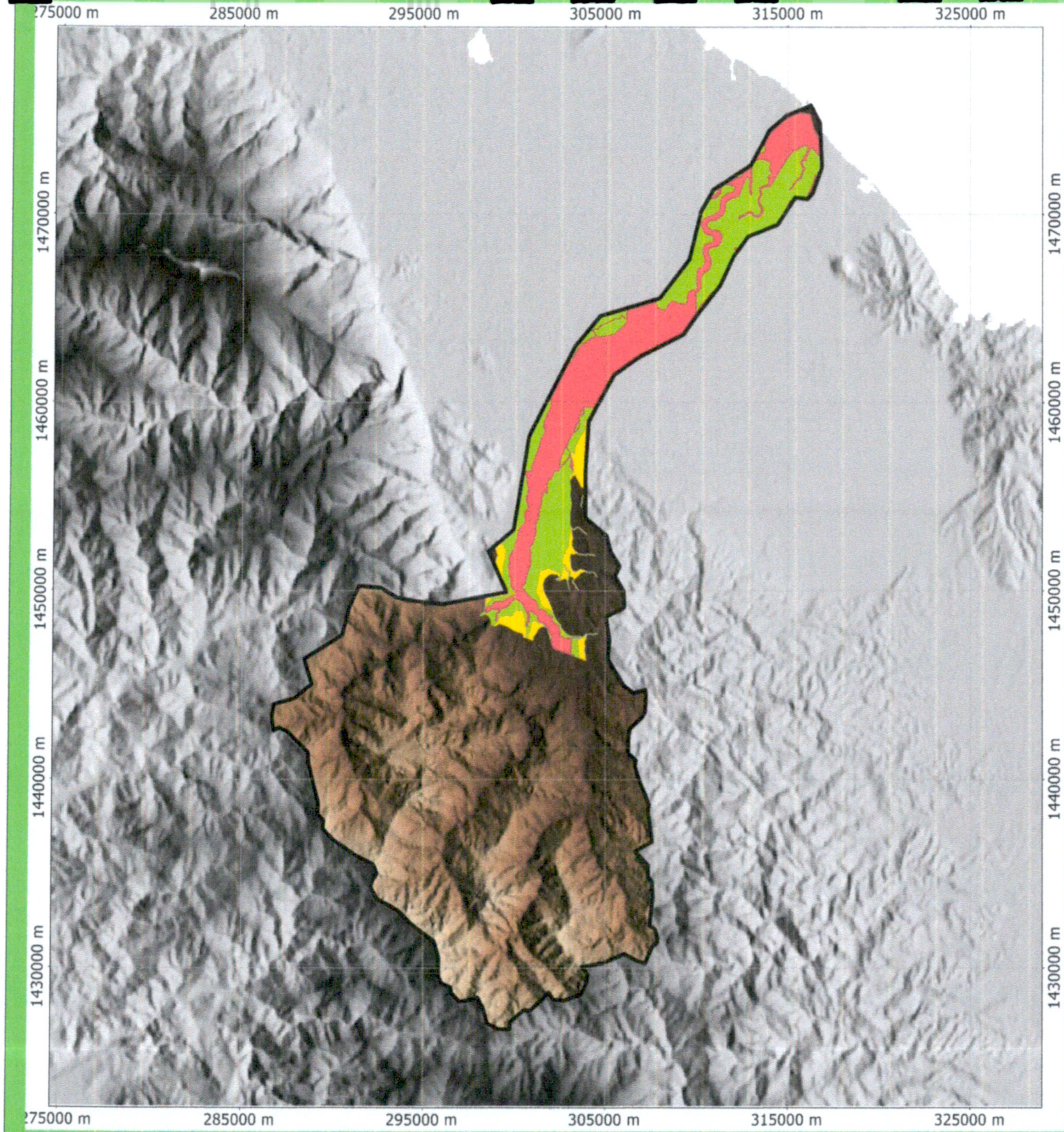
SCALE = 1:300000

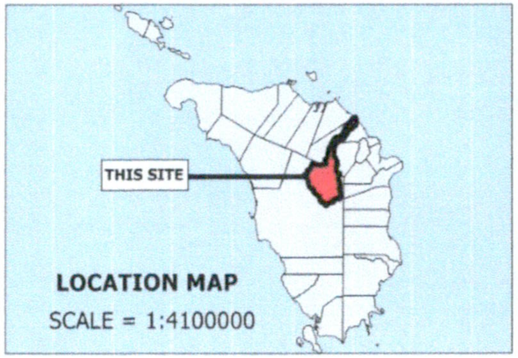
0 >1 m

Projection : Universal Transverse Mercator - Zone 51 (N)
Datum : Luzon (Philippines excluding Mindanao)

LEGEND

Flood Susceptibility	(Hectares)
None to Very Low	(35,583.28)
Low Flood Susceptibility	(3,695.32)
Moderate Flood Sus.	(1,823.15)
High Flood Susceptibility	(2,432.49)
WATERSHED AREA	
SUB-WATERSHED	





N
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MAP

showing the

FLOOD SUSCEPTIBILITY

of

MAG-ASAWANG TUBIG WATERSHED

Located in the Municipalities of Naujan and Victoria, Province of Oriental Mindoro and Mun. of Sablayan, Province of Occidental Mindoro

AREA = 43,534.24 hectares

SCALE = 1:300000

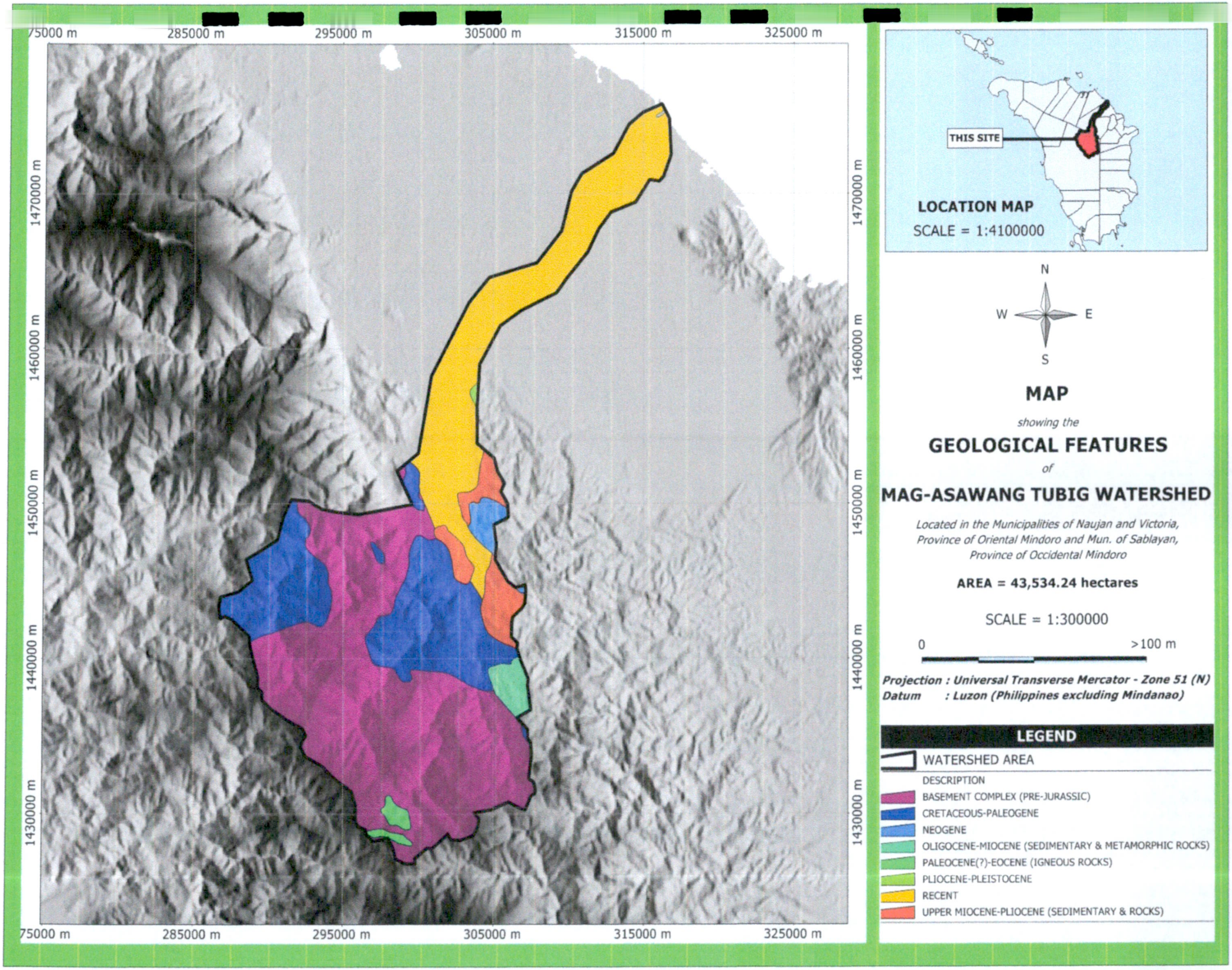
0 >100 m

Projection : Universal Transverse Mercator - Zone 51 (N)
Datum : Luzon (Philippines excluding Mindanao)

LEGEND

WATERSHED AREA

FLOOD SUSCEPTIBILITY
- Low
- Moderate
- High


75000 m
285000 m
295000 m
305000 m
315000 m
325000 m
1470000 m
1460000 m
1450000 m
1440000 m
1430000 m
THIS SITE
LOCATION MAP
SCALE = 1:4100000
N
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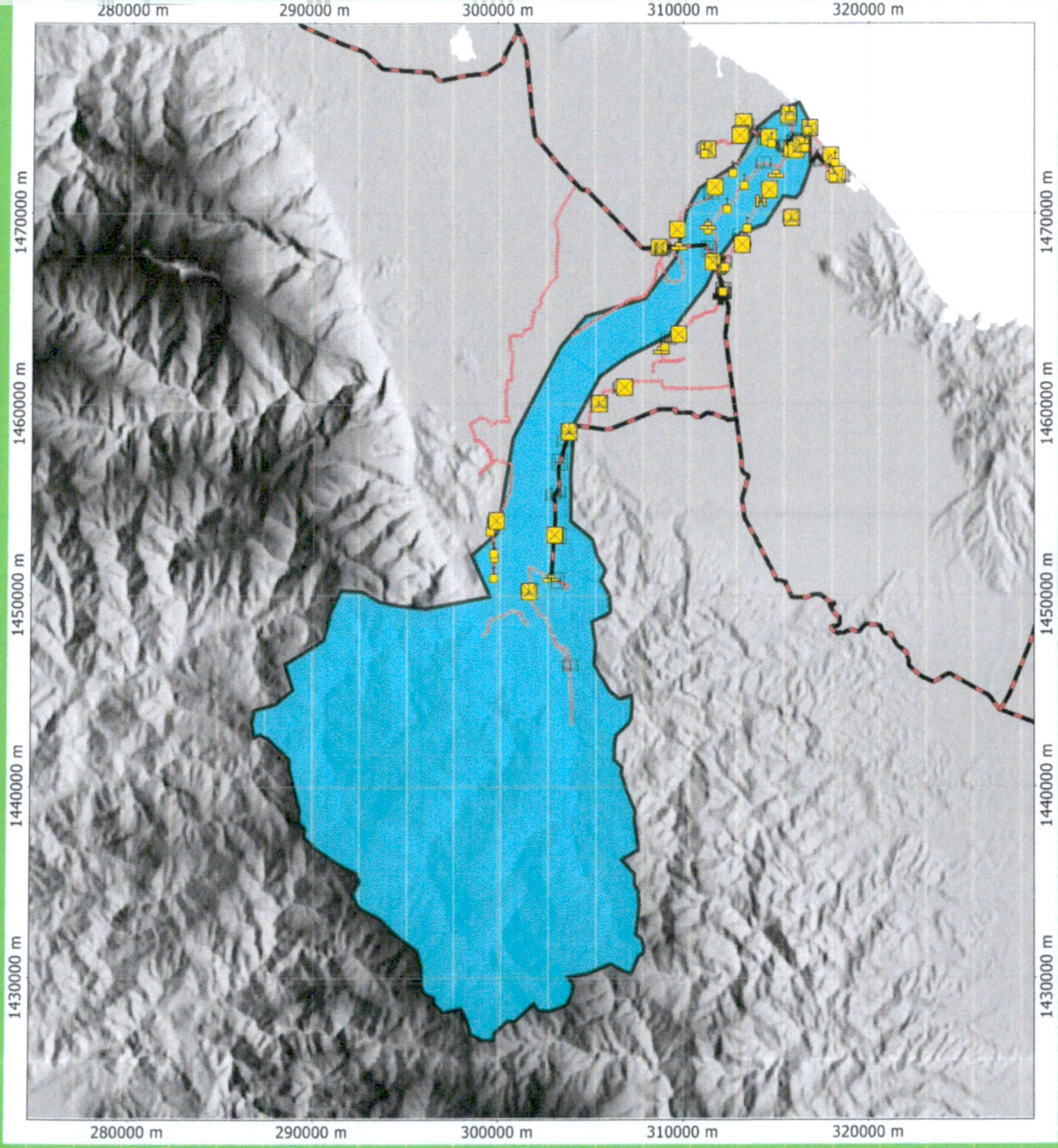
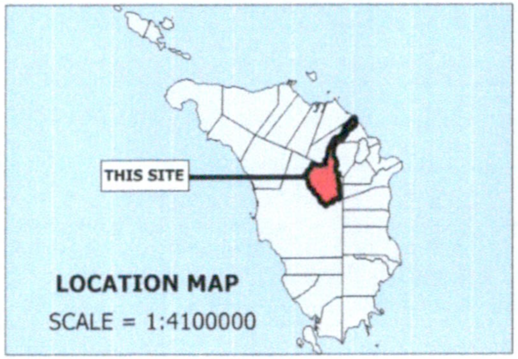
MAP
showing the
GEOLOGICAL FEATURES
of
MAG-ASAWANG TUBIG WATERSHED
Located in the Municipalities of Naujan and Victoria, Province of Oriental Mindoro and Mun. of Sablayan, Province of Occidental Mindoro
AREA = 43,534.24 hectares
SCALE = 1:300000
0
>100 m
Projection : Universal Transverse Mercator - Zone 51 (N)
Datum : Luzon (Philippines excluding Mindanao)
LEGEND
WATERSHED AREA
DESCRIPTION
BASEMENT COMPLEX (PRE-JURASSIC)
CRETACEOUS-PALEOGENE
NEOGENE
OLIGOCENE-MIOCENE (SEDIMENTARY & METAMORPHIC ROCKS)
PALEOCENE(?)-EOCENE (IGNEOUS ROCKS)
PLIOCENE-PLEISTOCENE
RECENT
UPPER MIOCENE-PLIOCENE (SEDIMENTARY & ROCKS)





LOCATION MAP
SCALE = 1:4100000

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MAP

showing the

INFRASTRUCTURES

of

MAG-ASAWANG TUBIG WATERSHED

Located in the Municipalities of Naujan and Victoria, Province of Oriental Mindoro and Mun. of Sablayan, Province of Occidental Mindoro

AREA = 43,534.24 hectares

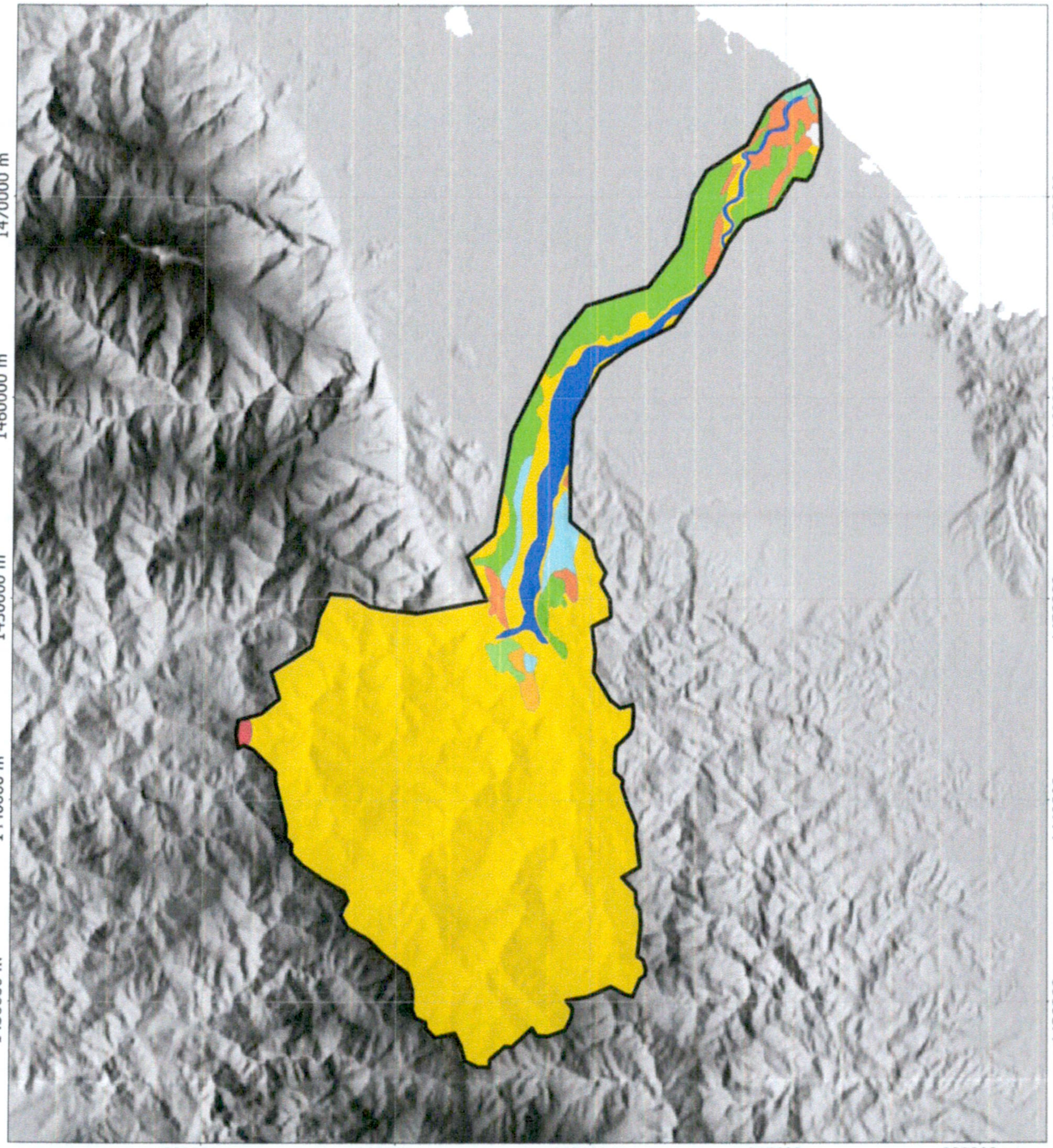
SCALE = 1:300000

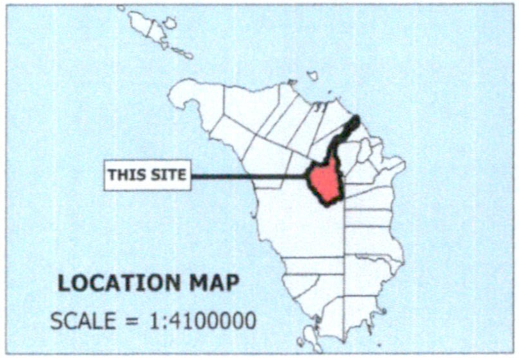
0 >100 m

Projection : Universal Transverse Mercator - Zone 51 (N)
Datum : Luzon (Philippines excluding Mindanao)

LEGEND

- Brgy. Hall
- Bridge
- Cemetery
- Church
- Government Owned
- Health Center
- Hospital
- Municipal Hall
- Public Market
- School
- Primary Road
- Existing Road/Trail w/in the Watershed
- WATERSHED BOUNDARY





LOCATION MAP
SCALE = 1:4100000

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MAP

showing the

LAND CAPABILITY

of

MAG-ASAWANG TUBIG WATERSHED

Located in the Municipalities of Naujan and Victoria,
Province of Oriental Mindoro and Mun. of Sablayan,
Province of Occidental Mindoro

AREA = 43,534.24 hectares

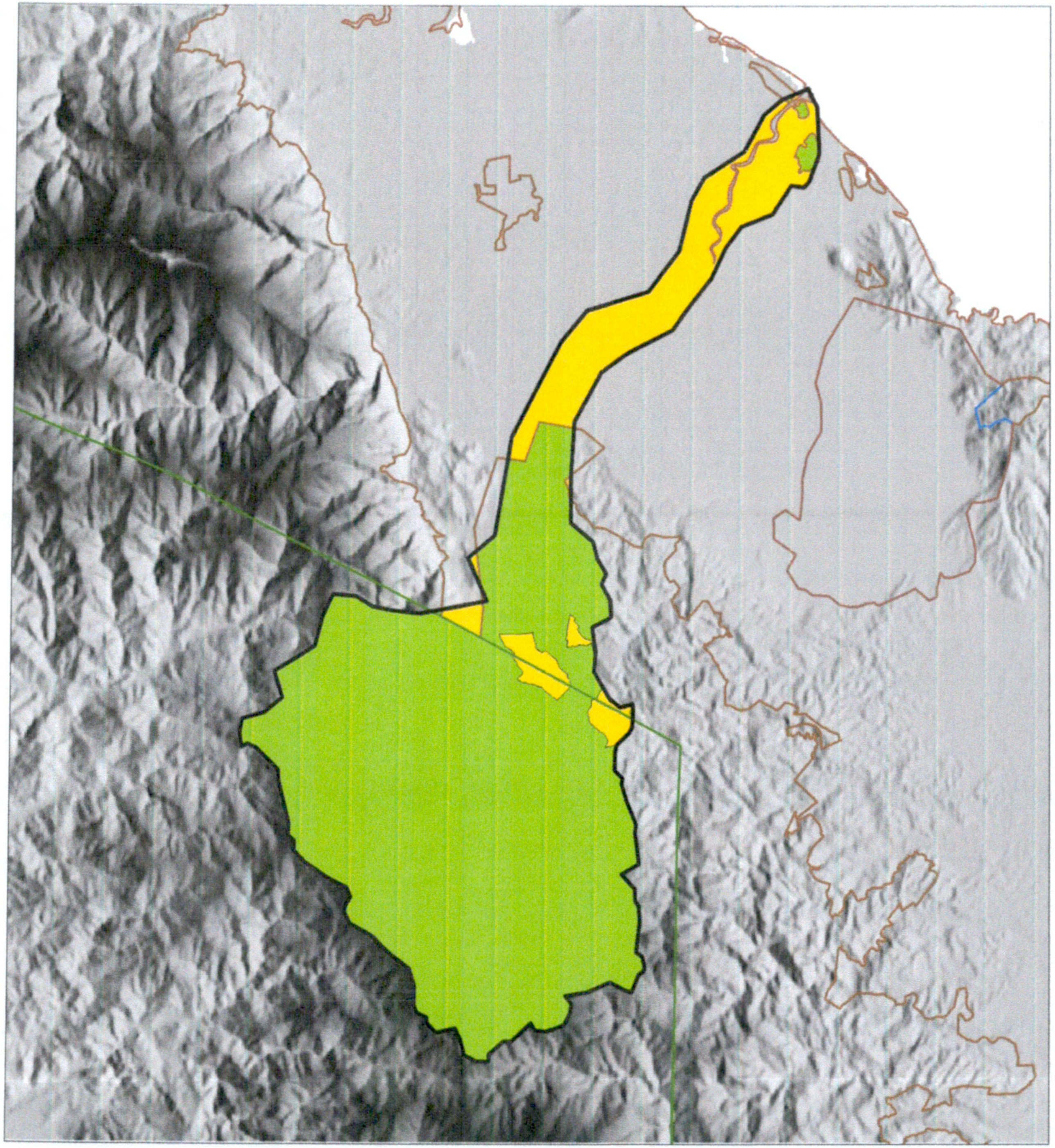
SCALE = 1:300000

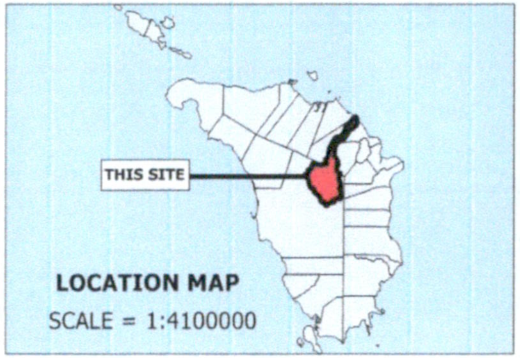
0 >100 m

Projection : Universal Transverse Mercator - Zone 51 (N)
Datum : Luzon (Philippines excluding Mindanao)

LEGEND

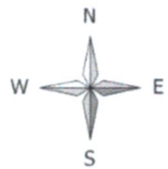
- WATERSHED AREA
- LAND CAPABILITY
- River
- Built-up Area
- Expansion Areas
- Erodible Lands (EFL)
- Non-Agricultural Use
- Fishponds/Saltbeds(EFL)
- Present Agro-Industrial Lands
- Potential Agro-Industrial Lands
- Alluvial Lands (Paddy Rice-Irrigated)
- Gently Sloping Lands (Paddy Rice-Irrigated)





LOCATION MAP

SCALE = 1:4100000



MAP

showing the

LAND CLASSIFICATION

of

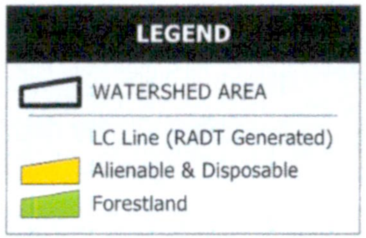
MAG-ASAWANG TUBIG WATERSHED

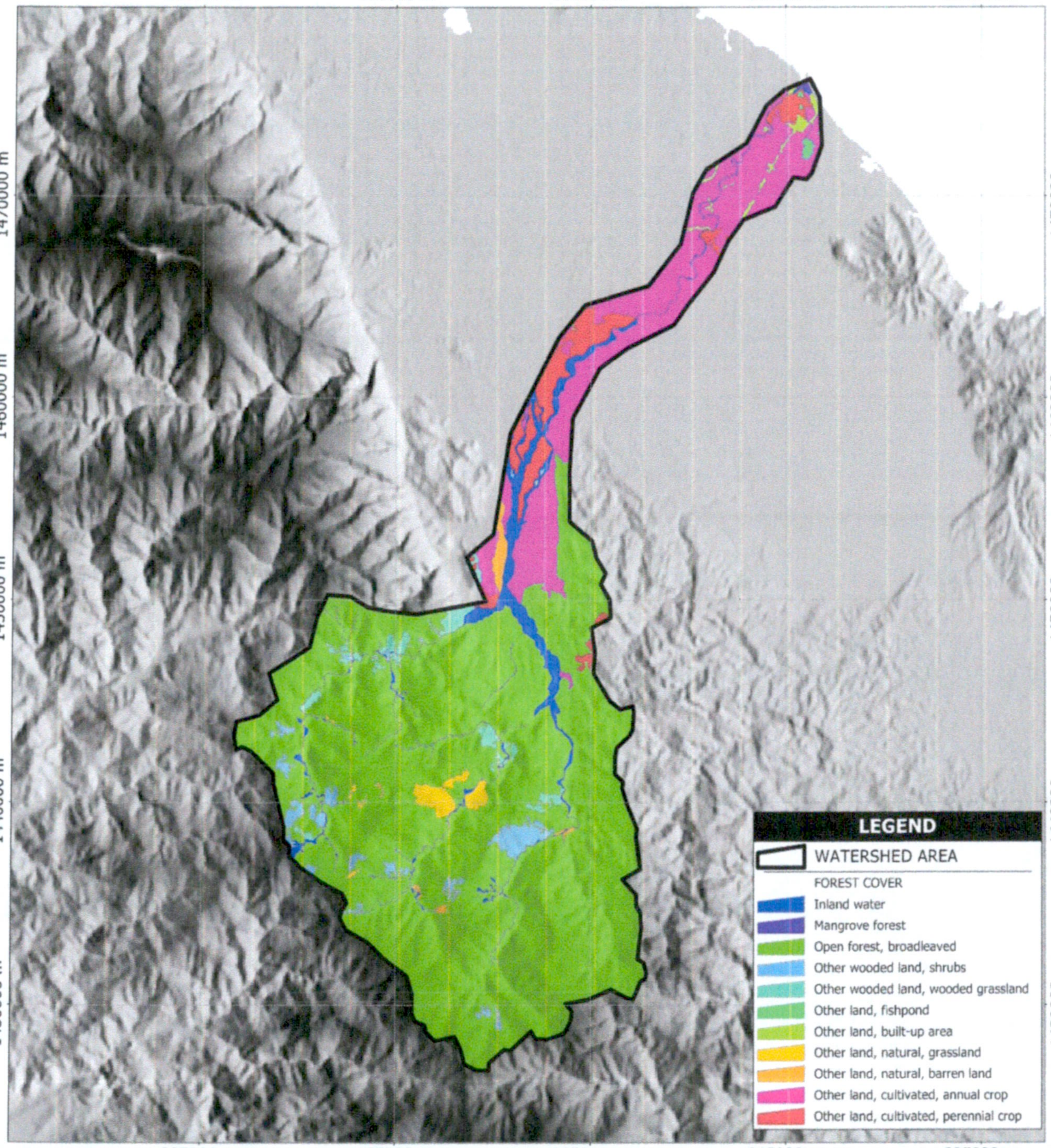
Located in the Municipalities of Naujan and Victoria, Province of Oriental Mindoro and Mun. of Sablayan, Province of Occidental Mindoro

AREA = 43,534.24 hectares

SCALE = 1:300000

Projection : Universal Transverse Mercator - Zone 51 (N)
Datum : Luzon (Philippines excluding Mindanao)





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MAP

showing the

LANDCOVER

of

MAG-ASAWANG TUBIG WATERSHED

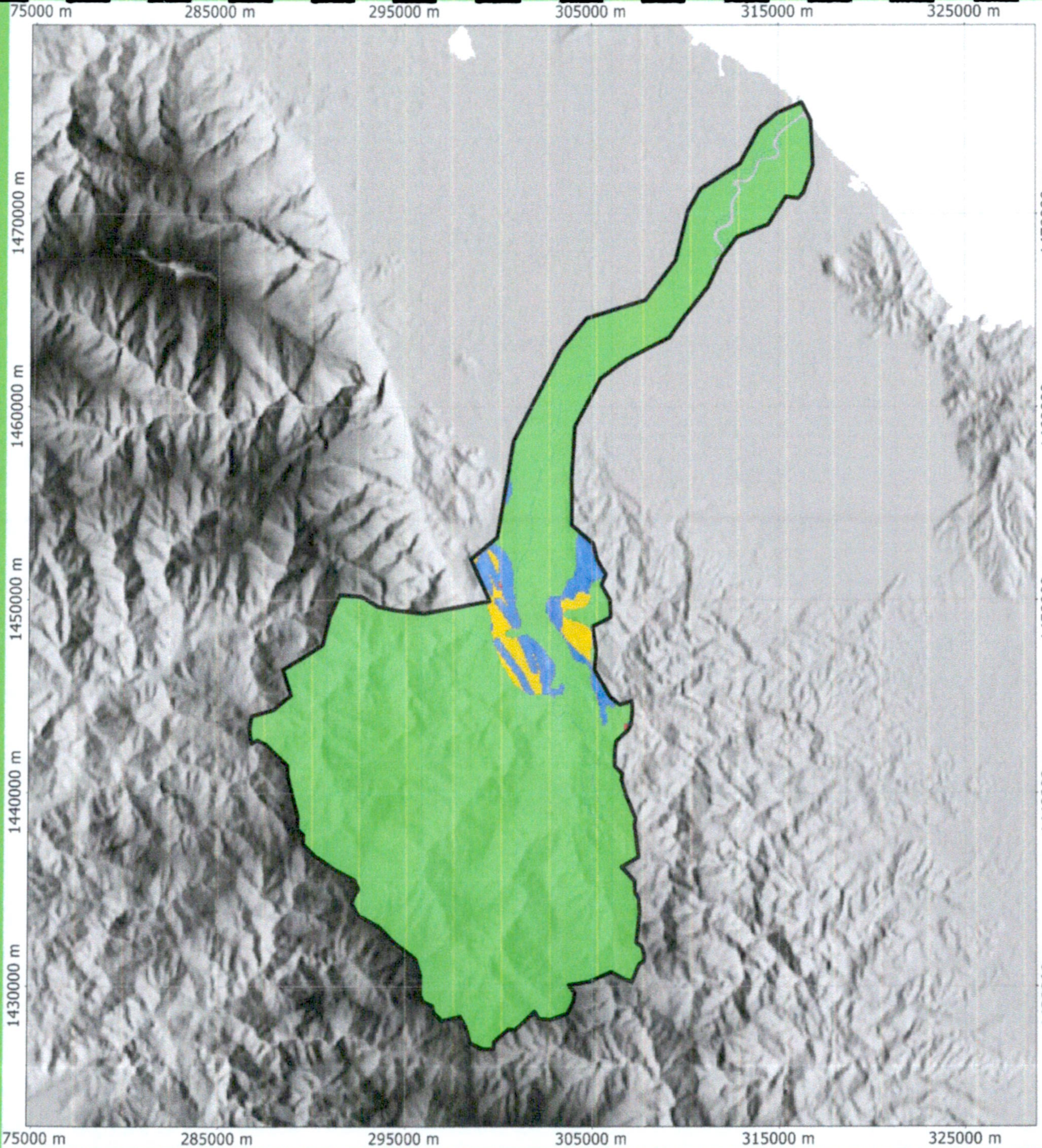
Located in the Municipalities of Naujan and Victoria, Province of Oriental Mindoro and Mun. of Sablayan, Province of Occidental Mindoro

AREA = 43,534.24 hectares

SCALE = 1:300000

0 >100 m

Projection : Universal Transverse Mercator - Zone 51 (N)
Datum : Luzon (Philippines excluding Mindanao)



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MAP

showing the

LANDSLIDE SUSCEPTIBILITY

of

MAG-ASAWANG TUBIG WATERSHED

Located in the Municipalities of Naujan and Victoria, Province of Oriental Mindoro and Mun. of Sablayan, Province of Occidental Mindoro

AREA = 43,534.24 hectares

SCALE = 1:300000

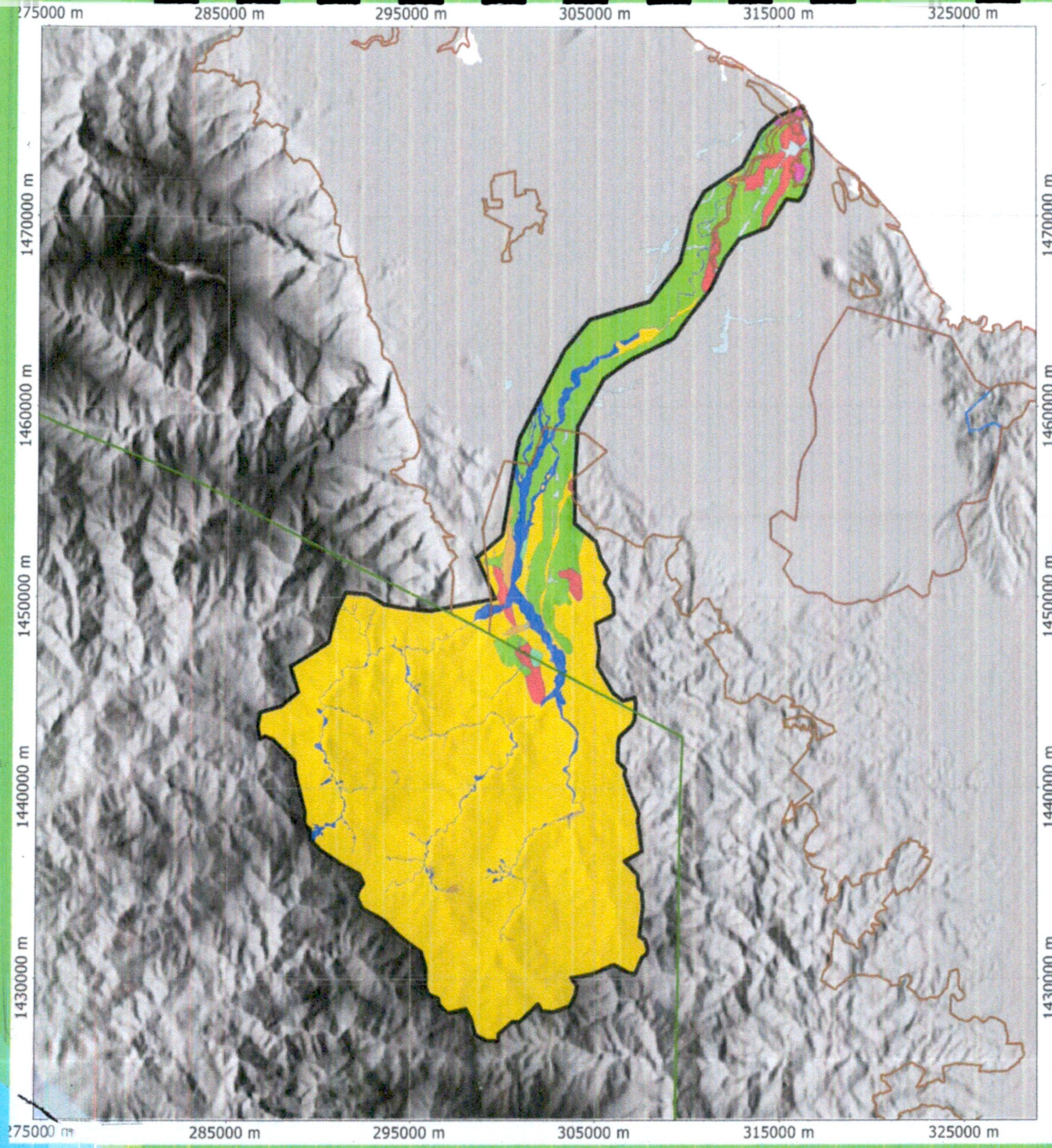
0 >100 m

Projection : Universal Transverse Mercator - Zone 51 (N)
Datum : Luzon (Philippines excluding Mindanao)

LEGEND

WATERSHED AREA

LANDSLIDE SUSCEPTIBILITY
- High
- Low
- Medium
- None_to_Very_Low



LOCATION MAP

SCALE = 1:4100000

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MAP

showing the

LAND USE MAP

of

MAG-ASAWANG TUBIG WATERSHED

*Located in the Municipalities of Naujan and Victoria,
Province of Oriental Mindoro and Mun. of Sablayan,
Province of Occidental Mindoro*

AREA = 43,534.24 hectares

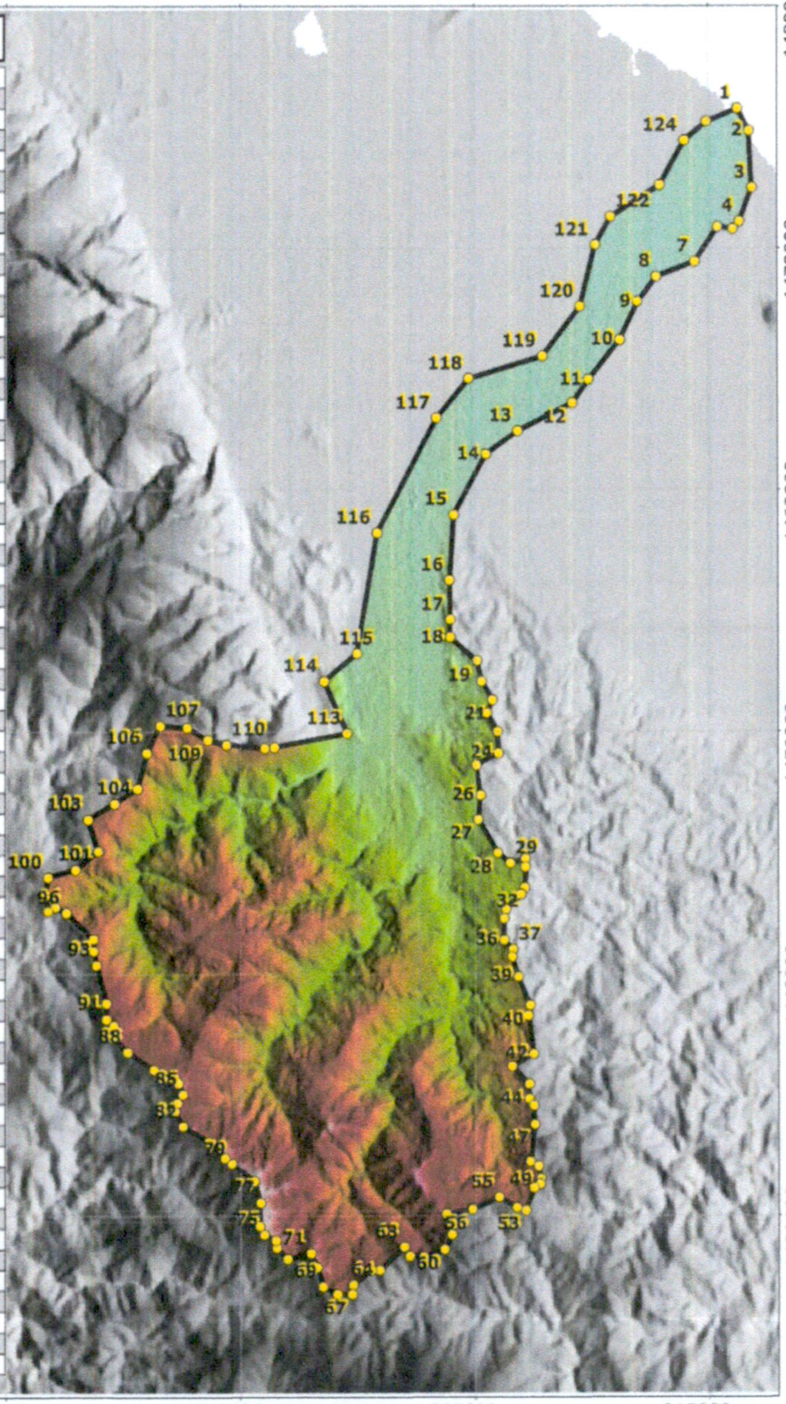
SCALE = 1:300000

0 >100 m

Projection : Universal Transverse Mercator - Zone 51 (N)
Datum : Luzon (Philippines excluding Mindanao)

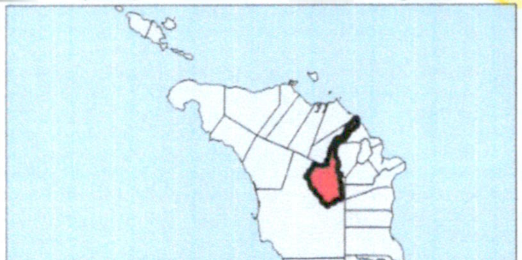
LEGEND

- WATERSHED AREA
- LC TL LINE (RADT generated)
- LAND USE
  - Fishpond
  - Inland Water
  - Built-up Areas
  - Expansion Areas
  - Agricultural Land
  - Open/Barren Land
  - Non-Agricultural Use
  - Agro-Industrial Lands



TECHNICAL DESCRIPTION

Corner	Easting	Northing	Corner	Easting	Northing
1	316254.47	1475783.51	64	300920.27	1427749.34
2	316745.84	1474861.05	65	300576.34	1427780.98
3	316856.85	1472495.36	66	299789.50	1427127.19
4	316346.20	1471114.79	67	299774.98	1426756.20
5	316065.60	1470807.44	68	299139.89	1426764.13
6	315410.86	1470895.91	69	298526.42	1427071.50
7	314450.30	1469445.09	70	298300.95	1427862.44
8	312831.86	1468833.64	71	298014.68	1428441.75
9	312023.90	1467776.08	72	297012.48	1428223.28
10	311266.08	1466215.51	73	296561.41	1428681.99
11	309925.83	1464569.85	74	296513.01	1428988.69
12	309230.77	1463612.22	75	296004.89	1429216.24
13	306884.50	1462464.34	76	295835.76	1429594.44
14	305471.12	1461481.42	77	295848.78	1430560.28
15	304081.42	1459000.65	78	295588.52	1431439.76
16	303911.02	1456292.57	79	294603.95	1432153.77
17	303927.33	1454638.68	80	294321.21	1432391.44
18	303916.18	1453903.81	81	293626.88	1433073.88
19	305078.27	1452940.50	82	292494.12	1433697.30
20	305292.34	1452114.81	83	292166.34	1434321.52
21	305766.34	1451334.99	84	292281.59	1434674.00
22	305521.69	1450799.82	85	292515.45	1435037.36
23	305980.41	1450004.71	86	292311.52	1435504.11
24	306026.28	1449133.15	87	291242.88	1436042.15
25	305045.31	1448639.72	88	290128.34	1436774.89
26	305231.17	1447390.02	89	289540.13	1437356.44
27	305147.89	1446402.35	90	289561.54	1437833.25
28	305995.70	1444989.40	91	289243.84	1438135.98
29	306509.37	1444579.75	92	289260.58	1438777.68
30	307159.66	1444746.97	93	288845.15	1440377.04
31	307197.26	1444412.04	94	288714.15	1440936.88
32	307141.55	1443584.81	95	288694.24	1441431.60
33	306968.87	1443277.04	96	287541.38	1442535.57
34	306318.51	1442683.78	97	287074.96	1442751.12
35	306251.57	1442306.60	98	286771.56	1442594.50
36	306232.18	1441407.56	99	286664.19	1443266.51
37	306652.74	1441007.75	100	286782.42	1443995.62
38	306601.21	1440697.19	101	287946.16	1444316.30
39	306857.46	1439896.43	102	288893.88	1445056.67
40	307359.02	1438692.25	103	288465.77	1446396.27
41	307310.55	1438265.74	104	289590.54	1447058.69
42	307527.31	1436702.42	105	290572.72	1447675.14
43	306608.17	1436184.37	106	290957.08	1449137.87
44	307315.63	1435446.27	107	291519.48	1450260.73
45	307335.13	1434850.22	108	292703.46	1450169.34
46	307524.53	1434568.91	109	293564.41	1449656.67
47	307574.66	1433794.61	110	294401.31	1449488.51
48	307389.93	1432261.20	111	296058.50	1449305.44
49	307702.24	1432066.47	112	296473.69	1449378.87
50	307830.83	1431559.43	113	299579.01	1449940.01
51	307791.45	1431305.48	114	298587.89	1452114.81
52	307541.47	1431154.09	115	299976.81	1453259.75
53	307161.83	1430255.65	116	300837.86	1458245.63
54	306783.25	1430364.29	117	303361.76	1462985.98
55	306021.44	1430764.19	118	304736.59	1464608.07
56	304869.78	1430272.04	119	307940.95	1465538.80
57	303728.73	1430079.44	120	309571.10	1467598.25
58	304057.78	1429670.74	121	310215.89	1470141.02
59	303983.46	1429217.75	122	310893.62	1471296.36
60	303670.92	1428607.41	123	312980.71	1472615.02
61	302785.49	1428295.62	124	313999.64	1474457.06
62	302181.15	1428335.25	125	314940.05	1475234.13
63	301946.73	1428713.87			



LOCATION MAP

SCALE = 1:4100000

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MAP

showing the coordinates of

MAG-ASAWANG TUBIG WATERSHED

AREA = 43,534.24 hectares

0 >100 m

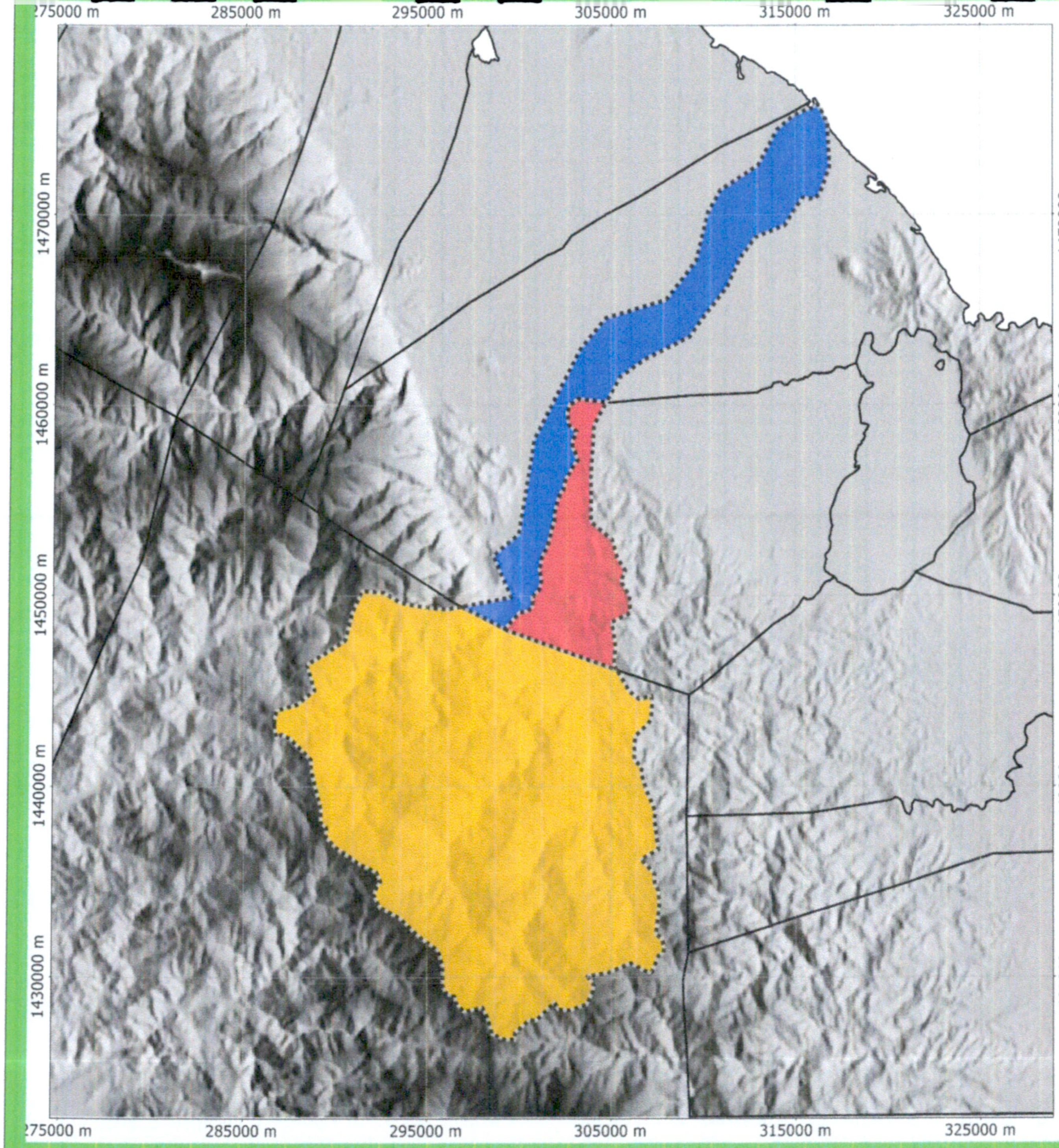
SCALE = 1:300000

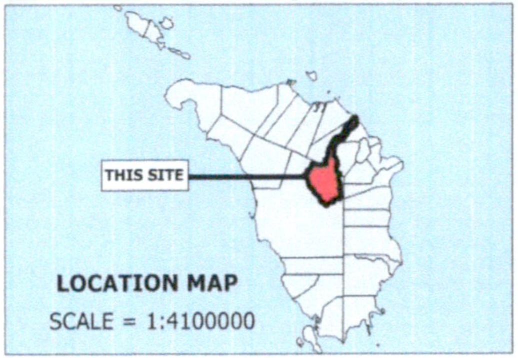
Located in the Municipalities of Naujan and Victoria, Province of Oriental Mindoro and Mun. of Sablayan, Province of Occidental Mindoro

Projection : Universal Transverse Mercator - Zone 51 (N)
Datum : Luzon (Philippines excluding Mindanao)

LEGEND

- CORNERS
- WATERSHED AREA





LOCATION MAP

SCALE = 1:4100000

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MAP

showing the

POLITICAL BOUNDARIES

of

MAG-ASAWANG TUBIG WATERSHED

Located in the Municipalities of Naujan and Victoria, Province of Oriental Mindoro and Mun. of Sablayan, Province of Occidental Mindoro

AREA = 43,534.24 hectares

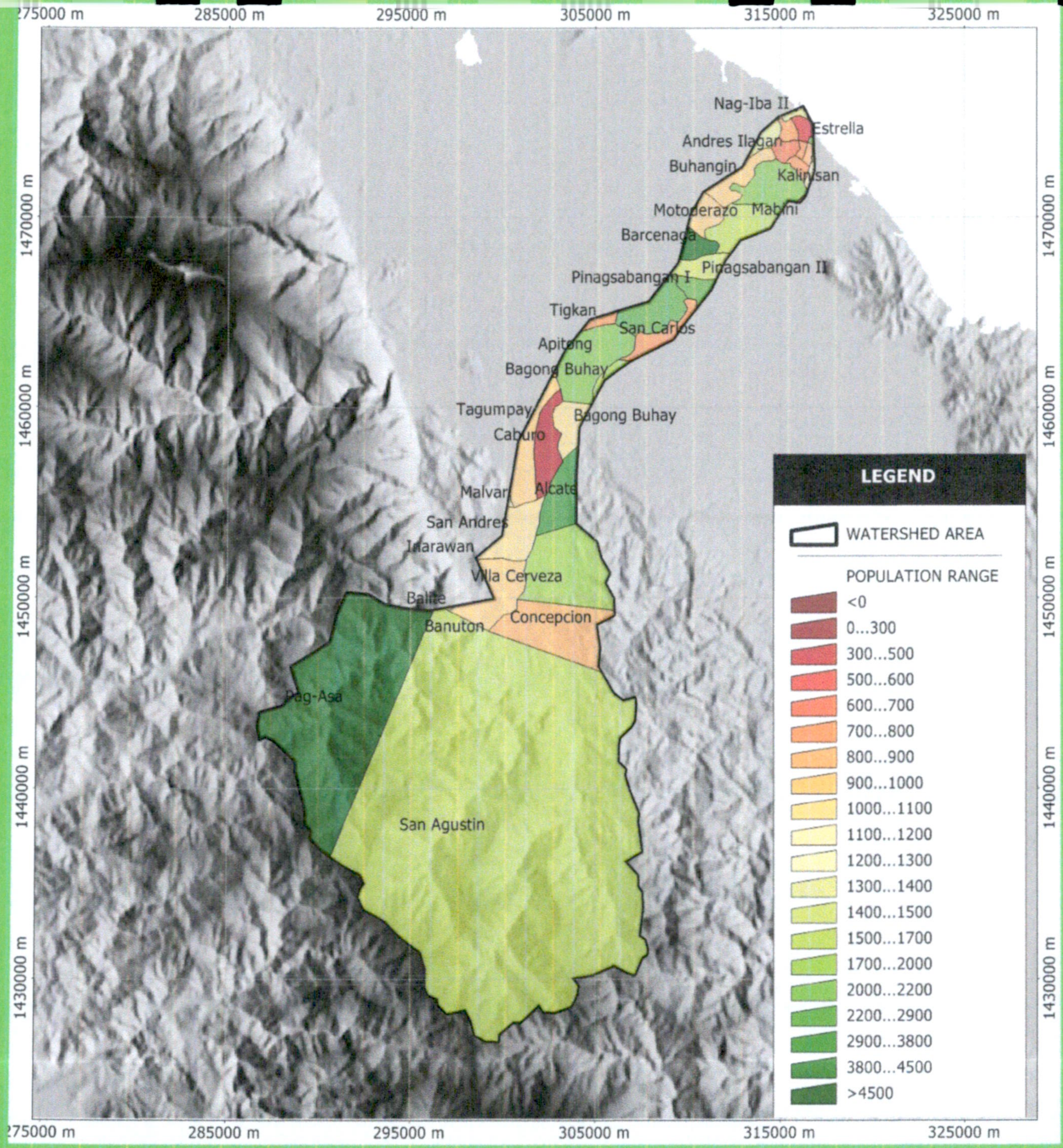
SCALE = 1:300000

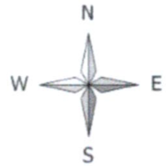
0 >1 m

Projection : Universal Transverse Mercator - Zone 51 (N)
Datum : Luzon (Philippines excluding Mindanao)

LEGEND

MUNICIPALITY
Naujan
Sablayan
Victoria





MAP

showing the

SIZE OF POPULATION

of

MAG-ASAWANG TUBIG WATERSHED

Located in the Municipalities of Naujan and Victoria, Province of Oriental Mindoro and Mun. of Sablayan, Province of Occidental Mindoro

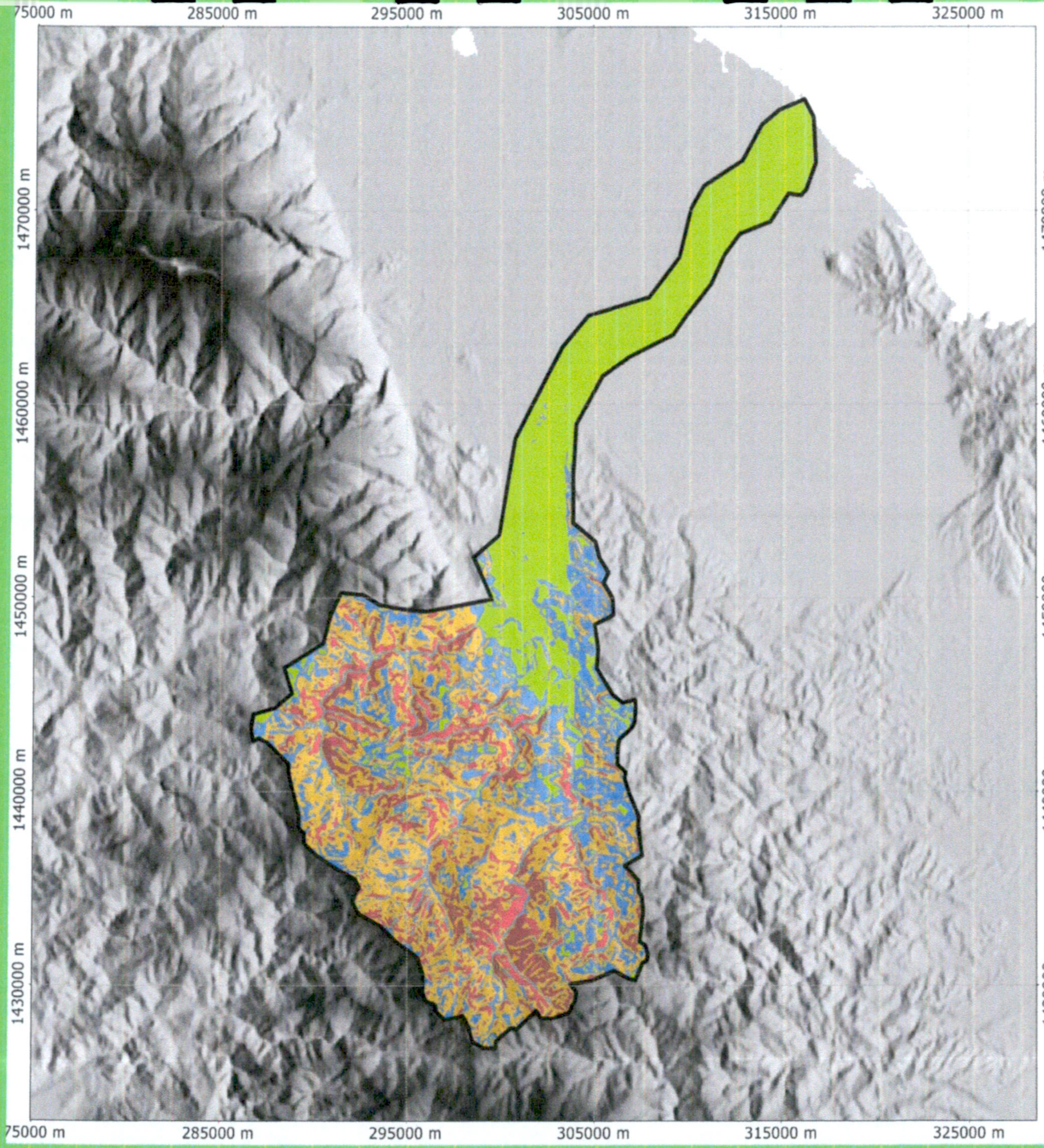
AREA = 43,534.24 hectares

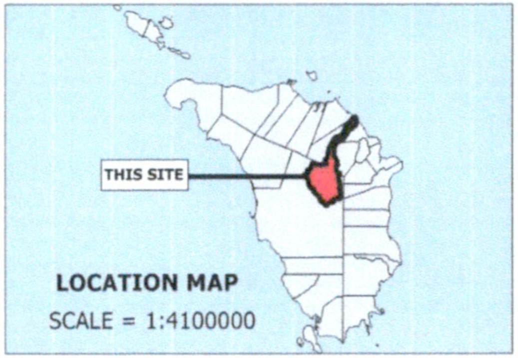
SCALE = 1:300000

0 >100 m

Projection : Universal Transverse Mercator - Zone 51 (N)
Datum : Luzon (Philippines excluding Mindanao)

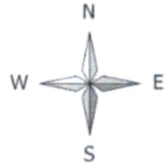
NOTE : Administrative Boundaries are Approximate
NSO CENSUS as of 2010





LOCATION MAP

SCALE = 1:4100000



MAP

showing the

SLOPE CATEGORY

of

MAG-ASAWANG TUBIG WATERSHED

Located in the Municipalities of Naujan and Victoria,
Province of Oriental Mindoro and Mun. of Sablayan,
Province of Occidental Mindoro

AREA = 43,534.24 hectares

SCALE = 1:300000

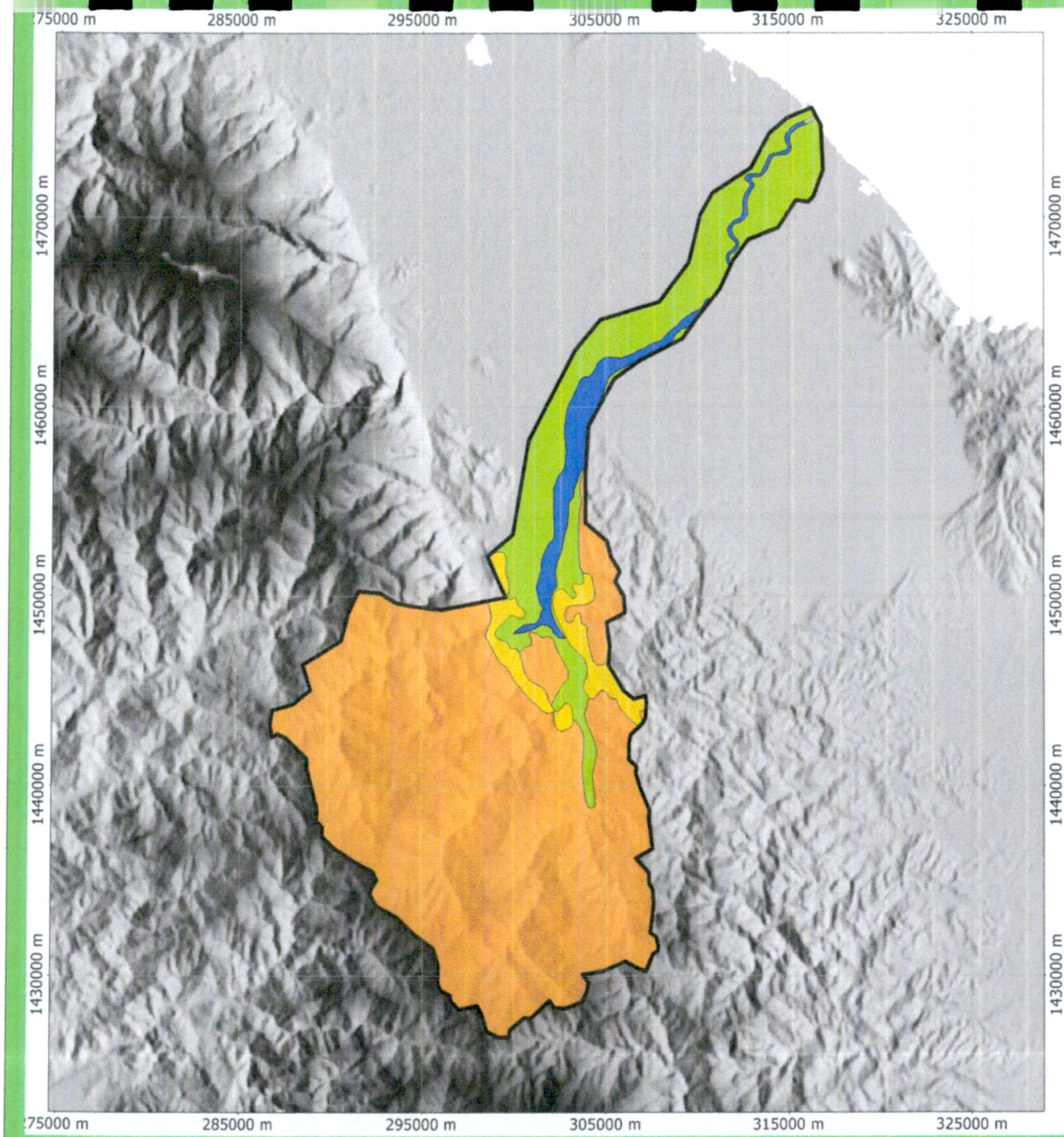
0 >100 m

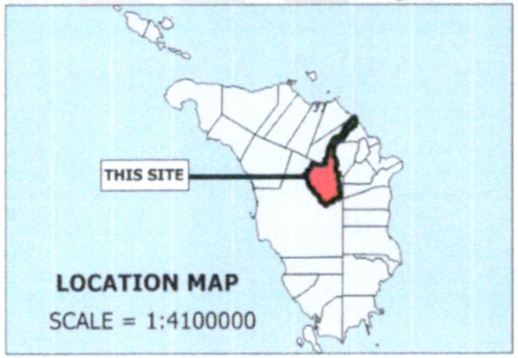
Projection : Universal Transverse Mercator - Zone 51 (N)
Datum : Luzon (Philippines excluding Mindanao)

LEGEND

WATERSHED AREA

SLOPE CATEGORY
- Level to Gently Sloping
- Moderate
- Severely Steep
- Steep
- Very Steep





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MAP

showing the

SOIL EROSION SUSCEPTIBILITY

of

MAG-ASAWANG TUBIG WATERSHED

Located in the Municipalities of Naujan and Victoria, Province of Oriental Mindoro and Mun. of Sablayan, Province of Occidental Mindoro

AREA = 43,534.24 hectares

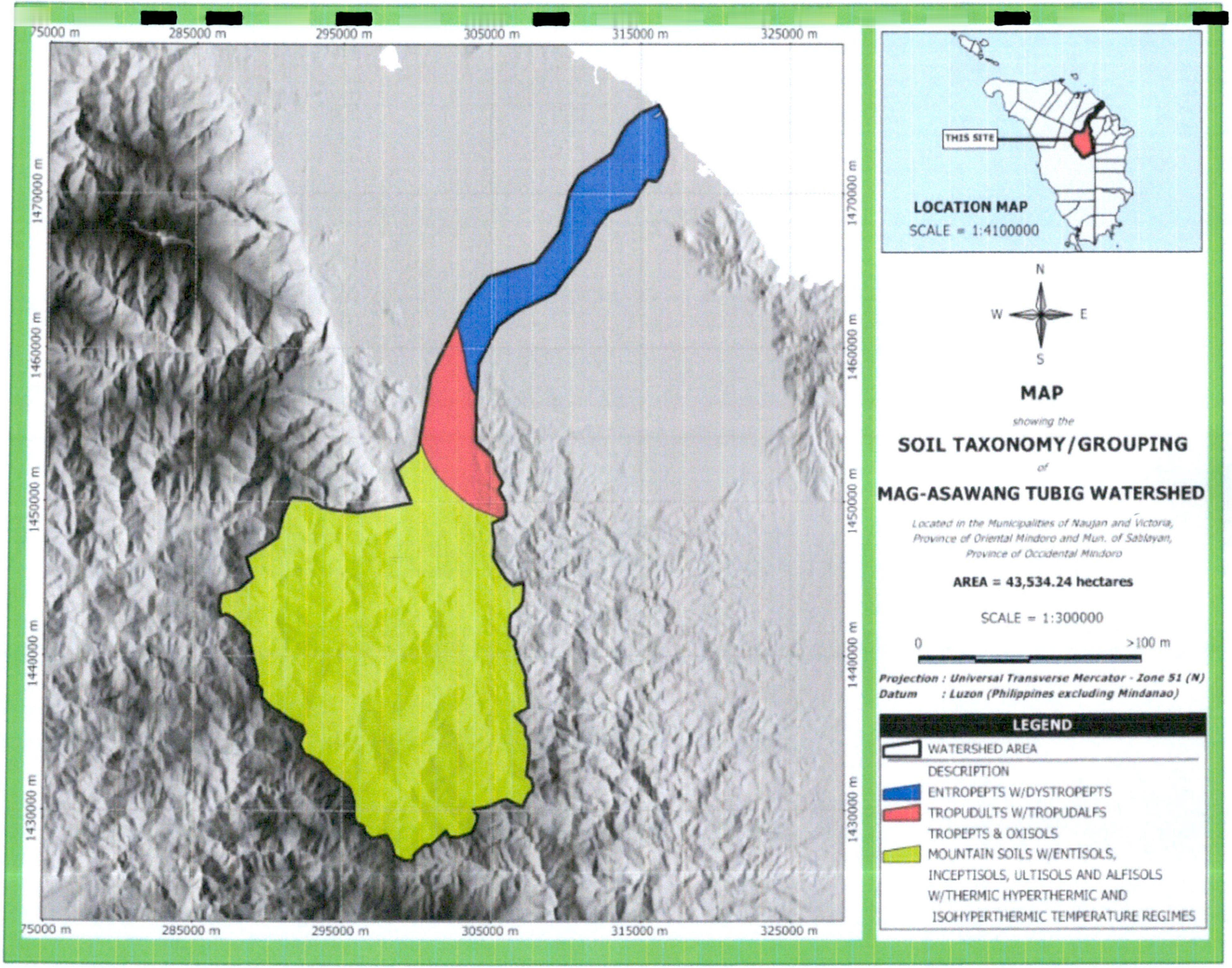
SCALE = 1:300000

0 >100 m

Projection : Universal Transverse Mercator - Zone 51 (N)
Datum : Luzon (Philippines excluding Mindanao)

LEGEND

- WATERSHED AREA
- SOIL SUSCEPTIBILITY
  - No Apparent Erosion
  - Slight Erosion
  - Moderate Erosion
  - River



LOCATION MAP
SCALE = 1:4100000
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MAP
showing the
SOIL TAXONOMY/GROUPING
of
MAG-ASAWANG TUBIG WATERSHED
Located in the Municipalities of Naujan and Victoria, Province of Oriental Mindoro and Mun. of Sablayan, Province of Occidental Mindoro
AREA = 43,534.24 hectares
SCALE = 1:300000
0
>100 m
Projection : Universal Transverse Mercator - Zone 51 (N)
Datum : Luzon (Philippines excluding Mindanao)
LEGEND
WATERSHED AREA
DESCRIPTION
ENTROPEPTS W/DYSTROPEPTS
TROPUDULTS W/TROPUDALFS
TROPEPTS & OXISOLS
MOUNTAIN SOILS W/ENTISOLS, INCEPTISOLS, ULTISOLS AND ALFISOLS W/THERMIC HYPERTHERMIC AND ISOHYPERTHERMIC TEMPERATURE REGIMES
275000 m
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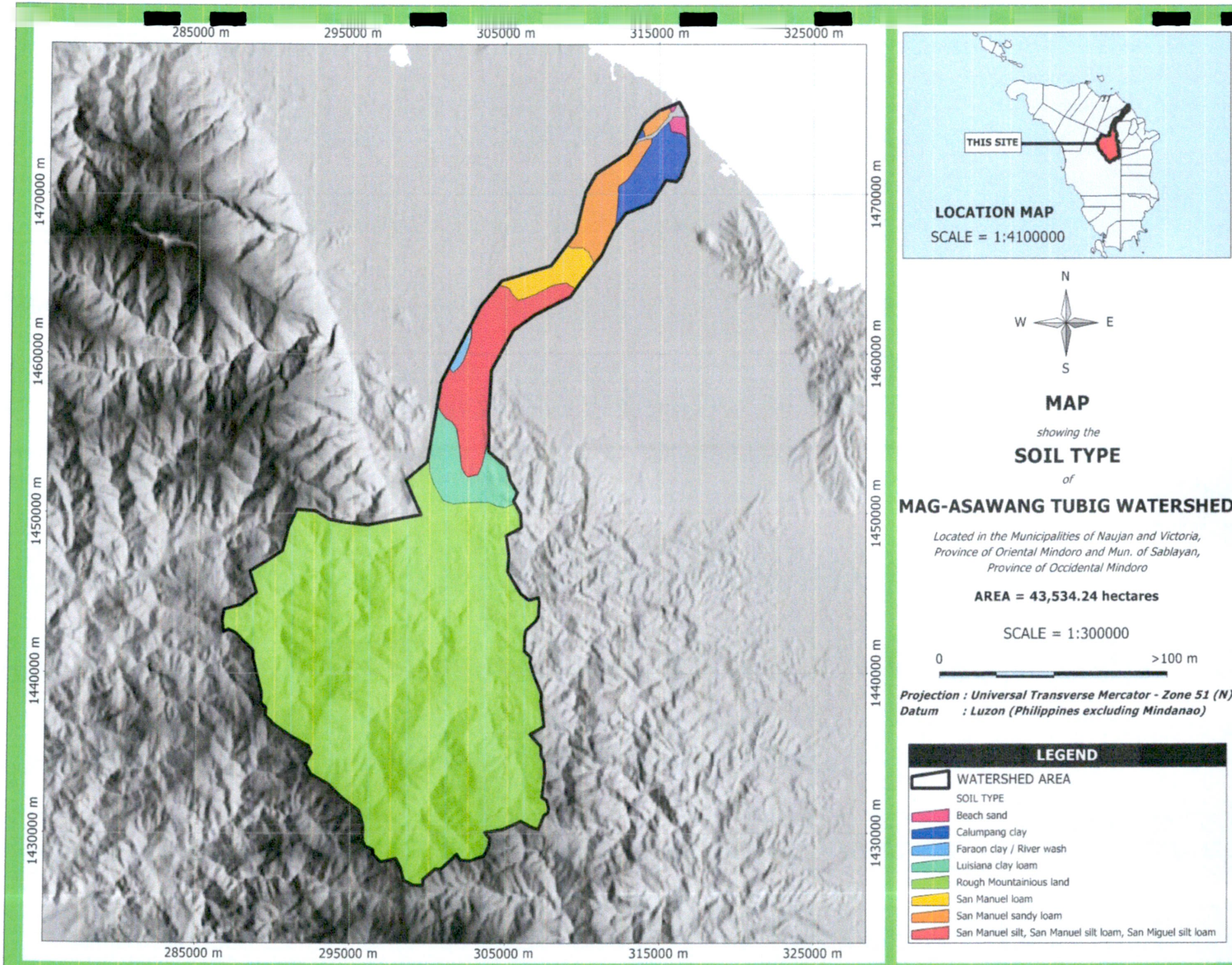


MAP

showing the

SOIL TYPE

of

MAG-ASAWANG TUBIG WATERSHED

Located in the Municipalities of Naujan and Victoria, Province of Oriental Mindoro and Mun. of Sablayan, Province of Occidental Mindoro

AREA = 43,534.24 hectares

SCALE = 1:300000

0 >100 m

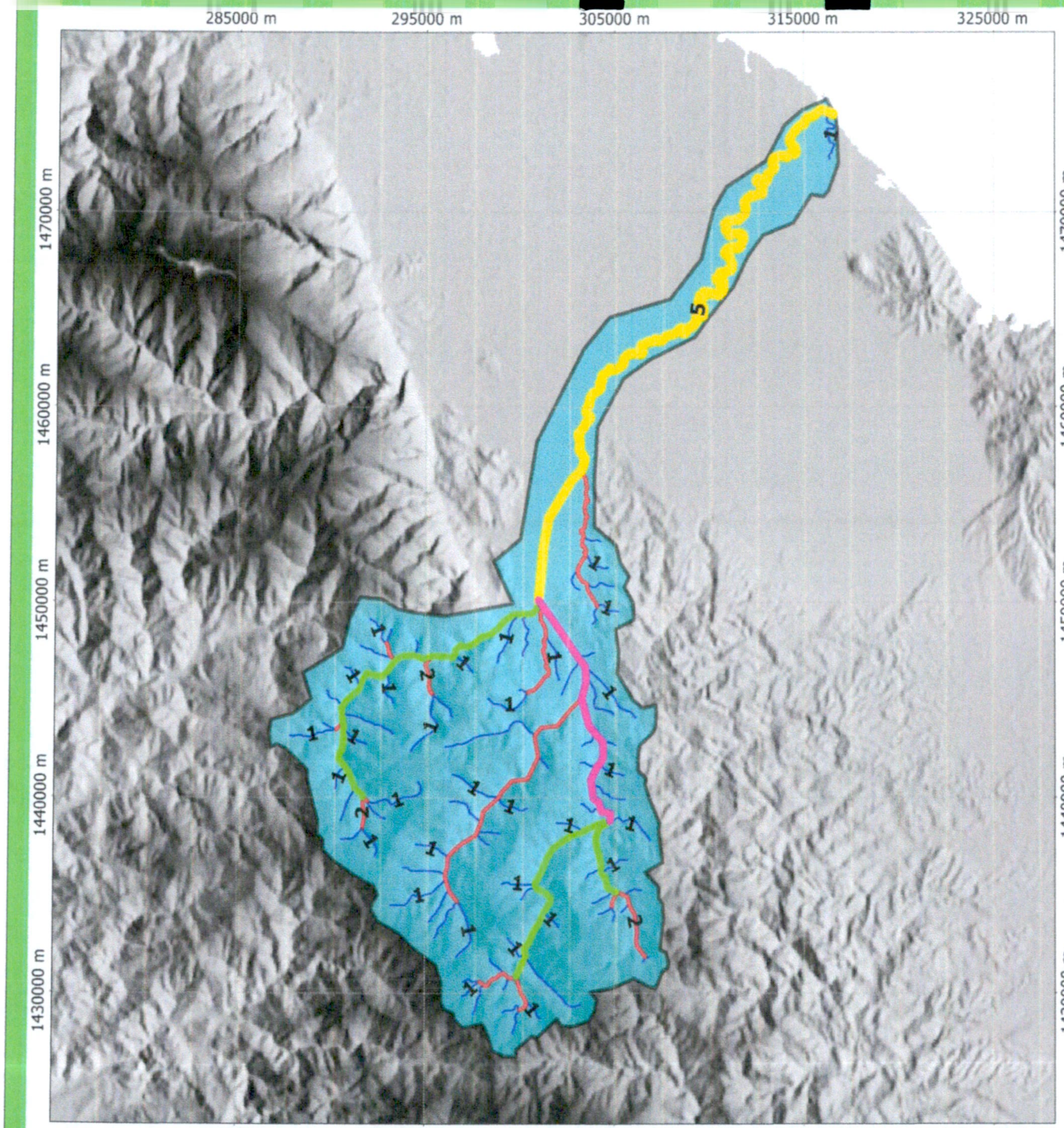
Projection : Universal Transverse Mercator - Zone 51 (N)
Datum : Luzon (Philippines excluding Mindanao)

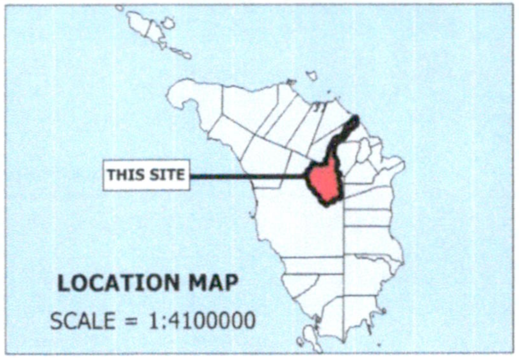
LEGEND

WATERSHED AREA

SOIL TYPE

- Beach sand
- Calumpang clay
- Faraon clay / River wash
- Luisiana clay loam
- Rough Mountainious land
- San Manuel loam
- San Manuel sandy loam
- San Manuel silt, San Manuel silt loam, San Miguel silt loam





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MAP

showing the

STREAM ORDER

of

MAG-ASAWANG TUBIG WATERSHED

Located in the Municipalities of Naujan and Victoria, Province of Oriental Mindoro and Mun. of Sablayan, Province of Occidental Mindoro

AREA = 43,534.24 hectares

SCALE = 1:300000

0 — >100 m

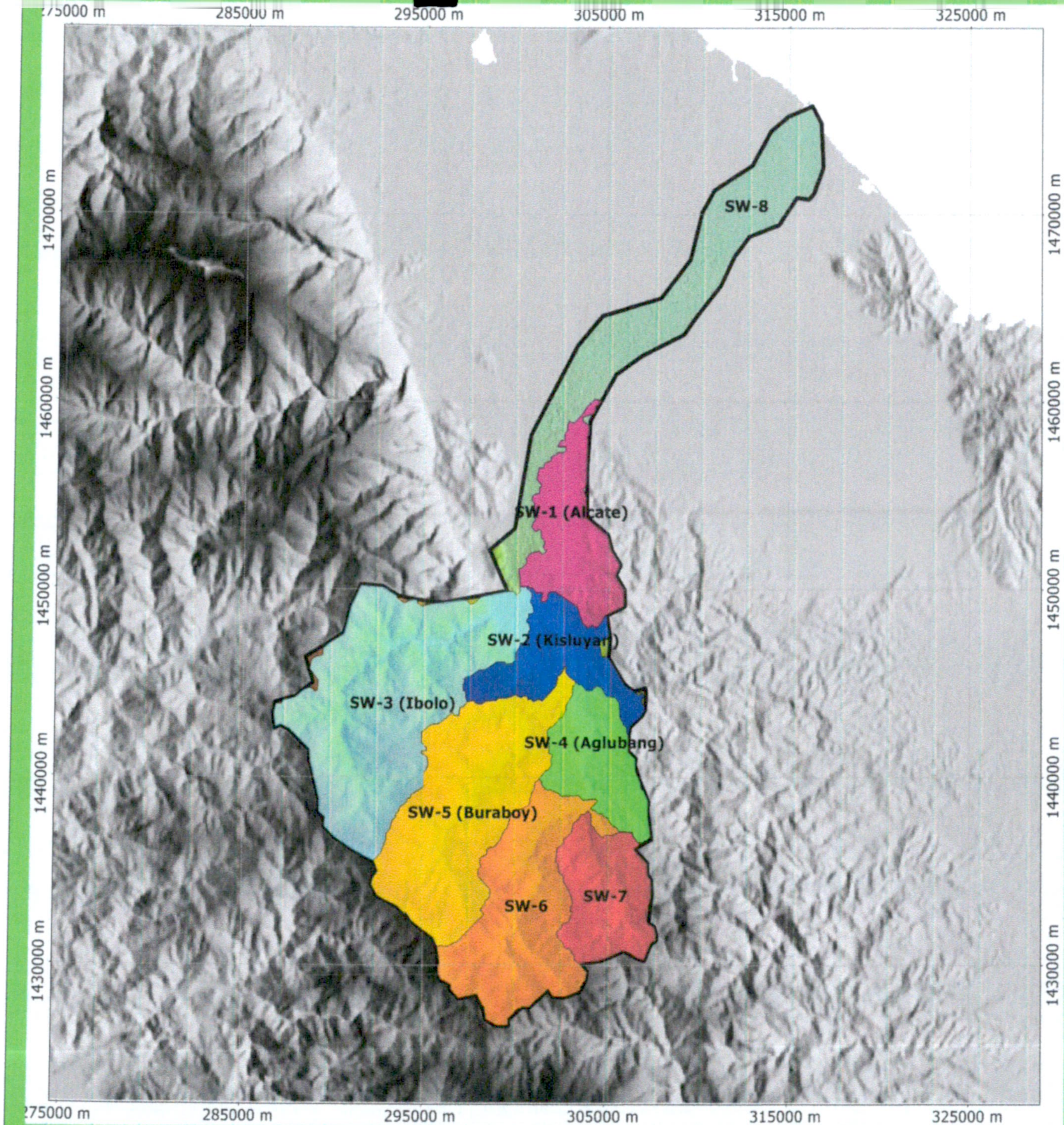
Projection : Universal Transverse Mercator - Zone 51 (N)
Datum : Luzon (Philippines excluding Mindanao)

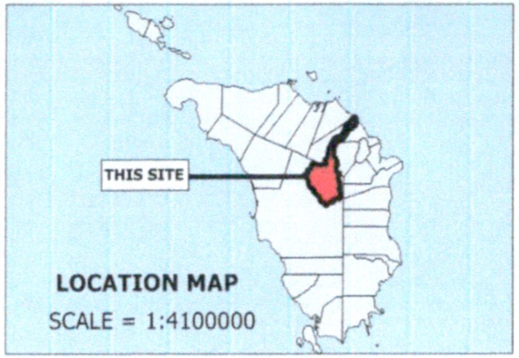
LEGEND

Creeks/Streams
- 1
- 2

Major Streams
- 3
- 4
- 5

WATERSHED AREA





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MAP

showing the

SUB-WATERSHED

of

MAG-ASAWANG TUBIG WATERSHED

Located in the Municipalities of Naujan and Victoria,
Province of Oriental Mindoro and Mun. of Sablayan,
Province of Occidental Mindoro

AREA = 43,534.24 hectares

SCALE = 1:300000

0 >1 m

Projection : Universal Transverse Mercator - Zone 51 (N)
Datum : Luzon (Philippines excluding Mindanao)

LEGEND

SUB-WATERSHED
- SW-1 (Alcate)
- SW-2 (Kisluyan)
- SW-3 (Ibolo)
- SW-4 (Aglubang)
- SW-5 (Buraboy)
- SW-6
- SW-7
- SW-8

WATERSHED AREA

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MAP

showing the

TENURIAL INSTRUMENTS

of

MAG-ASAWANG TUBIG WATERSHED

Located in the Municipalities of Naujan and Victoria, Province of Oriental Mindoro and Mun. of Sablayan, Province of Occidental Mindoro

AREA = 43,534.24 hectares

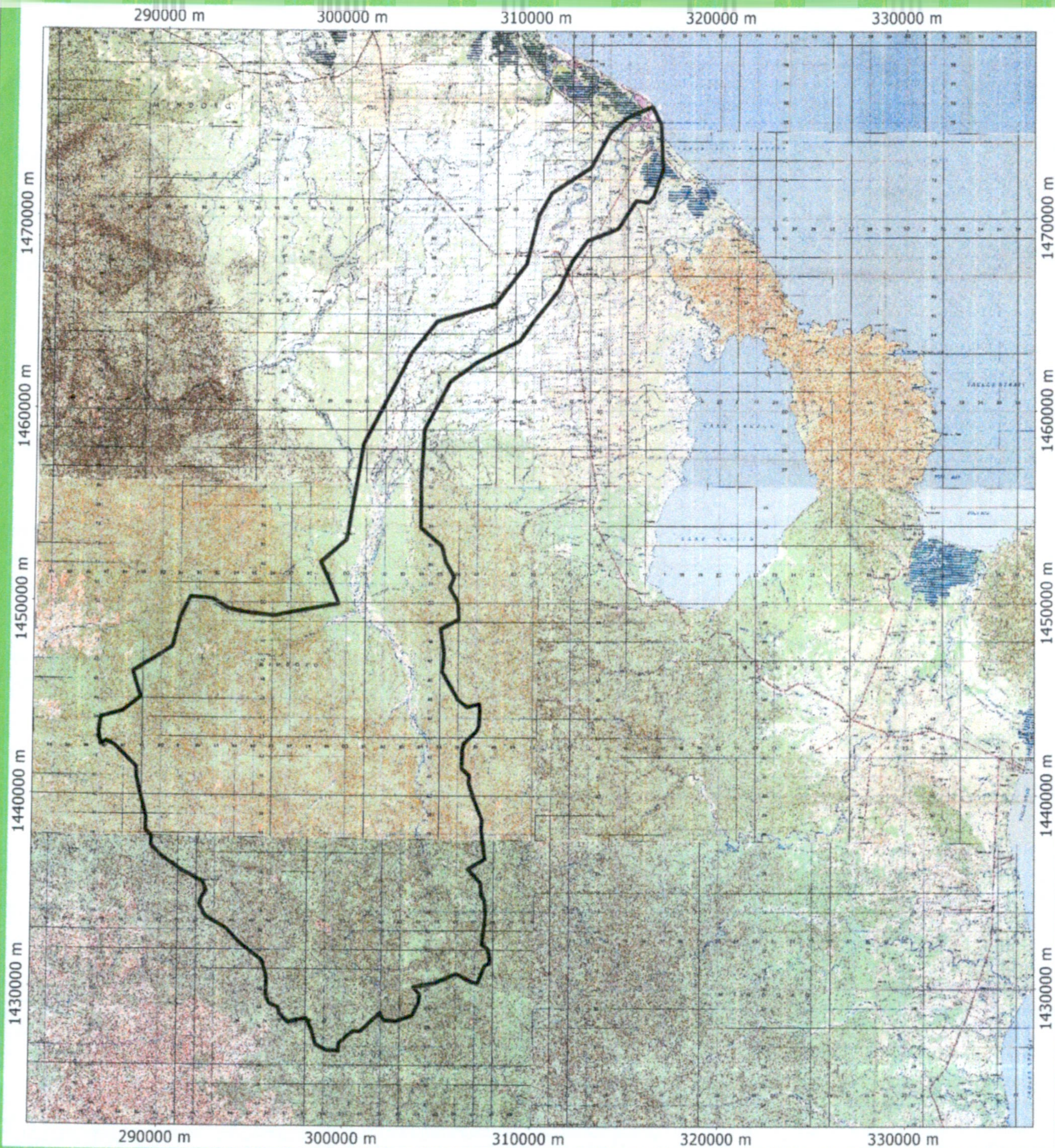
SCALE = 1:300000

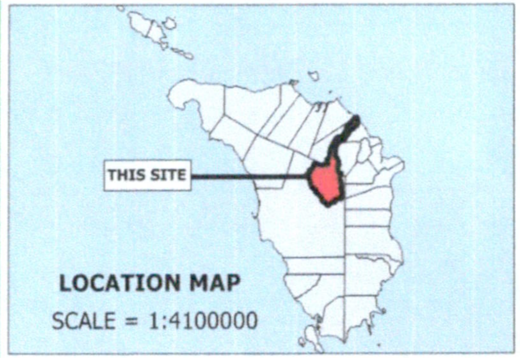
0 >100 m

Projection : Universal Transverse Mercator - Zone 51 (N)
Datum : Luzon (Philippines excluding Mindanao)

LEGEND

- WATERSHED AREA
- TENURE
- PA
- CADC
- FLGLA
- Watershed
- Barangay Forest





LOCATION MAP
SCALE = 1:4100000

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MAP

showing the

TOPOGRAPHY

of

MAG-ASAWANG TUBIG WATERSHED

Located in the Municipalities of Naujan and Victoria, Province of Oriental Mindoro and Mun. of Sablayan, Province of Occidental Mindoro

AREA = 43,534.24 hectares

SCALE = 1:300000

0 >100 m

Projection : Universal Transverse Mercator - Zone 51 (N)
Datum : Luzon (Philippines excluding Mindanao)

LEGEND

WATERSHED AREA

DATA SOURCE : DMA NO.

3258-I Quinabigan
3258-IV Mount Sinclair
3259-I Naujan
3259-II Pinamalayan
3259-III Cogonbuac
3259-IV New Macatoc
3260-II Nagiba
3260-III Calapan