Multi-hazards and Risk Assessment Report for Mataniko River Catchment in Guadalcanal, Solomon Islands

Multi-hazards and Risk Assessment Report for Mataniko River Catchment in Guadalcanal, Solomon Islands

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Produced and reviewed by GEF Pacific International Waters Ridge to Reef Regional Project, Pacific Community (SPC), Suva, Fiji

Pacific Community
Communauté du Pacifique

Suva, Fiji, 2021

Original text: English

Produced and reviewed by GEF Pacific International Waters Ridge to Reef Regional Project, Pacific Community (SPC), Suva, Fiji

Layout and Design by Navneet Lal/Pacific Community (SPC)

Prepared for publication at SPC's Suva Regional Office, Private Mail Bag, Suva, Fiji, 2021
www.spc.int | spc@spc.int

Printed by Quality Print, Suva, Fiji, 2021

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ABBREVIATIONS

AS	Australian Standard
CC	Climate Change
DRR	Disaster Risk Reduction
GEF	Global Environmental Facility
GIS	Geospatial Information System
ISO	International Organization of Standardization
IWR2R	International Water Ridge 2 Reef
MECDM	Ministry of Environment, Climate Change, Disaster Management and Meteorology
NZS	New Zealand Standard
PCRAFI	Pacific Catastrophe Risk Assessment and Financing Initiative
RS	Remote Sensing
SI	Solomon Islands
UNISDR	United Nations International Strategy for Disaster Reduction.
UNOCHA	United Nation Office of the Coordination of Humanitarian Affairs

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ACKNOWLEDGEMENTS

Funding received through Global Environment Facility (GEF) for the Pacific International Waters Ridge to Reef (IWR2R SI Project) to integrate watershed and coastal area for the strengthening of water resource protection in Honiara is acknowledged.

Mataniko communities including key informants and field assistants consulted during this assessment are acknowledged for their time spent with the assessment team. This report would be incomplete without such support.

Lastly, the author would like to acknowledge and thank Dr. Hilda Sakiti-Waqa and other reviewers for the comments made on the original script of this paper, which subsequently improved the quality of this report.

EXECUTIVE SUMMARY

This report provides a qualitative analysis of potential hazards and risks within the Mataniko river catchment in Guadalcanal, Solomon Islands. A multi-criteria consequence and likelihood scenario analysis developed by Australian Institute for Disaster Resilience based on AS/NZS ISO 31000: 2009 risk management guideline is used to analyze data and information on the consequence and likelihood of potential hazards within Mataniko River catchment.

Potential hazards are classified as hydrological, geophysical, meteorological, and anthropogenic. The extent of distribution of hazards' likelihood and consequence are categorized as local, catchment, island, and national boundaries. Extent of distribution of potential hazards is defined as the areas over which the impact can be experienced.

Riverine flooding and hydrological short circuiting are hazard events confined to the lowest point of the catchment boundary. Landslide (wet ground movement) hazard occurs on steep slopes along major rivers and streams and on aspect facing away from the sun. Coastal inundation is confined to coastal areas where the Mataniko catchment meets the ocean.

Occurrence of Landslide (dry ground movement), rock fall, subsidence and erosion are confined to steep slopes along Major River and streams and on riverbed and valleys within the catchment. Seismic waves generated by earthquakes uniformly propagate throughout the catchment, island national boundaries.

Occurrence of drought, Tropical Cyclone and extreme temperature events are distributed at the island and national boundaries. Distribution of high intensity rainfall varies throughout the catchment as it depends on the position of the rain clouds above the catchment.

Risk analysis and prioritization identifies Tropical Cyclone to be the highest priority hazard for Mataniko river catchment. Hydrological short-circuiting and high rainfall events are considered as high priority hazards after Tropical Cyclone. This report also identifies riverine flash floods, landslide (wet ground movement), coastal inundation, earthquake and fire as common hazards within the catchment boundary that pose certain degrees of risk to human and the ecosystems once these systems cross-path with these hazards.

1. INTRODUCTION

Mataniko watershed and catchment boundary lies within the Honiara City Council and Guadalcanal Province administration boundaries. Mataniko watershed and catchment boundary covers an area of 5802 Ha. The area of study and assessment covers the entire watershed and catchment boundary of the river system and its tributaries. The assessment conducted within the watershed and catchment boundary, focused on risks associated with the occurrence of natural and anthropogenic hazards. This assessment identifies and defines risks associated with the occurrence of environmental, anthropogenic and climate related hazards. Figure 1 identifies the location of the Mataniko river catchment boundary on Guadalcanal in Solomon Islands.

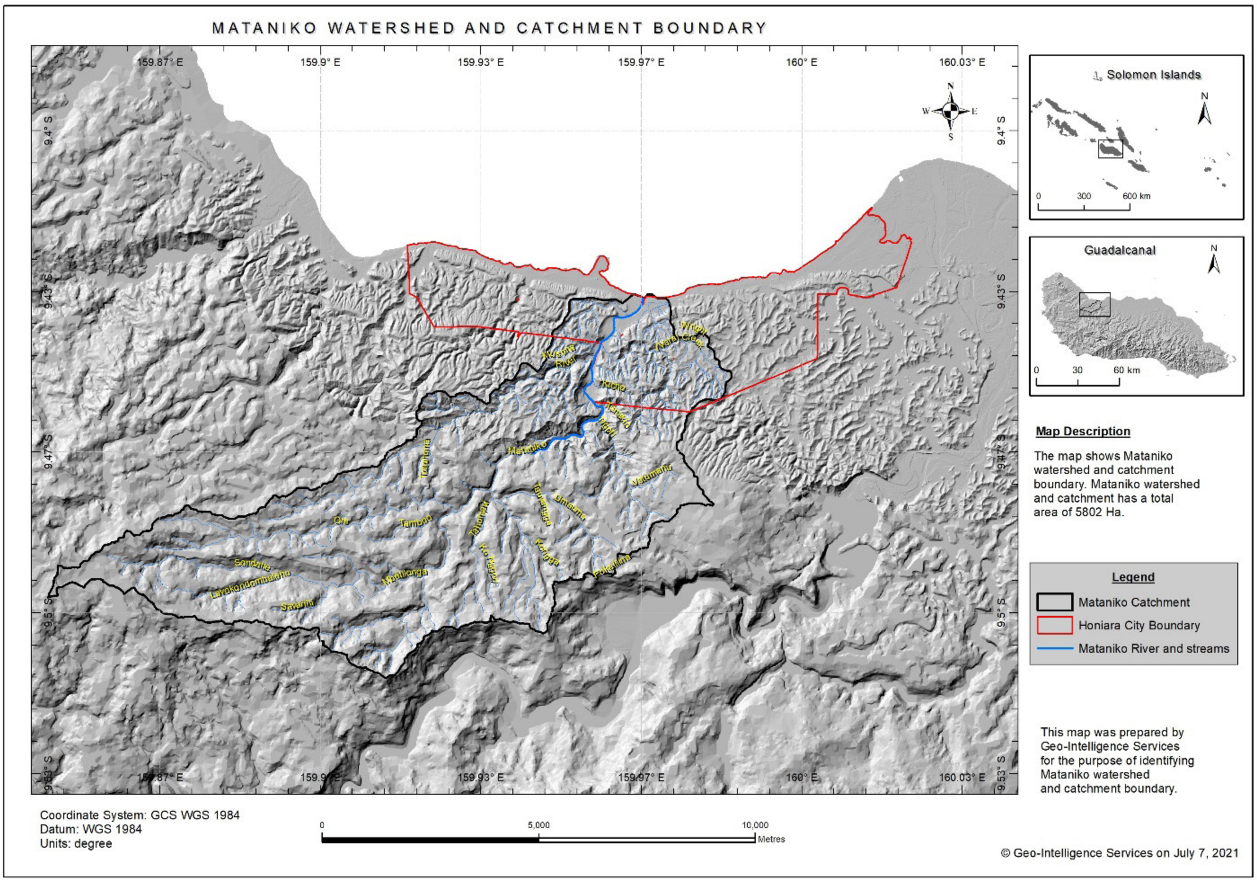

Figure 1: The map shows Mataniko river catchment within Guadalcanal and Honiara political administration boundaries.

1.1 Geophysical Environment

The Mataniko river basin and catchment lies within the Central geological province according to Coleman's classification (Coleman, 1965). The geology is dominated by diorite formations bounded by outcrops of the Miocene limestone (Hackman, 1979). Rock formation within the Mataniko watershed and catchment boundary consist of calcareous sandstone/mudstone of Miocene to recent, which overlies diorite of Oligocene. Calcareous and volcanic course sediments are distributed along the river channel. Coral limestone of Pleistocene age is distributed at the upper parts of marine terraces and river gorge.

In the Northern ridges of the catchment, the limestone is exposed into steep ridges and outcrops to a greater or lesser extent to the eastern and western ridges. Towards the coast, the limestone are fronted by grass escarpment set on the Pleistocene Honiara beds, 'a group of calcareous sediments of varied lithology which rise from the sea as series of three or four terraces'(Hackman, 1979). In some areas, these sediments rest on a poorly known Lungga beds. Alluvial deposition is generally restricted within the valley with sediments being largely confined to small fans along the riverbank. Figure 2 shows the parent soil material indicating rock formation within the river catchment boundary.

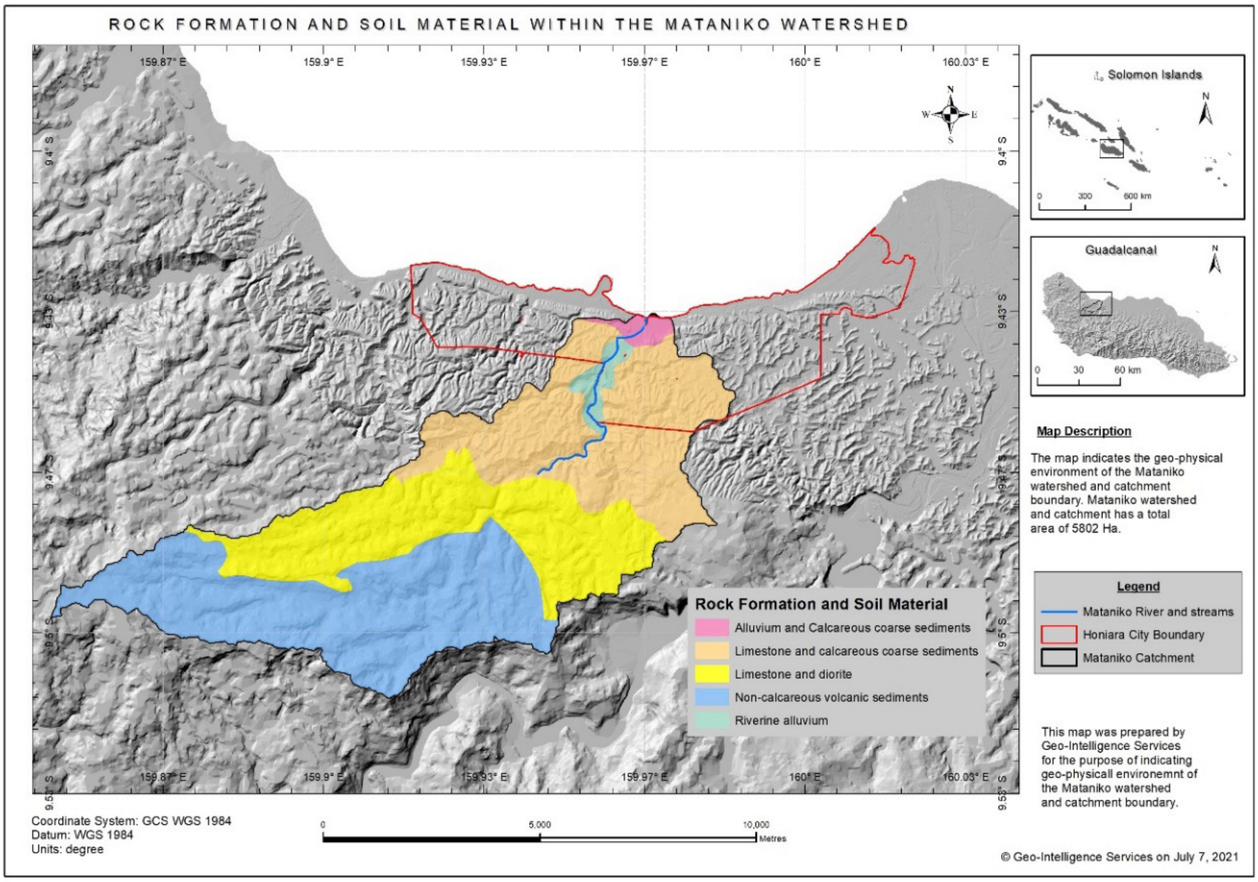

Figure 2: The map shows rock formations and parent soil materials within the Mataniko river catchment.

Surface topography of the catchment area consists of dissected terrain with narrow ridge tops and very steep ridge slopes. Narrow valley as seen along the Mataniko catchment, is prone to hydrological short-circuiting floods during extreme rainfall events. Figure 3 indicates landform distribution within the river catchment boundary.

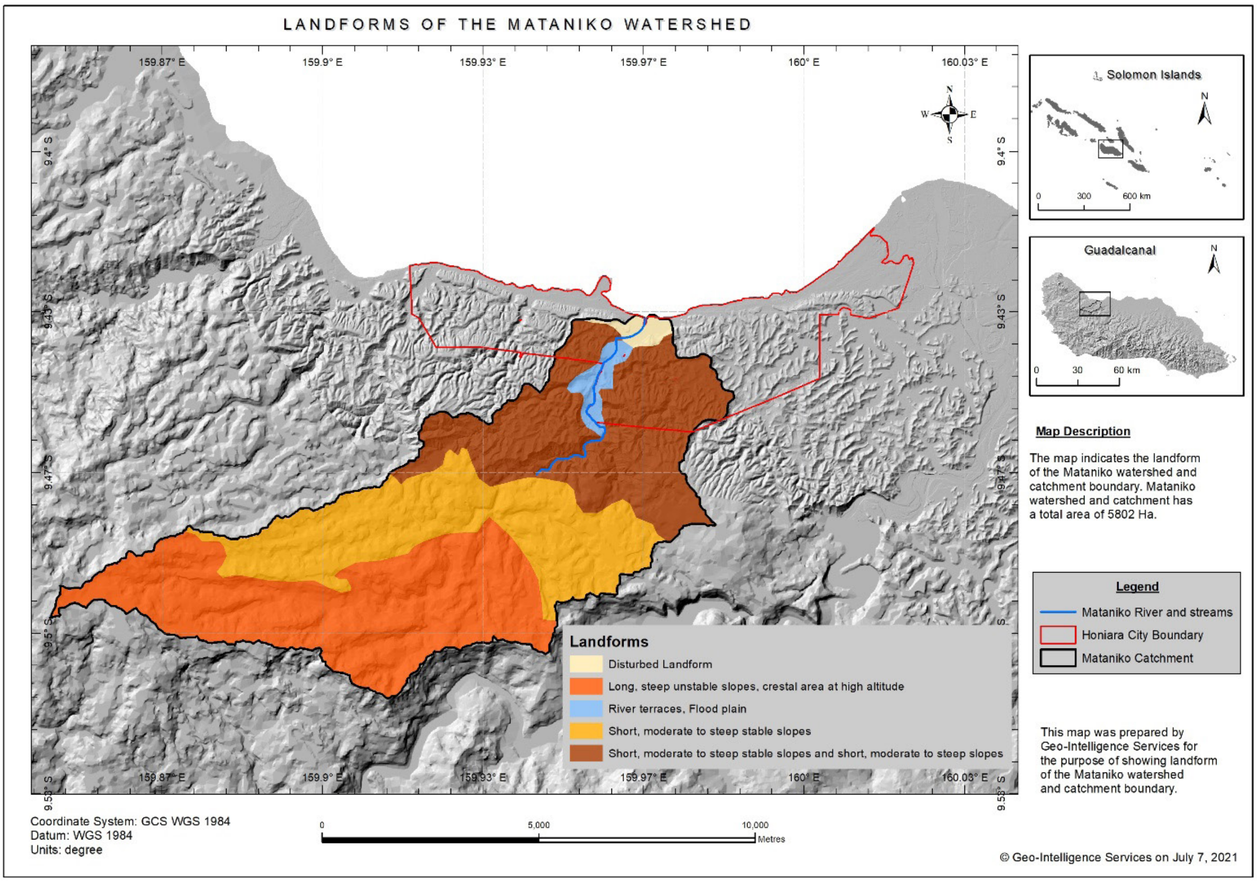

Figure 3: The map shows landforms indicating the nature of surface topography of the Mataniko river catchment.

1.2 Biophysical Environment

Biophysical environment is characterized by grassland of *Themeda australis* and *Imperata cylindrical,* hilly forests and small patches of lowland and swamp forests. A detail vegetation history reveals that massive grassland extensions occur at the expense of forest taxa as a result of burning events consistent with forest clearance and urban settlements (Haberle, 1996).

Past human activities such as farming, settlement and road works had altered the biophysical environment within the lower and mid-section of the Mataniko water catchment. The satellite map (Figure 4) indicates the spatial characteristics of biophysical environment within the Mataniko river catchment boundary.

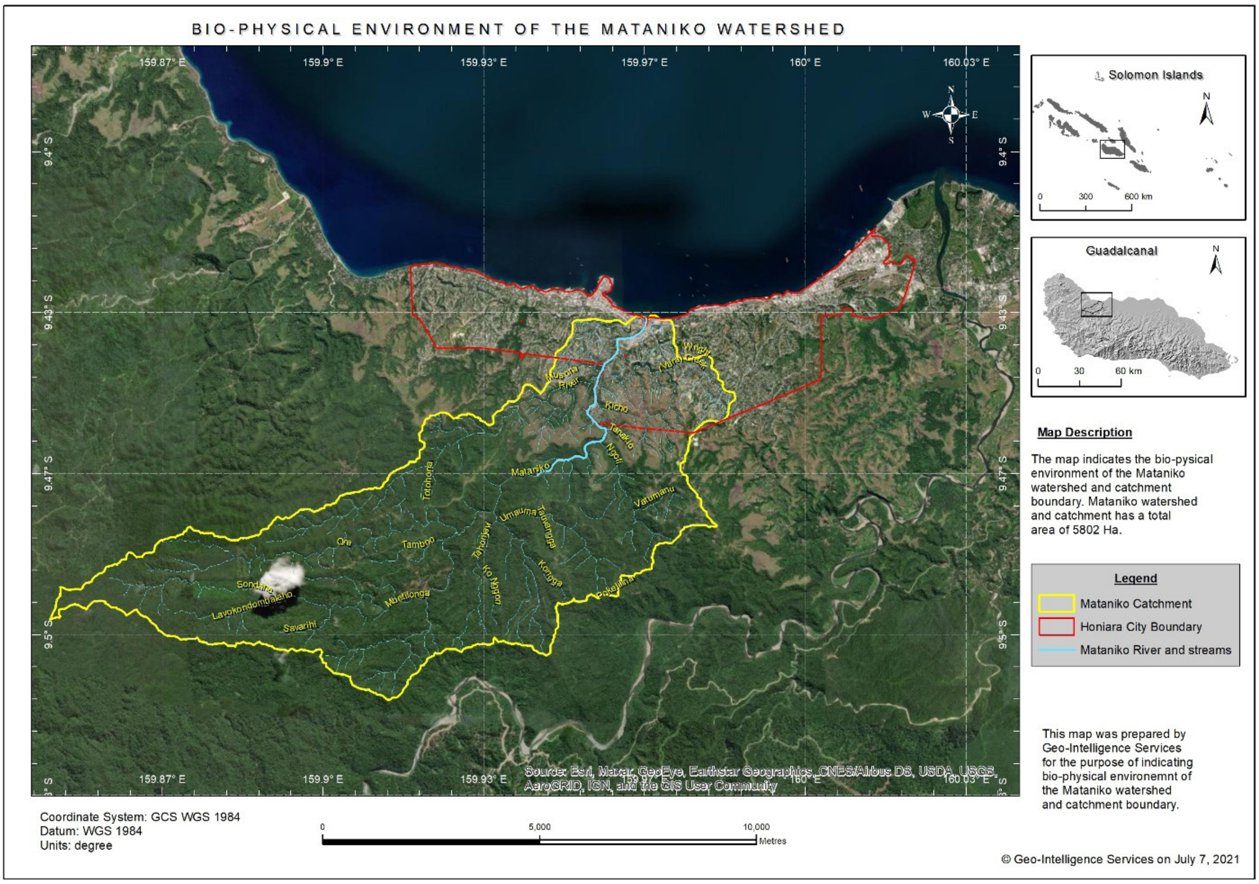

Figure 4: The map shows land cover and biophysical environment of Mataniko river catchment.

1.3 Hazards and Risk

Solomon Island is expected to incur, over the long term, average annual loss of USD 20 million due to geophysical, hydrological, and meteorological hazards. In the next 50 years, the Solomon Islands has a 50 percent chance of experiencing a single event loss exceeding USD 240 million and a 10 percent chance of experiencing a single event loss exceeding USD 520 million (PCRAFI, 2015)

The positions of individual Islands and geographical regions of larger islands, in relation to plate tectonic boundaries, latitude and longitude as well as their size and topography, determines the incidence to natural hazards (D. Radford & R. Blong, 1992). Because of the variability, each island and separate geographic areas within larger islands have to be studied individually to determine their exposure to hazards.

In the case of Guadalcanal Province, incidences to geophysical, hydrological, and meteorological hazards impacting the northern geographic region include heavy rain and strong wind associated with Tropical Cyclone, flash flooding due to heavy rainfall, landslide, rock fall, drought, storm surge and earthquake. The April 2014 hydro-meteorological hazards had significantly impacted the Mataniko watershed and catchment boundary causing significant economic losses as well as losses of lives to communities living on flood plain areas of the catchment (UN OCHA, 2014).

1.4 Hazards Assessment for Risk Management

Developing an understanding on hazards is an important step in the risk management process. Hazard assessment provides information on the spatial and temporal distribution of specific hazard event. Spatial distribution of hazard is influenced by regions and by topography. Temporal distribution is influenced by factors such as frequency of occurrence, speed and duration of events and seasonal weather conditions (Middelmann, 2007).

There are different methods and tools available for assessing hazards and risks. However, appropriate methods of assessments may be undertaken to varying degrees of details depending on what hazards being assessed, the risk factors to be determined, and the information, data and resources available (Middelmann, 2007). Thus, hazards and risk assessment methods can be qualitative, semi-quantitative and probabilistic.

The Sendai framework provides the basis for assessing hazards and risks relating to geophysical, hydrological, meteorological and anthropogenic hazards (UNISDR, 2015). A guideline on national disaster risk assessment is developed as part of a series of thematic guidelines to support national implementation of Sendai Framework (UNISDR, 2017). Organizations, institutions, and governments also develop standard procedures for assessing and managing risks. For example, Australia and New Zealand jointly develop a standard procedure called AS/NZS ISO 31000 for assessing and managing risks (AS/NZS ISO 31000, 2009).

1.5 Aims and Objectives

This study aims to understand risks from the environment, climate, and human related activities within the Mataniko watershed and catchment boundary resulting from environment, climate, and anthropogenic hazards. The objectives are:

i. To identify potential hazards within the Mataniko water catchment boundary
ii. To determine the spatial distribution of the potential hazards
iii. To provide hazards prioritizing options to minimize the risks from potential hazards

This report uses AS/NZS ISO 31000 and Australian Institute for Disaster Resilience risk assessment guideline to accomplish the three objectives. A multi-criteria impact and likelihood scenario analysis is used. This method assesses two dimensions of risk: consequence and likelihood.

1.6 Rationale

The need to strike a balance between human development activities and the ecosystem with geophysical, hydrological, meteorological, and anthropogenic hazards provide guidance on quantifying the consequences of development activities within the catchment area as well as, the potential risks posed by these hazards to elements within the watershed and catchment boundary.

Mataniko watershed and catchment boundary is located on Guadalcanal, which is known for frequent Tropical Cyclone as well as active seismic activities. Therefore, it is exposed to hydro-meteorological and geophysical hazards. Previous hazards events incurred the loss in millions of dollars from the Nation Government and aid donor’s budget.

Understanding the risks emanating from the environment, climate and human related activities is important for mitigating the expected loss posed by these hazards to humans and ecosystems within the watershed and catchment boundary.

2. METHODOLOGY

Hazards and risks identification and prioritization were conducted for the entire Mataniko river watershed and catchment boundary. The assessment was conducted by 1) determining and identifying existence of potential geophysical, hydrological, meteorological, and anthropogenic hazards; 2) collation and processing of variables to develop potential hazard scenarios; 3) multiplying consequence and likelihood of hazards to determine risk; 4) prioritization of hazards for risks management.

2.1 Identifying potential hazards

Potential hazards within the catchment boundary were identified through community consultations and review of literatures. Community consultations involved participatory mapping and key informant discussions. Maps of the Mataniko river catchment were prepared and shared with the Tuvaruhu, Kana Hill, Musona, Vara Creek and Koa Hill communities during consultation. Key informants within those communities provided information on both potential and existing hazards by sketching them onto the maps. Spatial distribution of hazards within the catchment were identified and mapped during this process.

Ground truthing was conducted to validate and document information provided by the key informant during participatory mapping. Other hazards that were not identified during community consultation and literature review were documented during ground truthing. Potential environment, climate anthropogenic hazards identified were grouped into hazard types for reporting in the result section of this report.

2.2 Risk Assessment

Qualitative research approach based on AS/NZS ISO 31000: 2009 and Australian Institute for Disaster Resilience risk management guideline was used in this report (AS/NZS ISO 31000, 2009; Australian Institute for Disaster Resilience, 2015). The level of risk associated to the potential hazards were examined. This step was conducted by reviewing past occurrences of hazards and possible scenarios. The likelihood of the hazards occurring and the potential impacts of the hazards on people, properties, critical infrastructures, and environment were examined.

Available datasets required to conduct the assessment were sourced and collated from MECDM risk information management systems. Other online portals such as relief web, PCRAFI, Pacific Data hub and the environment data portal were also consulted in the process of collating data.

2.3 Risk analysis

A multi-criteria consequence and likelihood scenario analysis developed by Australian Institute for Disaster Resilience based on AS/NZS ISO 31000: 2009 risk management guideline was used to analyze data and information on consequence and likelihood of potential hazards within Mataniko River catchment (Australian Institute for Disaster Resilience, 2015). The generic risk formula, *Risk = Consequence x likelihood* was used to determine risk values for specific hazards.

Risk was expressed as a combination of consequences of an event and the associated likelihood of the event's occurrence. Consequence was the outcome of an event affecting the 'elements of value'. Likelihood was the chance of an event to occur impacting the 'elements of value'.

Four 'elements of value': social, property, critical infrastructure, and environment, were assessed to determine the consequence in the risk equation. See appendix 2 – appendix 5 for the four 'elements of value' and their criteria used in assessing consequence.

Likelihood of potential hazards impacting the 'elements of value' within the Mataniko River Catchment was determined by assessing the hazards' frequencies or its probabilities in Solomon Islands and on Guadalcanal. Appendix 1 showed the frequency criteria used in assessing the likelihood of potential hazards impacting the 'elements of value'.

The risk values were calculated and classified into five categories: very high, high, moderate, low, and very low. Classification of risk into five level guides the prioritization of potential hazard events within the Mataniko River catchment boundary for risk management purposes.

3. RESULT

Potential hazard events are identified and classified. The levels of risks associated with these hazards are prioritized for risk management actions.

3.1 Potential hazards

Potential hazards identify within the Mataniko watershed and catchment boundary are classified into four classes as shown in the table (Table 1). Hazards are classified as hydrological, geophysical, meteorological, and anthropogenic (first column). Column 2 of the table shows individual hazard events that fall under each hazard type in column 1. Potential hazards and events within the watershed are identified during community consultation and review of past reports on hazards in the Solomon Islands.

Table 1: The table shows potential hazard events identify within the catchment of Mataniko River

Hazard Types	Potential Hazard Events
Hydrological hazards	• Riverine flash flooding • Landslide (wet ground movement) • Coastal inundation • Hydrological short circuiting
Geophysical hazards	• Landslide (dry ground movement) • Rock fall • Subsidence • Earthquake • Erosion
Meteorological Hazards	• High rainfall events • High temperature events • Droughts or low water • Tropical Cyclone
Anthropogenic Hazards	• Ground movement • Fire • Chemical spill

The classification of hazard type is based on the mechanism that triggers the hazards. Excess water triggers riverine flooding, Landslide, coastal inundation, and hydrological short-circuiting. These potential hazards events triggered by excess water are classified as hydrological hazard.

The formation and structure of rocks and soil and the processes within the earth's crust triggers landslide, rock fall, subsidence, and earthquake. These potential hazard events are classified as geophysical hazards.

Short and long-term condition of the atmosphere can trigger potential hazards. Hazard events triggered by the condition of the atmosphere such as high intensity rainfall, extreme temperature, droughts, and Tropical Cyclone are classified as meteorological hazards.

Human activities and negligence have the potential to trigger hazards. Human activities and negligence observed within the catchment boundary that can trigger potential hazard are ground movements from logging operation, fire, and inappropriate disposal of toxic liquid and solid wastes. Potential hazard events resulting from human activities and negligence are classified as anthropogenic hazard.

3.2 Extent of distribution of potential hazards

The extent of distribution of potential hazards varies throughout the Mataniko river catchment boundary. Extent of distribution of potential hazards is defined as the areas over which the impact can be experienced. The extent of distribution of hazards' likelihood and consequence are categorized as local, catchment, island, and national boundaries. The table (Table 2) shows the extent of distribution of potential hazards in the catchment boundary.

Table 2: The table identifies potential hazards and determine their distribution within the catchment boundary

Hazard Types	Potential Hazard events	Extent of Distribution
Hydrological hazards	• Riverine flash flooding • Landslide (wet movement) • Coastal inundation • Hydrological short-circuiting	• Catchment • Local • Local • Catchment
Geophysical hazards	• Landslide (dry movement) • Rock fall • Subsidence • Earthquake • Erosion	• Local • Local • Local • Island and national • Local
Meteorological hazards	• High rainfall events • High temperature events • Drought • Tropical Cyclone	• Catchment • Island and national • Island and national • Island and national
Anthropogenic Hazards	• Ground movement • Fire • Chemical spill	• Local • Local • Local

Extent of distributions of hydrological hazards are confined to specific locations within the catchment. Riverine flooding and hydrological short-circuiting are hazard events confined to the lowest point of the catchment boundary. Figure 5 identifies high-exposed areas to riverine flooding and hydrological short-circuiting hazard within the catchment boundary. Map in appendix 6 shows the extent of flood hazard within the entire river catchment.

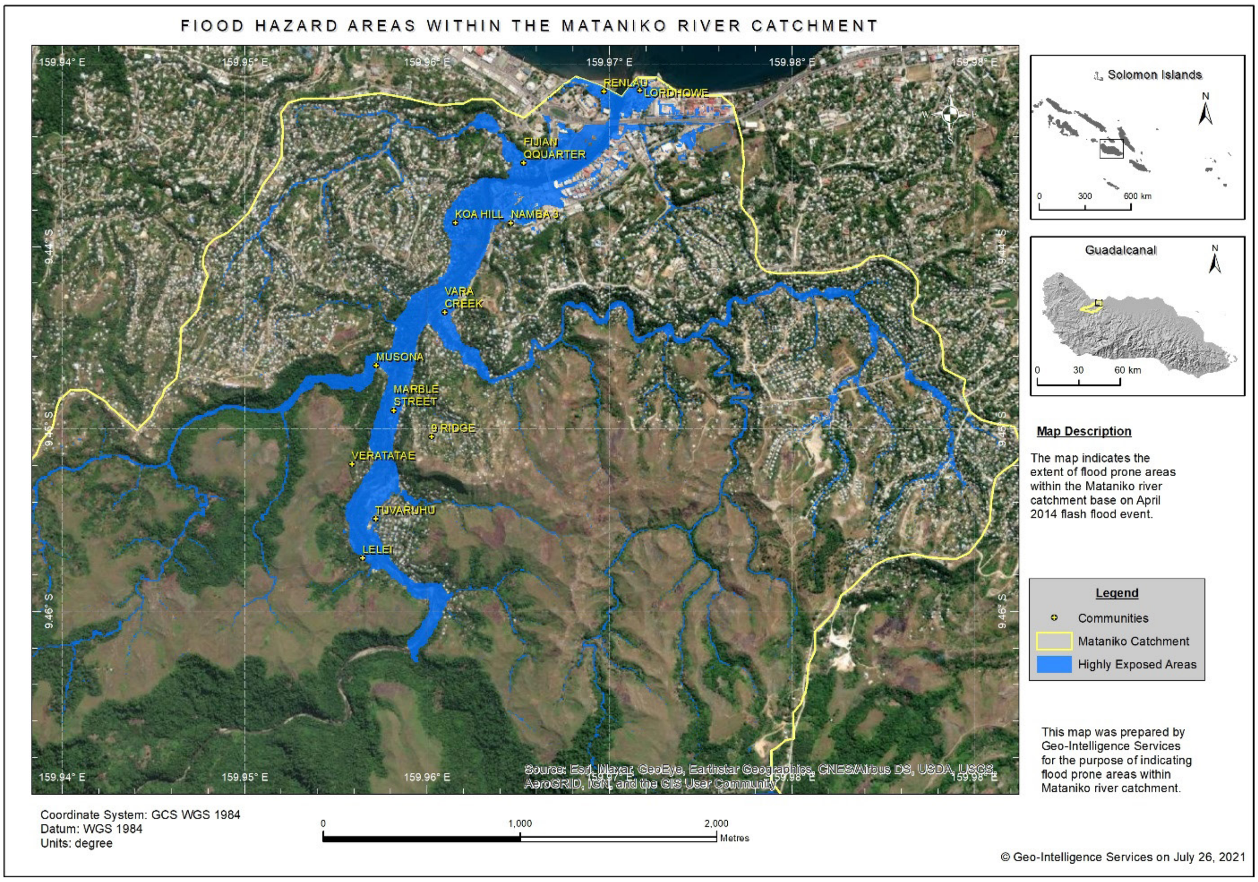

Figure 5: Map of flood hazard high-exposed areas based on 2014 flood hazard event.

Landslide (wet ground movement) hazard occurs on steep slopes along major rivers and streams and on aspect facing away from the sun. Figure 6 identifies high-exposed areas to landslide hazard within the river catchment boundary. Map in appendix 7 shows the extent of landslide hazard within the entire river catchment.

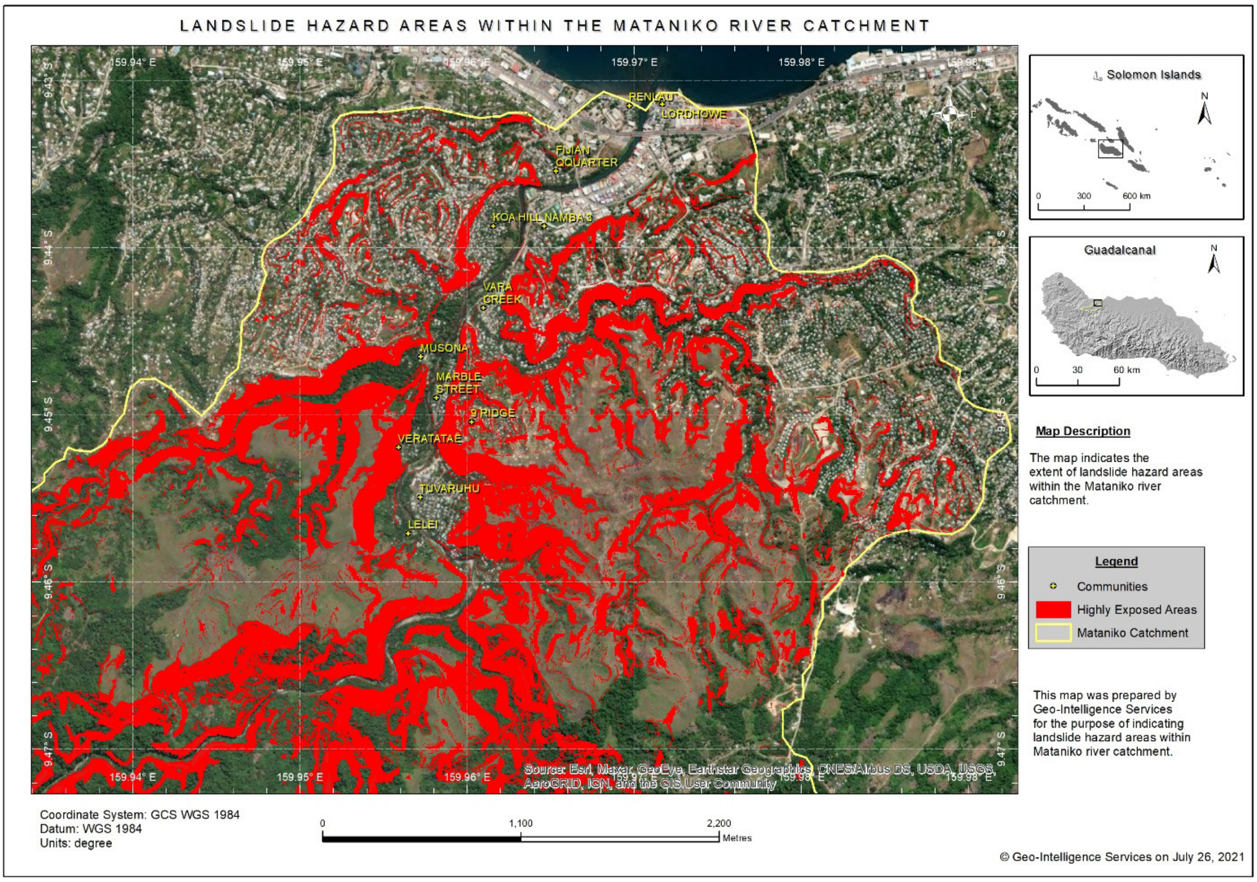

Figure 6: Map of landslide hazard high-exposed areas within the river catchment.

Coastal inundation is confined to coastal areas where the Mataniko catchment meets the ocean. Figure 7 identifies high-exposed areas to coastal hazard within the river catchment boundary. Map in appendix 8 shows the spatial extent of coastal hazards within the Mataniko river catchment boundary.

Figure 7: Map of coastal hazards high-exposed areas within the river catchment.

Extent of distributions of geophysical hazards are localized or confined to specific locations within the catchment boundary except earthquake. Occurrence of Landslide (dry ground movement), rock fall, subsidence and erosion are confined to steep slopes along Major River and streams and on riverbed and valleys within the catchment. Figure 6 shows high-exposed areas to landslide hazard within the river catchment.

Seismic waves generated by earthquakes will uniformly propagate throughout the catchment, islands, and national boundaries. Figure 8 shows the spatial extent of earthquake hazard hotspot areas at the national boundary. Earthquake hazard events causing major damage within close proximity to the river catchment are shown on the map.

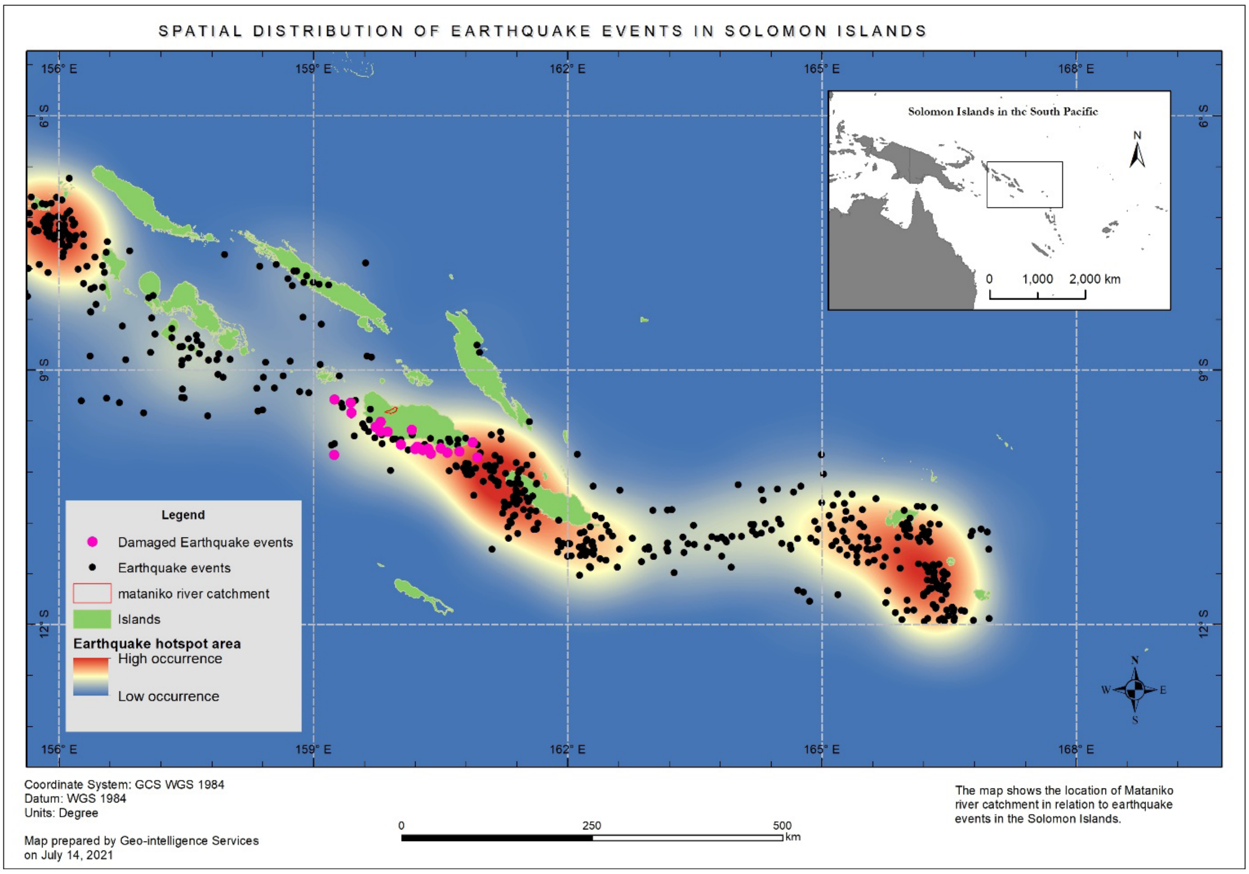

Figure 8: Map of earthquake hazards hotspot areas in Solomon Islands.

The extent of distributions of meteorological hazards are uniformed throughout the catchment boundary. Occurrence of drought, Tropical Cyclone and extreme temperature events are distributed at the island and national boundaries. Distribution of high intensity rainfall varies throughout the catchment as it depends on the position of the rain clouds above the catchment. Figure 9 shows the distribution of Tropical Cyclone hotspot areas at the national boundary.

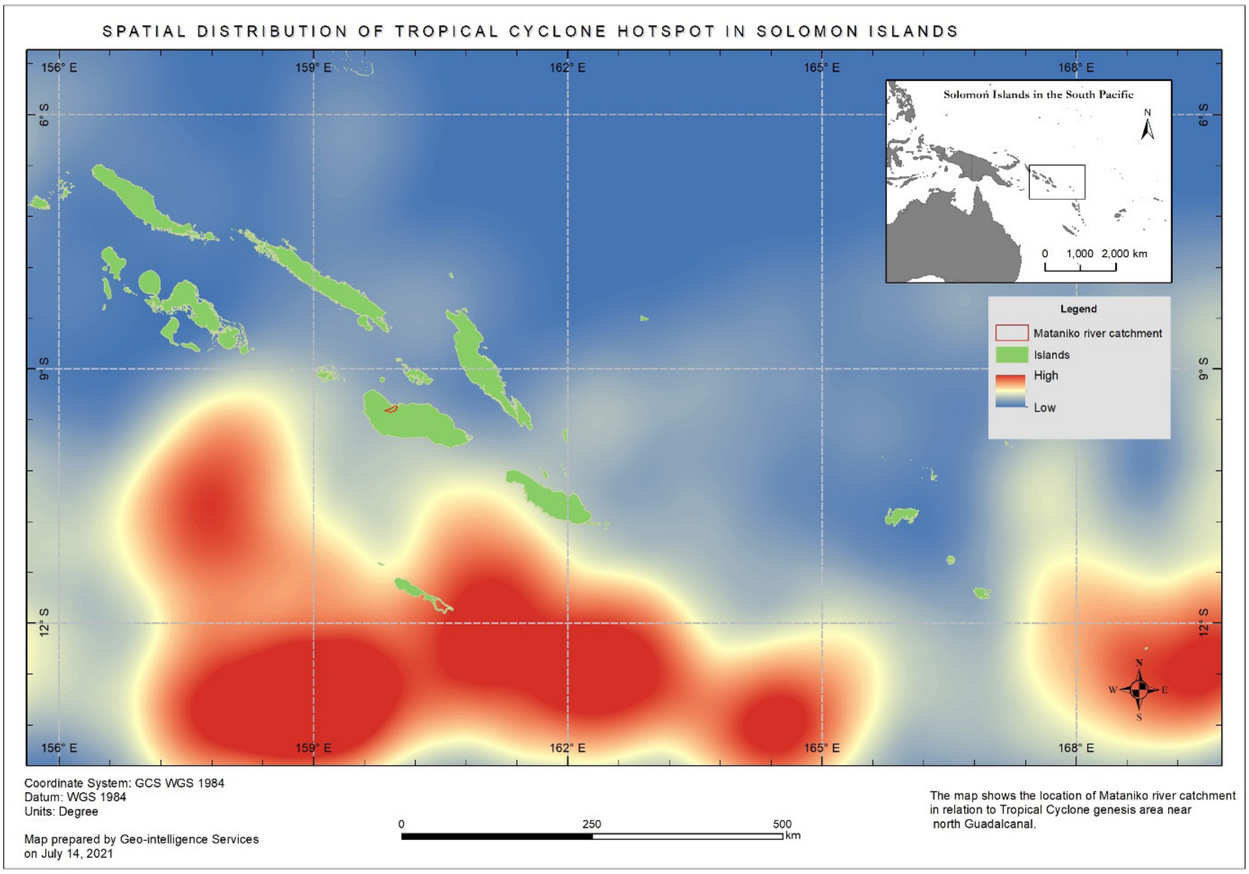

Figure 9: Map of Tropical Cyclone genesis areas in the Solomon Islands.

The extent of distributions of anthropogenic hazards are localized or confined to specific points and locations within the catchment boundary. Ground movement because of logging operation occurs in the upper section of the catchment. Fire hazard is confined to grassland and build-up areas in the lower section of the catchment. Chemical spill is confined to the lower sections of the river and streams.

3.3 Qualitative risk assessments

Qualitative risk assessments on potential hazard events analyzed the frequency or probability and consequence of hazard events identified and the impact pose onto the ecosystem and human developments within the Mataniko watershed and catchment boundary. A multi-criteria consequence and likelihood scenario analysis developed by Australian Institute for Disaster Resilience based on AS/NZS ISO 31000: 2009 risk management guideline was used (Australian Institute for Disaster Resilience, 2015).

3.3.3 Likelihood assessment of hazards

The table (Table 3) shows the output of qualitative assessment based on the frequencies of potential hazard events reviewed from National Disaster Office's situation reports, Natural Disasters in the Solomon Islands Volume 1 – Volume 3 and community consultations (D. A. Radford & R. J. Blong, 1992a, 1992b; Radford, Blong, & Flood, 1992). Frequency is part of the general risk equation and determines the likelihood that the elements of human and ecosystem could be impacted by the hazards. Frequency assessment criteria is based on the probabilities of occurrence of potential hazards. See appendix 1 of this report for the probability ranking potential hazards used in this assessment. A scale of 1 – 6 is used in the ranking of likelihood.

Table 3: The table shows ranking of likelihood of potential hazards based on frequency of hazard's occurrence reviewed from reports and community consultation.

Potential Hazard events	Category	Likelihood	Frequency
Riverine flash flooding	Very unlikely	2	1 % - 2% chance of occurrence in any year
Landslide (wet movement)	Probable	4	10% - 50% chance of occurrence in any year
Coastal inundation	Probable	4	10% - 50% chance of occurrence in any year
Hydrological short-circuiting	Likely	5	50% - 100% chance of occurrence in any year
Landslide (dry movement)	Probable	4	10% - 50% chance of occurrence in any year
Rock fall	Unlikely	3	2% - 10% chance of occurrence in any year
Subsidence	Very unlikely	2	1% - 2% chance of occurrence in any year
Earthquake	Very unlikely	2	1% - 2% chance of occurrence in any year
Erosion	Very unlikely	2	1% - 2% chance of occurrence in any year
High rainfall events	Probable	4	10% - 50% chance of occurrence in any year
High temperature events	Probable	4	10% - 50% chance of occurrence in any year
Droughts or low water	Unlikely	3	2% - 10% chance of occurrence in any year
Tropical Cyclone	Almost certain	6	100 % chance of occurrence in any year
Ground movement	Probable	4	10% - 50% chance of occurrence in any year
Fire	Unlikely	3	2% - 10% chance of occurrence in any year
Chemical spill	Very unlikely	2	1% - 2% chance of occurrence in any year

3.3.2 Consequence assessment of hazards

Consequences from the impacts of identified hazards onto human and ecosystems are categorized into four 'elements of value' categories. The four 'elements of value' used in this report are social impacts, property damage, critical infrastructure impact and environment damage. The table (Table 4) shows the output on the consequence of potential hazard events reviewed from National Disaster Office situation reports, Natural Disasters in the Solomon Islands, community consultations and expert judgment. Consequence assessment criteria is based on the severity of impacts on 'elements of values. See appendix 2 – appendix 5 of this report for the severity ranking of consequence used in this assessment.

Table 4: The table Shows consequence of potential hazard events categorized into a scale of 1 - 5

Hazards	Social Impacts	Property damage	Critical Infrastructure Impacts	Environmental Damage	Total Consequences
Riverine flash flooding	3	2	2	2	9
Landslide (wet movement)	1	2	0	2	5
Coastal inundation	0	2	1	1	4
Hydrological short-circuiting	1	2	2	1	6
Landslide (dry movement)	0	1	0	1	2
Rock fall	0	0	0	1	1
Subsidence	0	0	0	2	2
Earthquake	1	2	1	2	6
Erosion	0	1	1	1	3
High rainfall events	3	2	1	1	7
High temperature events	0	1	0	0	1
Droughts or low water	0	0	0	1	1
Tropical Cyclone	2	3	3	3	11
Ground movement	0	0	0	2	2
Fire	1	2	0	1	4
Chemical spill	1	0	0	1	2

The assessment on consequences of potential hazards for the ‘elements of value’ are summarized. Table 5 shows the ranking of the summarized consequence variables for ‘elements of value’ in Table 4, column 6.

Table 5: Table showing total consequence variable ranking.

Variable Total	Consequence ranking	Descriptive notes
1 - 3	1	Minor
4 - 5	2	Slight
6 - 7	3	Moderate
8 - 9	4	Severe
10 - 11	5	Very Severe
> 11	6	Catastrophic

The consequence variables of 'elements of value' are ranked from a scale of 1 – 6 as shown in table 5 to give equal weights to consequence once multiplied with likelihood to determine risk. Table 6 shows the summarized consequence ranking.

Table 6: The table shows summarized ranking of consequence variables of 'elements of value'.

Hazards	Consequence total	Consequence Ranking	Descriptive notes
Riverine flash flooding	9	4	Severe
Landslide (wet movement)	5	2	Slight
Coastal inundation	4	2	Slight
Hydrological short-circuiting	6	3	Moderate
Landslide (dry movement)	2	1	Minor
Rock fall	1	1	Minor
Subsidence	2	1	Minor
Earthquake	6	3	Moderate
Erosion	3	1	Minor
High rainfall events	7	3	Moderate
High temperature events	1	1	Minor
Droughts or low water	1	1	Minor
Tropical Cyclone	11	5	Very Severe
Ground movement	2	1	Minor
Fire	4	2	Slight
Chemical spill	2	1	Minor

3.4 Risk analysis and prioritization

The output of risk analysis generated in this section is based on the risk equation, *R = consequence x likelihood* (AS/NZS ISO 31000, 2009; Australian Institute for Disaster Resilience, 2015). Information on consequence and likelihood generated from qualitative risk assessment section is analyzed to determine risk from potential hazards within the catchment boundary. The table (Table 7) highlights the output of risk analysis by multiplying consequence and likelihood of potential hazards. Risk values in column 4 of table 7 are summarized into five levels of risk shown in table 8.

Table 7: The table shows the product of frequency and consequence based on the risk equation.

Hazards	Likelihood	Consequence	Risk
Riverine flash flooding	2	4	8
Landslide (wet movement)	4	2	8
Coastal inundation	4	2	8
Hydrological short-circuiting	5	3	15
Landslide (dry movement)	4	1	4
Rock fall	3	1	3

Hazards	Likelihood	Consequence	Risk
Subsidence	2	1	2
Earthquake	2	3	6
Erosion	2	1	2
High rainfall events	4	3	12
High temperature events	4	1	4
Droughts or low water	3	1	3
Tropical Cyclone	6	5	30
Ground movement	4	1	4
Fire	3	2	6
Chemical spill	2	1	2

Table 8 summarizes risk values associated with potential hazards identify in the Mataniko watershed and catchment boundary in table 7. Prioritization of risk values identify hazards from highest to lowest priorities for human and ecosystems management within the catchment. The table shows prioritization of risks to determine hazards that should be considered and prioritized for further risk analysis.

Table 8: The table shows the categories used to determine the level of risk to potential hazards.

Level of risk	Descriptive notes
< 2	Very low
3 - 5	Low
6 - 10	Moderate
11 - 15	High
> 15	Very high

Table 9 identifies and sorted hazards based on the level of risk using the risk value-summarized table (table 8). Based on the scale assigned to the level of risk, meteorological and hydrological hazards should be considered as the highest priority for Mataniko watershed and catchment boundary management. In addition, the level of risks above the scale of six should be considered as priorities for the management of human and ecosystems within the catchment boundary and a detail risk analysis.

Table 9: The table defines the level of risks for potential hazards

Hazards	Level of risk	Descriptive notes
Tropical Cyclone	30	Very high
Hydrological short-circuiting	15	High
High rainfall events	12	High
Riverine flash floods	8	Moderate
Landslide (wet movement of soil)	8	Moderate
Coastal inundation	8	Moderate

Hazards	Level of risk	Descriptive notes
Earthquake	6	Moderate
Fire	6	Moderate
Landslide (dry movement)	4	Low
High temperature events	4	Low
Ground movement	4	Low
Rock fall	3	Low
Drought or low water	3	Low
Subsidence	2	Very low
Erosion	2	Very low
Chemical spill	2	Very low

4. DISCUSSION

This report provides the initial step to assess and analyze potential hazards and risks within the Mataniko river catchment in Guadalcanal, Solomon Islands. The discussion in this section focuses on issues and lesson learned in this assessment.

The extent of potential hazards identify in this report are either confined to a specific geographic location or distributed throughout the catchment, island, and national boundaries. The occurrence and impacts of hydrological, geophysical, and anthropogenic hazards are confined to specific geographic areas except earthquake events. On the other hand, the extent of occurrence and impacts of meteorological hazards are distributed throughout the catchment, island, and national boundaries. Implications on determining the extent of distribution of potential hazards provides an understanding on the extent and the level of risks associated with these hazards within the Mataniko river catchment.

The National Emergency Risk Assessment Guideline for Australia (Australian Institute for Disaster Resilience, 2015) based on AS/NZS ISO 31000: 2009 provides a generic risk assessment guideline adopted in this report. The risk formula derived from this guideline is $R = C \times L$; where R is the risk to be determined, C and L are consequence and likelihood of potential hazards.

Likelihood determines how likely, human and ecosystems elements ('elements of value') within the catchment could be impacted based on the frequency of occurrence of potential hazards. Consequence determines how severe, human and ecosystems elements ('elements of value') could be impacted based on historical evidence of hazard impacts. The consequence and likelihood values are determined qualitatively based the criteria developed for scaling and ranking of variables. Scales and ranks representing consequence and likelihood are equally determined to maintain the same weight on both variables.

Ranking of risk from the highest to the lowest values has simplified the choice of prioritizing hazards that pose the greatest risk to human and ecosystems ('elements of value') within the catchment boundary of Mataniko watershed.

Risk analysis and prioritization identifies Tropical Cyclone to be the highest priority hazard for Mataniko river catchment. It is important to note that Tropical Cyclone can also triggers secondary hazards like flash floods, landslide (wet ground movement), coastal inundation and strong winds. Risk reduction measures for Tropical Cyclone also need to prioritize these hazards.

Hydrological short-circuiting and high rainfall events are considered high priority hazards. Hydrological short-circuiting is a type of flood hazard that gives little lag time between the onset of intense rainfall and the rise in floodwater. This is common in the Mataniko catchment where rugged terrain and narrow river channel exist. High rainfall events used in this report can be a rainfall event greater than 250 mm over a 24-hour period.

It should be noted that hazards with moderate level of risk in table 9 should also be considered in any risk management strategy for the Mataniko watershed and catchment boundary. This report identifies riverine flash floods, landslide (wet ground movement), coastal inundation, earthquake, and fire as hazards with moderate level of risk and should be considered. These are common hazards within the catchment boundary that pose certain degrees of risk to human and the ecosystems once these systems cross-path with these hazards.

Hazards spatially represented in maps provided in this report, identify areas in which ‘elements of value’ will be at risk to potential hazard events identify in the report.

This assessment adopts a qualitative approach to risk analysis since quantitative risk analysis approach will require extensive information, data, and resources, which is currently limited during this study. The qualitative approach does not quantify or assess exposure, vulnerability, and adaptive capacity of ‘objects of value’. This is seen as a limitation in this assessment.

However, qualitative approach used in this report provides the initial steps to conduct detail risk analysis and risk management on ‘elements of value’ within the Mataniko river catchment.

5. CONCLUSION

Potential hazard events and their distribution within the Mataniko watershed and catchment boundary have been identified in this study. Sixteen potential hazard events are identified and classified into four hazards types: geophysical, hydrological, meteorological, and anthropogenic hazards. Identification of potential hazard events and their distribution is an important step in risk assessment and analysis conducted in this study for the Mataniko water catchment boundary.

Qualitative risk assessment approach is conducted by assessing consequence and likelihood of potential hazard events within the catchment. The approach enables the analysis and ranking of risk associated with potential hazard events by multiplying consequence and likelihood values of hazards derived from situation reports and historical records of disaster events. The risk equation, *R = Consequence x Likelihood* is used to calculate risk values associated with potential hazard events. Categorizing and ranking risks values into five levels (from highest to lowest) enables risk prioritization, which is an important step in risk management for the Mataniko river catchment.

This study identifies Tropical Cyclones to be the potential hazard event of highest priority followed by hydrological short-circuiting and high rainfall events. This report also identifies riverine flash floods, landslide (wet ground movement), coastal inundation, earthquake, and fire as hazards with moderate level of risk and should be considered in risk management plan for the Mataniko river catchment.

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APPENDICES

A. Appendix 1:

Risk Assessment - Likelihood Assessment Table

Frequency	Category	Percent Chance	Description
1	Rare	Less than a 1% chance of occurrence in any year	Hazards with return period > 100
2	Very Unlikely	Between a 1 - 2% chance of occurrence in any year	Occurs every 50 - 100 years and includes hazards that have not occurred but may occur in the future
3	Unlikely	Between a 2 - 10% chance of occurrence in any year	Occurs every 20 - 50 years
4	Probable	Between a 10 - 50% chance of occurrence in any year	Occurs every 5 - 20 years
5	Likely	Between a 50 - 100% chance of occurrence in any year	Occurs above 5 Years
6	Almost certain	100% chance of occurrence in any year	The hazard occurs every year

B. Appendix 2:

Risk Assessment - Consequence Table - Social Variables

Consequence	Category	Description
0	none	Not likely to result in fatalities
1	Minor	Could result in fewer than 5 fatalities
2	Moderate	Could result in 5 - 10 fatalities
3	Severe	Could result in 10 - 50 fatalities
4	Catastrophic	Could result in above 50 fatalities

C. Appendix 3:

Risk Assessment - Consequence Table - Property Variables

Consequence	Category	Description
0	None	Not likely to result in property damage
1	Minor	Could cause minor damages to properties
2	Moderate	Localized severe damage to properties
3	Severe	Island-wide severe damages to properties
4	Catastrophic	Nation-wide sever damages to properties

D. Appendix 4:

Risk Assessment - Consequence Table - Critical Infrastructures

Consequence	Category	Description
0	None	Not likely to disrupt important services
1	Minor	Could disrupt 1 important service
2	Moderate	Could disrupt 2 important services
3	Severe	Could disrupt more than 3 important services
4	Catastrophic	Could disrupt more than 3 important services

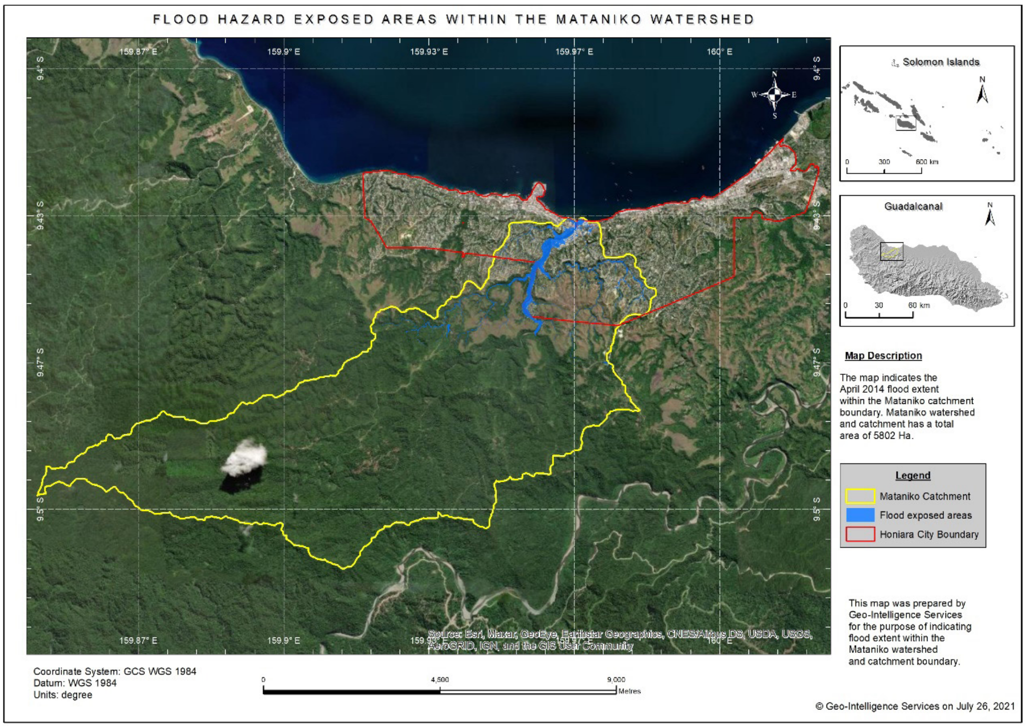
E. Appendix 5:

Risk Assessment - Consequence Table - Environmental damage

Consequence	Category	Description
0	None	No environmental damage
1	Minor	Localized and reversible damage. Clean up is possible
2	Moderate	Major but reversible damage. Clean up is difficult
3	Severe	Severe and irreversible environmental damage. Full clean up not possible
4	Catastrophic	Severe and Nation-wide irreversible environmental damage.

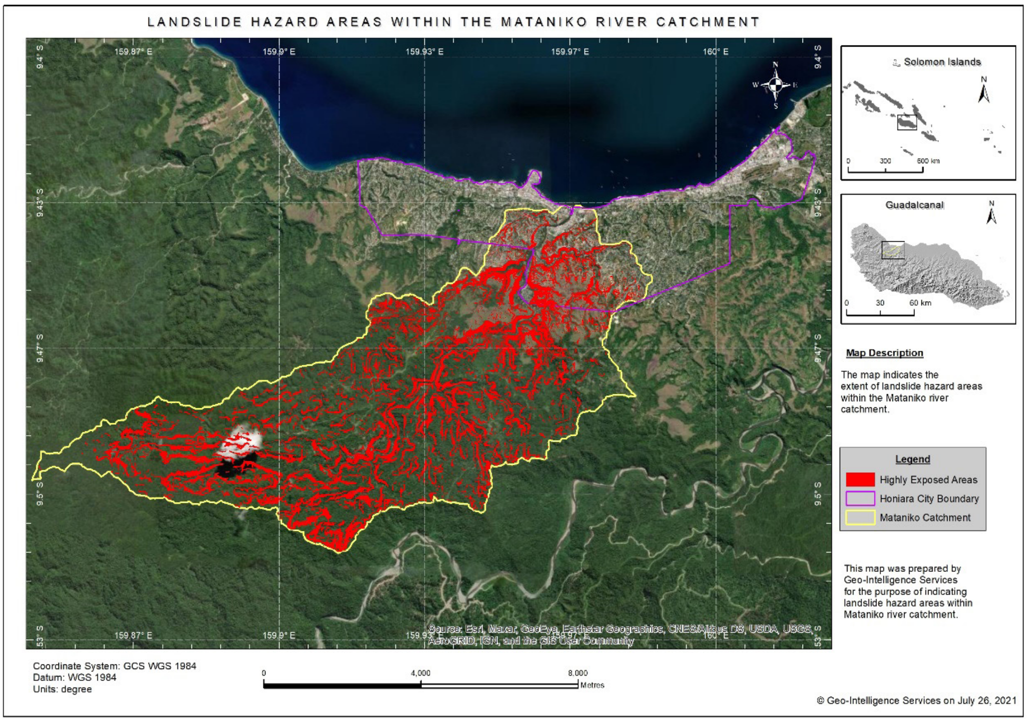
F. Appendix 6:

Spatial extent of flood hazard



G. Appendix 7:

Spatial extent of landslide prone areas



H. Appendix 8:

Spatial extent of coastal hazards