

Local Sediment Disaster Risk Reduction Plan



Morawakakanda

(Kotapola Pradeshiya Sabha , Matara District)

“Creating Disaster Resilient Neighbourhood in Morawakakanda”



Morawakakanda

Local Sediment Disaster Risk Reduction Plan

Towards the Disaster Resilient Neighborhood



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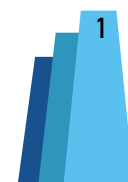


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Abbreviations and Acronyms

DS-Divisional Secretariat

DDMCU- District Disaster Management Coordinating Unit

DMC- Disaster Management Center

GN- Grama Niladhari

JICA-Japan International Cooperation Agency

LHM- Land Hazard Map

LSDRRP- Local Sediment Disaster Risk Reduction Plan

LUPPD- Land Use Policy Planning Department

LA- Local Authority

NBRO- National Building Research Organisation

NPPD- National Physical Planning Department

PS-Pradeshiya Saba

UDA-Urban Development Authorities

Executive Summary

The Technical Corporation for Landslide Mitigation Project (TCLMP) was initiated in 2014, and the second phase of the project (SABO) was started after completing phase one in 2016. Phase one, TCLMP, was focused on structural measurement, and SABO was focused on non-structural measurements. NBRO initiative to develop this plan as a part of the Project for Capacity Strengthen on Development of Non-structural Measures for Landslide Risk Reduction in Sri Lanka (SABO), a technical cooperation project between NBRO and Japan International Cooperation Agency (JICA).

The SABO project was implemented in three pilot sites in Sri Lanka, Morawakakanda in Matara, Weeriyapura in Badulla and Udapotha in Kegalle. The project has three main outputs: demarcation of the landslide flow-path boundaries using the Yellow-Zone-Red-Zone method, development of landslide early warning threshold levels, and development of land-use guidelines for the sediment disaster-prone areas.

The Sediment Disaster can be identified as one of the severe disasters in Sri Lanka because of intensive rainfall and human interventions. In this circumstance, there is a need for a proper landslide management plan to secure the community and human properties in sediment disaster areas. The Local Sediment Disaster Risk Reduction Plan (LSDRRP) is a comprehensive site-specific plan that focuses on the local level to minimize the impact of sediment disasters by using structural and non-structural mitigations.

This LSDRRP plan comprises the landslide hazard-prone areas, landslide flow based on the Yellow zone and Red zone concept, land use zoning in the area, and actions taken for the risk reduction. The report also included the current risk status of the community and the existing landslide early warning mechanism.

NBRO consulted Kotapola Pradeshiya Sabah, Divisional Secretariat, and residents in Morawakanda during the preparation of the zoning plan. The project report was shared with the relevant stakeholders to bring their feedback to the plan.

This LSDRRP for Morawakakanda is owned by Kotapola Pradeshiya Sabah (PS) will take action with the cooperation of relevant agencies such as Kotapola Divisional Secretariat, District Disaster Management Coordinating Unit (DDMCU), and National Building Research Organization (NBRO) in Matara District to mitigate sediment disaster risk according to the action plan written in Section 6.



Introduction



1. Introduction

1.1. Background

Sediment Disaster is one of the most severe natural disasters in Sri Lanka. In the central and southern mountainous areas, sediment disasters such as slope failures, landslides, and debris flow frequently occur in the monsoon period because of the fragile geology and steep topography. In recent years, sediment disasters caused by heavy rainfall in the spring monsoon season have become severer. In addition, increasing exposure to the hazards due to rapid reclamation and development has been raising sediment disaster risks in urban and rural areas. The establishment and improvement of the early warning system and legal arrangement for land use planning and development standards are urgent issues in Sri Lanka.

Morawakkanda is a major landslide (width of 198m and length of 2,085m) in Matara District on 25th May 2017, causing nine deaths and eleven people missing. It is essential to identify landslide susceptible locations and predict the probability of occurrence of each. (K.G. N Saroja, C. S Menikpura & J.Gunathilaka , 2019). Disaster risk assessments, early warning systems, and land use planning assessments are required to mitigate future landslide threats in the country. The Project of “Capacity Strengthening on Development of Non-structural Measures for Landslide Risk Reduction in Sri Lanka” was set up between National Building Research Organization (NBRO) and Japan International Cooperation Agency (JICA). The project aims at strengthening the capacity of NBRO on non-structural measures such as sediment disaster risk assessments, improving early warning systems using existing observation networks, and land use and development standards.

Local Sediment Disaster Risk Reduction Plan (LSDRRP) is a comprehensive plan to promote sediment disaster risk reduction measures at the local level, including non-structural measures developed based on site-specific sediment disaster risk assessment. The LSDRRP also clarifies the role and responsibility of the local organizations.

1.2. Objectives

The objectives of LSDRRP are as follows;

- Reduce landslide vulnerability by 50 % of old landslide valley of Morawakakanda
- Introduce non-structural landslide DRR measures
- Optimum utilization of lands prone to landslide hazard
- Zero the life damages and minimize the casualties due to landslides
- Minimize the economic damage

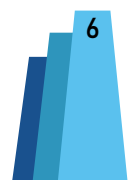
1.3. Vision

The vision of LSDRRP is;

“Creating A Disaster Resilient-Neighborhood in Morawakakanda”

1.4. Target Users for the LSDRRP

The primary target users of the guideline are the practitioners of land use planning and development control of both the national government and local government, including the officials of Local Authorities (LA), Urban Development Authority (UDA), National Physical Planning Department (NPPD), Land Use Policy Planning Department (LUPPD), and NBRO.



2

Current Setting



2. Current Setting of Morawakkanda

2.1. General Information of Kotapola PS

Morawakkanda is a part of Morawaka Grama Niladari (GN), located southwestern boundary of the Kotapola Pradeshiya Sabaha (PS). Kotapola PS is located in the northern part of Matara District, neighbouring Ratnapura District at north and Galle District at west. The administrative territory of Kotapola PS is about 175.5 km², which overlaps with Kotapola DS Division. The population of Kotapola PS is 63,255 (2012 Census). The average monthly income is about 20,000 LKR.

National highway AA017 goes through the centre of the Morawaka GN from SW to NE. Deniyaya town, another populated area, is along the highway.

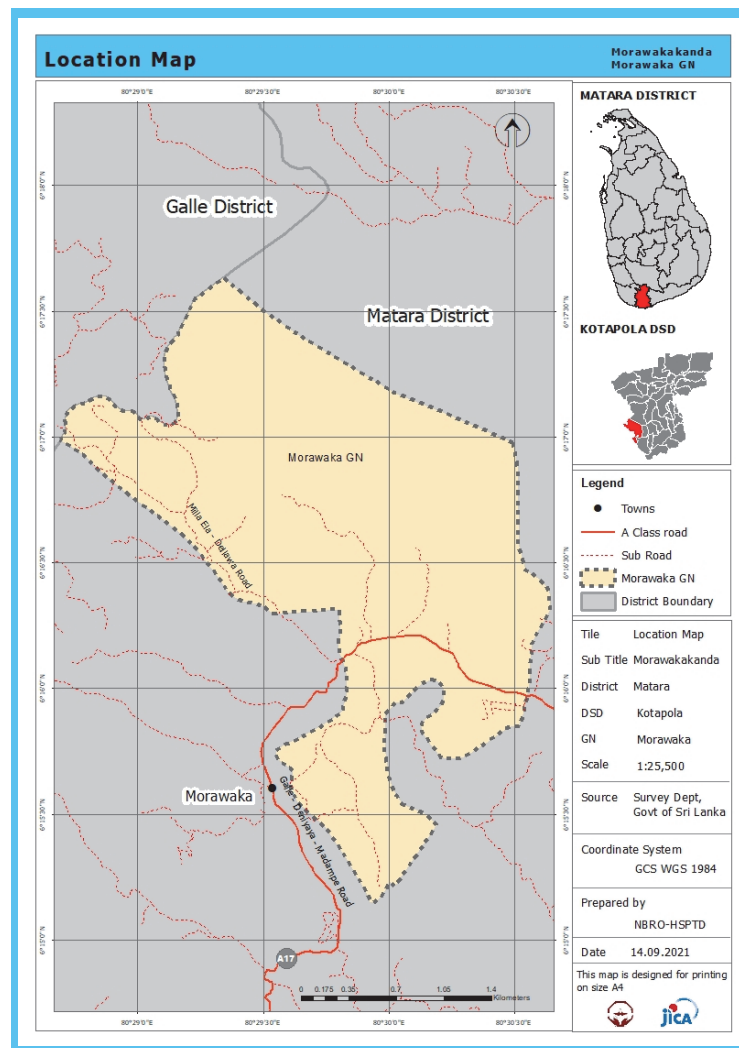


Figure 1: Location Map of Morawaka GN

2.2. General Information of Morawaka GN and Morawakkanda

2.2.1. Geographic information

Morawakkanda is located in the hill area of Morawaka GN. The main town of Morawaka is located along with the National Highway A17.

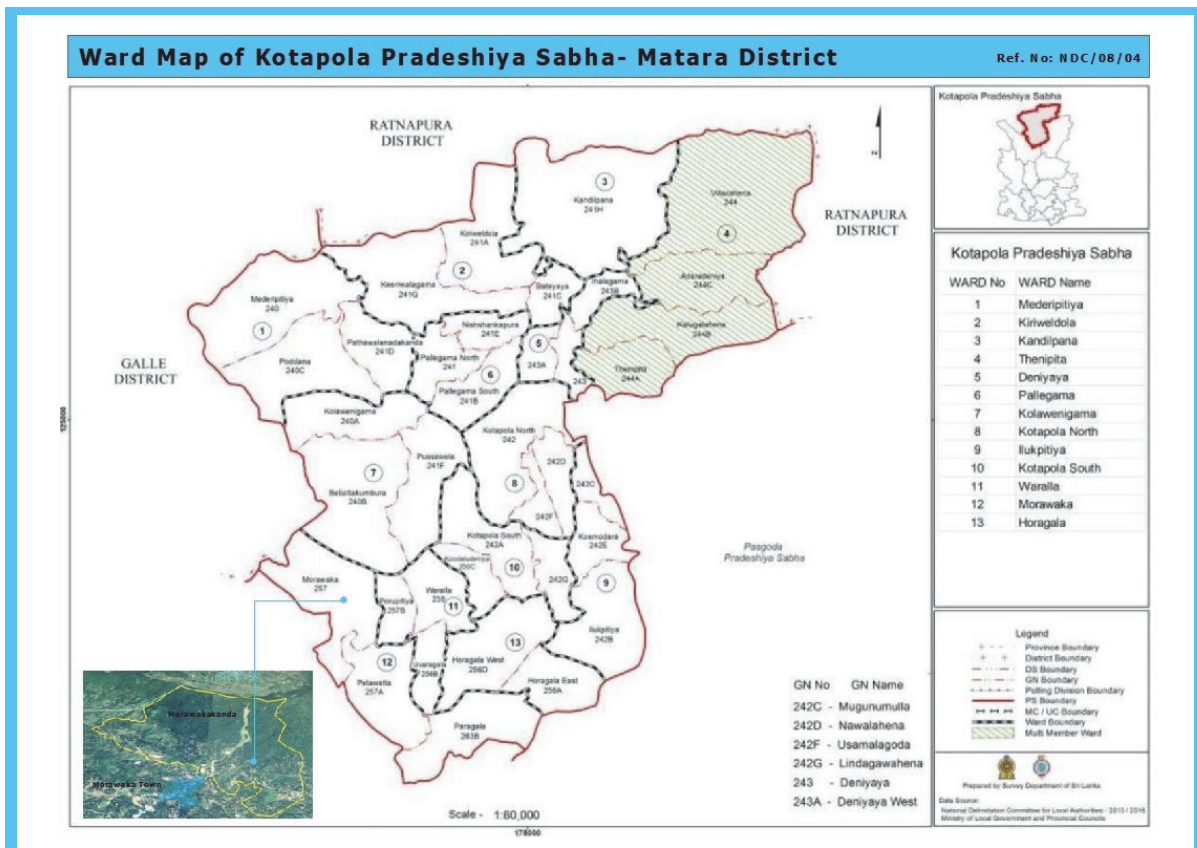


Figure 2: Ward map of Kotapola PS

2.2.2. Demographic Background

The population of Morawaka GN was 2,851 in 2012. The Male population and female population are 1,366, 1,485 respectively. Population Density is sixteen persons per square Kilometer, and building density is sixteen per square Kilometer.

There are 148 population living in the project area. Among them, 67 are Male, and 81 are Female.

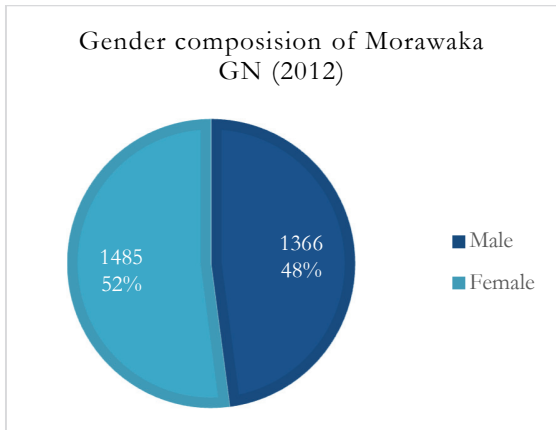


Figure 3: Gender composition in Morawaka GN

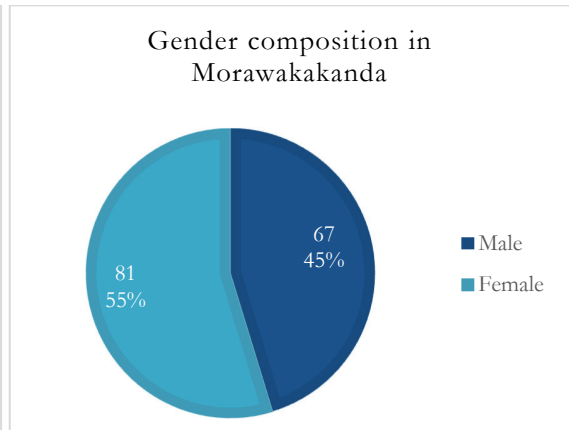


Figure 4: Gender composition in Morawakanda target area

The age category of the Morawakakanda area is distributed as figure 4: 84 (57%) people are fallen under the labour force age (15-64) group, and the dependency (<15 and >64) population are 64 (43%). The working people need to tolerate the damage cost along with the cost of dependent people.

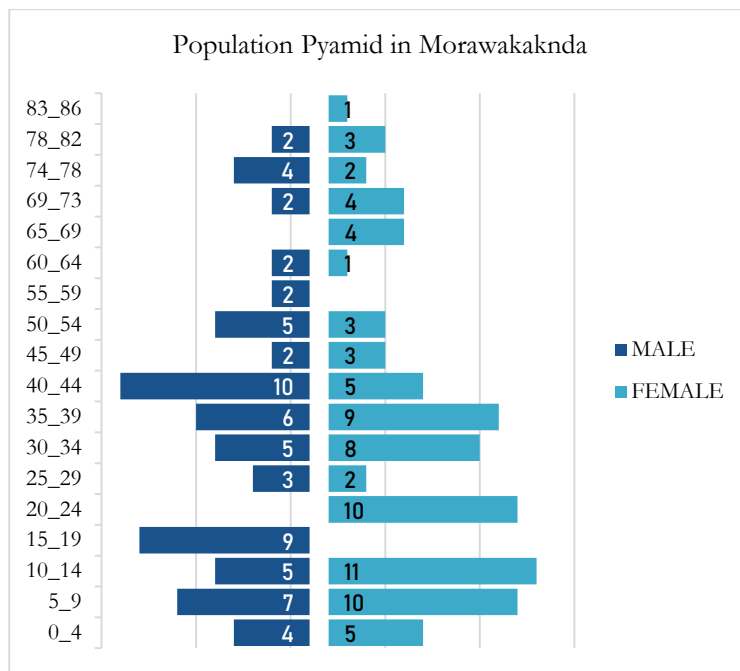


Figure 5: Population pyramid in Morawakakanda hazard zone

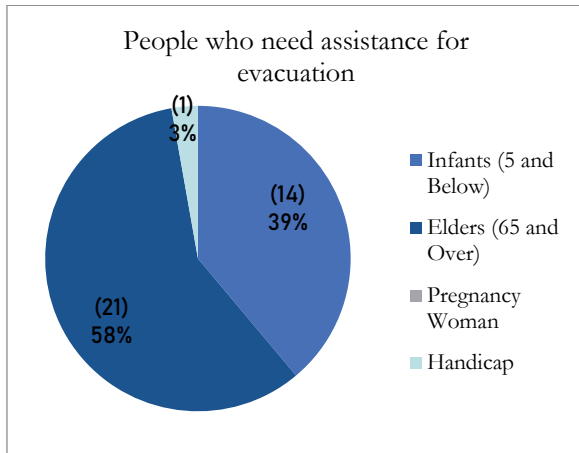


Figure 6: People who need assistance for evacuation

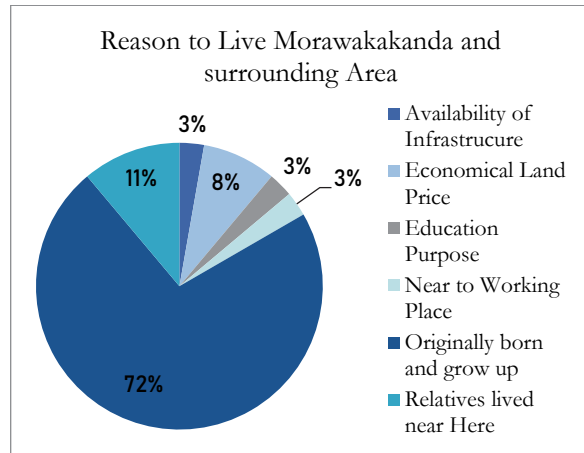


Figure 7: Reasons to live Morawakakanda and surrounding

The majority of the people, 106 (72%), were born and grown up in the project area. The reason behind remaining the communities in the landslide high-risk area may be the adjoining town centres providing adequate services and facilities to the community. Specifically the people, who needs assistance to the evacuate, can be categorized, 58% are elders (The persons who are age 65 and above), 39% are infants (The person who are age 5 and under), and 3% are Handicap.

2.2.3. Housing Conditions

The Morawakakanda GN consisted of 753 housing units (2012 Census & Statistic Survey), and out of these, 643 are permanent dwellings, 103 are semi-permanents and 7 housing units are improvised. There are thirty-eight housing units in the yellow zone and two houses are in red zone area. All these housing units are constructed by using permanent materials.

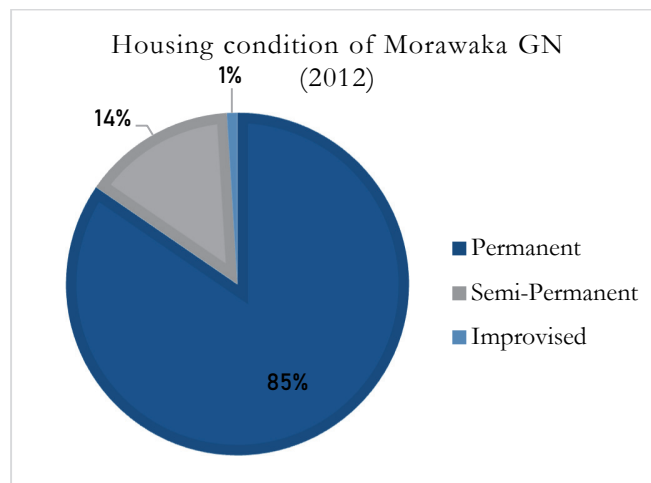


Figure 8: Housing Condition of Morawakakanda GN

2.2.4. Essential Public Facilities

Majority of important public facilities are located along the national highway A17:(Galle, Imaduwa, Akuressa, Deniyaya to Madampe). The following table shows the public facilities exist in Morawaka DS area. Location of those facilities are shown in Figure 9.

School	Morawaka Kanishta Vidyalaya (Primary School) Morawaka Primary School (Primary School) Morawaka Keerthi Abeywickrama National School (High School)
Institutions	Zonal Education Office Vocational Training Center
Health center	District Hospital Morawaka Nuruwa Rural Hospital
Police Station	Police Station Morawaka
Public Market	Public Market Morawaka
National Highway	A17

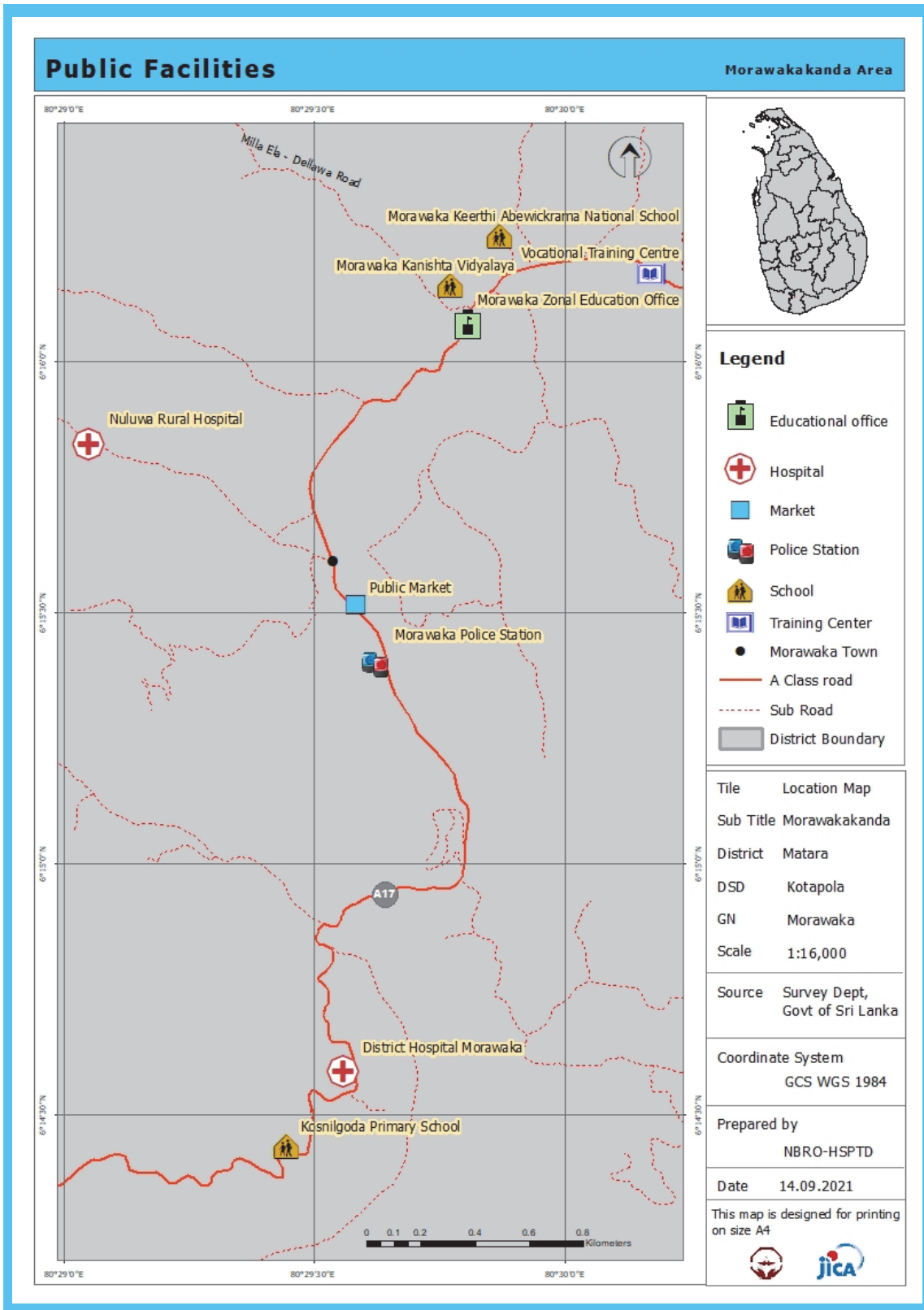


Figure 9: Public facilities

2.2.5. Climate Condition

Rainfall pattern

Morawakkanda is located at an intermediate climate zone of the country, and annual rainfall is between 1750-2500 mm. The area gets frequent rain from South West Monsoon. The below table shows the monthly rainfall variation for 2013-2016 in the Morawakkanda surrounding area.

Table 1: Monthly rainfall distribution

Month	Rainfall (mm)			
	2013	2014	2015	2016
January	410.2	2.28	8.39	1.27
February	158.7	0	37.34	37.85
March	98.7	104.9	54.11	43.69
April	243.2	13.46	140.46	39.88
May	100.4	80.01	52.58	173.72
June	42.2	20.06	22.86	11.17
July	59.9	6.6	32	34.53
August	70.1	46.74	160.51	7.11
September	77.2	35.54	292.1	8.15
October	171.1	257.54	151.88	29.21
November	201.1	196.34	194.81	167.12
December	232.3	323.83	137.42	104.64

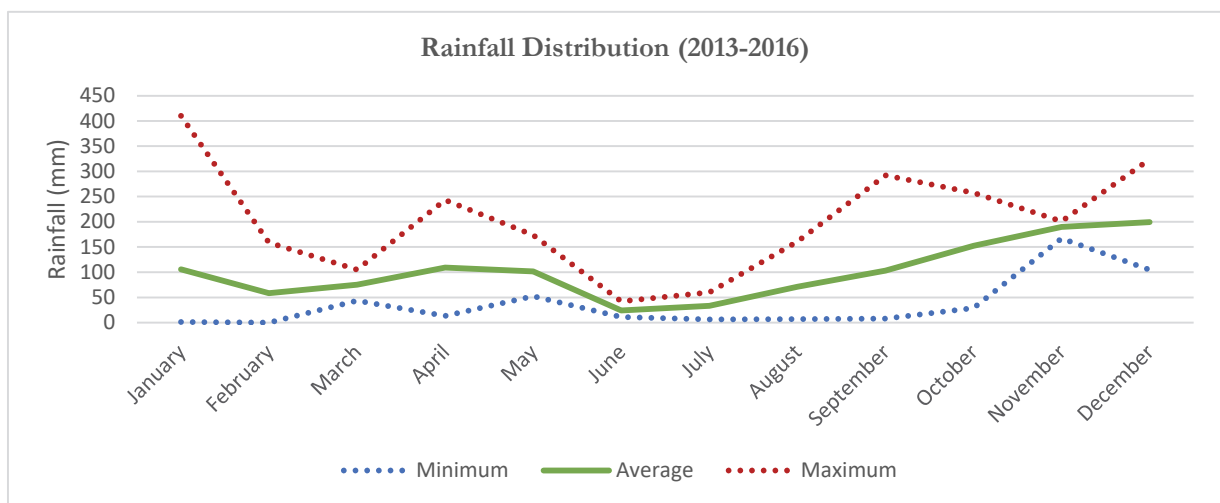


Figure 10: Rainfall Distribution

The above figure shows the rainfall distribution in the Morawakakanda, and it was categorized into minimum, maximum and average rainfall levels. The results show the highest average rainfall received to the area is in November, during the southwest monsoon period, and the lowest rainfall received in June. The higher-level rainfall fluxuation could be identified in different months: January, April and September. The inter monsoon rains occurs in April and October. The deviation in April and September could be resulted due to intermonsoon period. North-East monsoon activates in October to December. The monsoon effects vary El-Nino and La-Nino. The High variation could be resulted due to strength of monsoon event.

Temperature

The average annual temperature of the area is 27°C. The highest average monthly temperature is usually recorded during June, which is around 29°C. The lowest average monthly temperature of the year is encountered during December, which is around 26.7°C. Below table 04 shows the average monthly temperatures for each month 2014-2016 in Southern Province.

Table 2: Annual temperature

Month	Temperature (Celsius)		
	2014	2015	2016
January	26.5	26.7	27.1
February	26.9	26.7	27.6
March	28.1	27.4	28.6
April	28.2	27.6	30.1
May	28.4	28	28.5
June	29.3	28.8	29.3
July	29.4	25.5	29.7
August	28	27.9	29.7
September	27.9	27.1	29.1
October	27.2	27	29
November	26.5	26.7	27.3
December	26	26.6	27.5

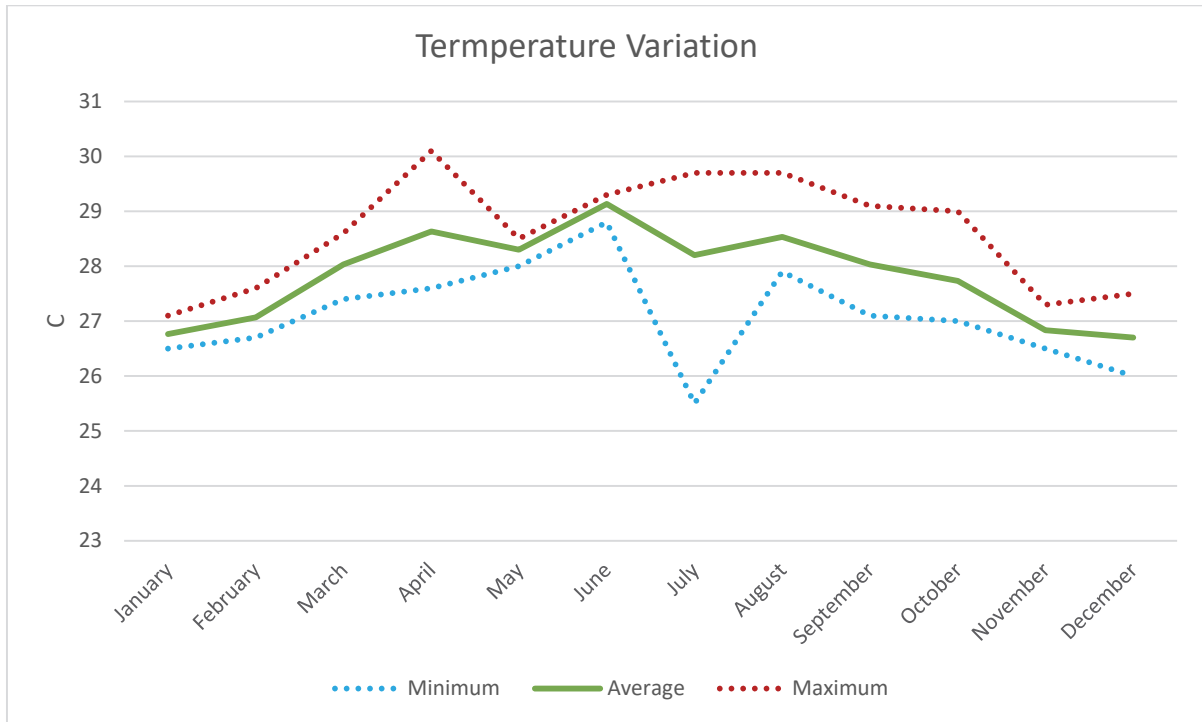


Figure 11: Temperature variation of the area

The temperature variation observes that only 2.5°C changes over the year and highest peak in June and lowest in December/January period.

2.2.6. Disaster Record

In May 2017, there were few landslides occurred in the area, and Morawakakanda was the debris flow in the area. This debris flow transported debris to more than three kilometers with average width of fifty meters. The debris flow travels through a dry or wet valley. There is a stream flows in the valley, and according to residents, the stream flow was temporary stopped for few hours before the incident. The experts justified that, a small landslide was occurred and disrupted the dream water flow and it was created a temporary dam. This small dam breach created a debris flow. Intense rainfall triggers this landslide event in the area.

The highest ever rainfall for the month was record, which cumulative total was 530mm and within 24-hrs rainfall was 440mm. Twenty-three deaths, fourteen houses were destroyed during the incident. Twenty-one families were relocated, and another sixty families are to be relocated. The unstable debris mass remains in the upper slope area.

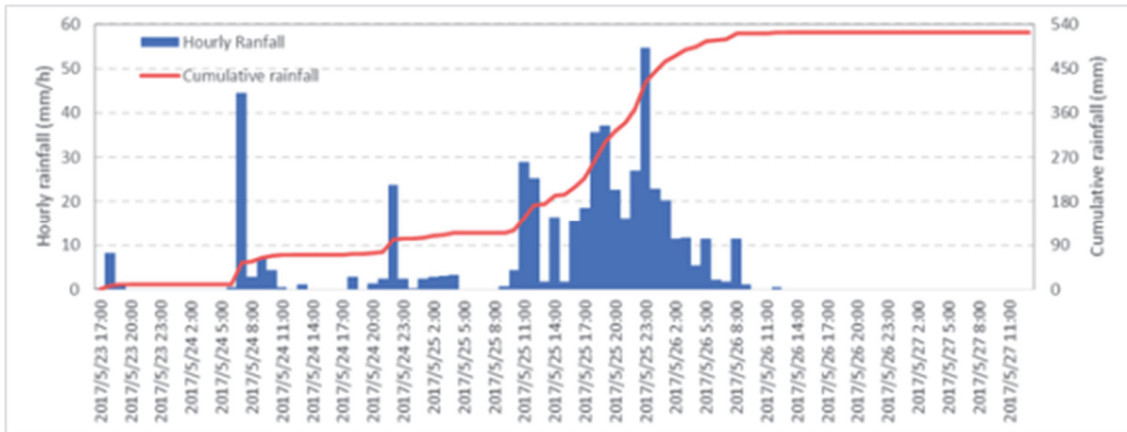


Table 3: Basic information of landslide

Basic information of landslide	
Landslide type	Landslide
Date of occurrence	May 26,2017 23:30
Date of inspection	May 31,2017
Crown width	48 m
Crown height	114 m
Initiation area length	221 m
Maximum width	198 m
Length of landslide	2085 m
Width at middle	164 m
Slope type	Concave
Initiation area slope angle	17-18 deg
Deposited area slope angle	1.7 deg
Erosion type	Straight
Hydrology pattern	Stream

2.2.7. Current Land Use

Kotapola DS Division prepared a Land use map of Morawaka GN in 2010 (Figure 8), and the area statistics are shown in Table 4. The major Land use types in Morawaka GN are Forest, Tea, and Scrub.

Table 4: Land use types

Land use Type	Area(ha)
Chena	1,931
Coconut	201
Ela	19
Forest	8,676
Grassland	23
Home Garden	3,378
Jeep or Cart Track	430
Main Road (B)	1,458
Minor Road	86
Other Plantation	82
Paddy	1,152
River	347
Rock	46
Rubber	74
Scrub	2,652
Tea	5,047
Total	25601

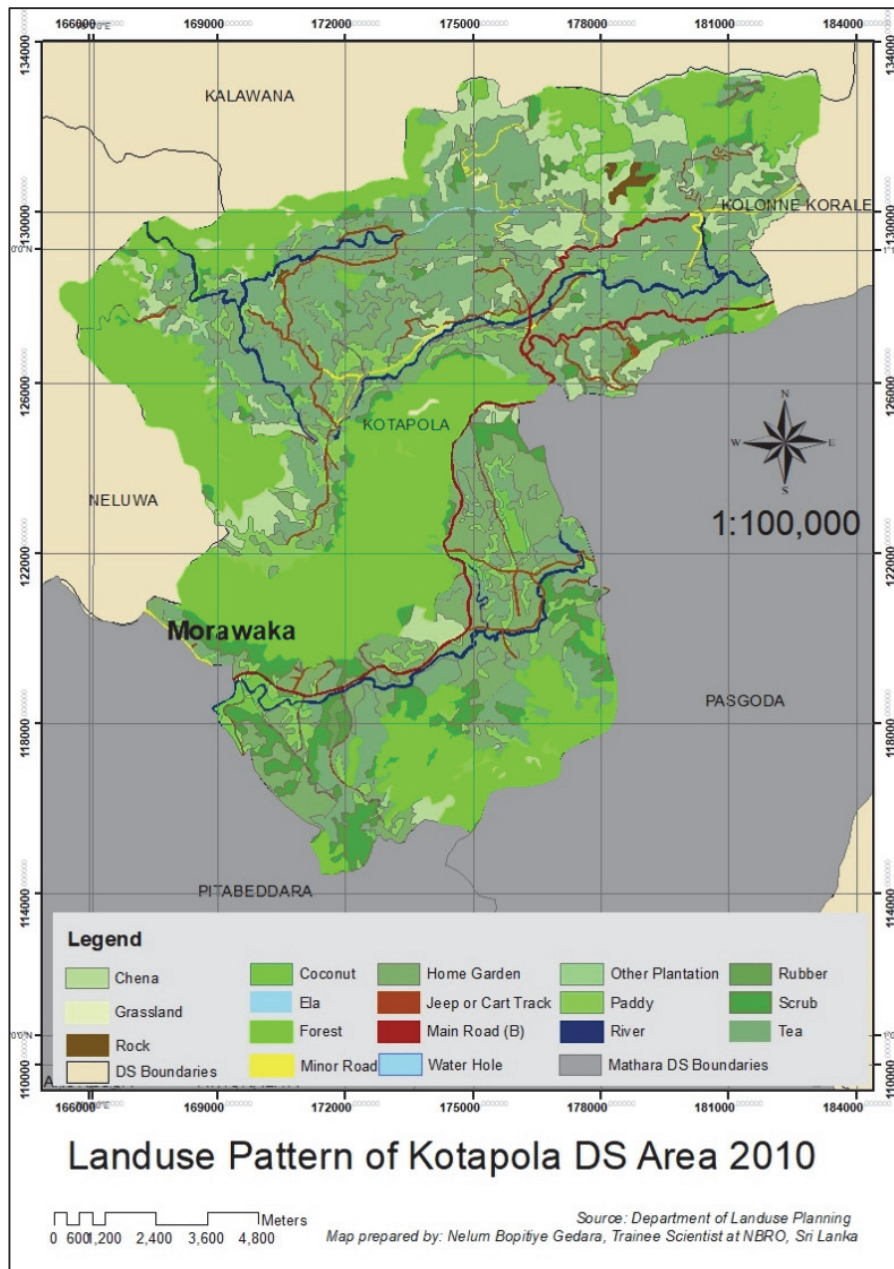


Figure 12: Land use pattern

The above map shows the spatial distribution of land uses in the Morawaka GN division. The mountain area is covered with forest lands, and downstream areas are covered with paddy. 33.9% of total GN land is covered with natural forest, and home gardens coverage is 13.2%. Major agriculture types are tea (19.7%), paddy (4.5%), and chena (7.5%).

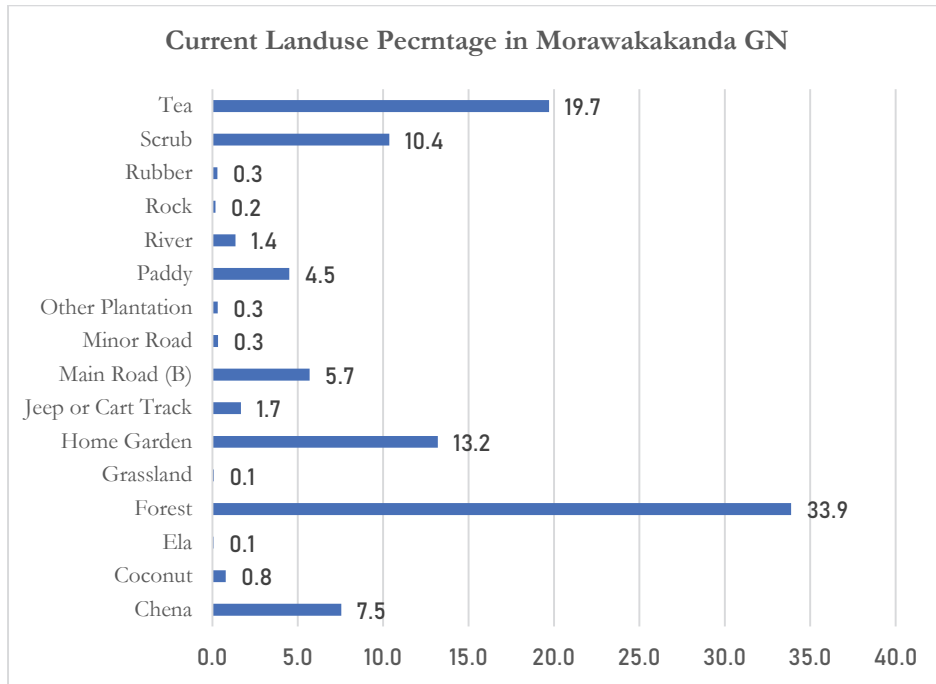


Figure 13: Current land use percentage in Morawakakanda area

2.2.8. Current Land Use with Yellow and Red Zone in the target area

An updated land-use map was prepared using aerial image interpretation captured through drone technology in 2020 by NBRO. The aerial image was classified according to the existing land use classification system used for landslide risk mapping and generated a 1:1000 land use map for the project area. These high-resolution images help to identify the detail various of the ground, and it helps identify the exact building shapes and sizes. The black squares represent the existing building layer, and small buildings were located adjoining to the forest area. Larger-size buildings are located near the main roads, and building density is also higher near the road. The map highlighted the existing landslide flow path and marked the possible landslide debris flow paths generated through the yellow-red zone method described in the next section.

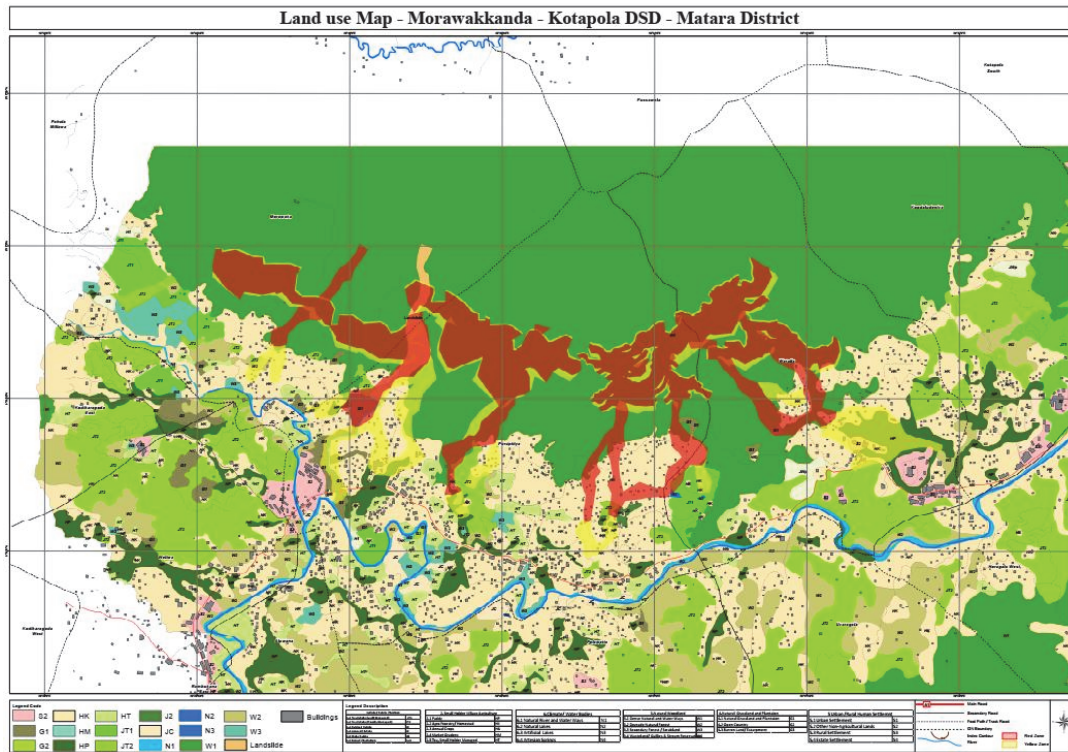


Figure 14: Current land use plan

2.3. Concept of Yellow/Red Zone

Sediment Disaster Hazard Area (Yellow Zone) is defined as an area prone to sediment disaster. If an area is designated as a Yellow Zone: 1) early warning systems should be established, and 2) steps to raise the awareness of local people about sediment disasters should be taken. Special Sediment Disaster Hazard Area (Red Zone) is designated where there is a severe risk of damage to buildings and threat to residents; thus, structural and non-structural measures, including development regulation, should be applied based on the appropriate land use planning.

1. Yellow/Red Zone for Slide

Slide blocks are classified into three ranks, A, B and C, in terms of the clarity of slide topography and its activity based on the topographical interpretation. These ranks are defined and shown in the following table.

Table 5: Classification of ranks

Classification of Ranks	Definition
Rank A	The slide is confirmed to be completely active at the field survey; and Its shape, including its foot, is identifiable.
Rank B	The shape of the slide, including its foot, is identifiable, but the slide is not confirmed to be active at the field survey; or The slide is confirmed to be locally active, and its shape is not identifiable.
Rank C	The slide is not confirmed to be active at the field survey, and also its shape, including its foot, is not identifiable.

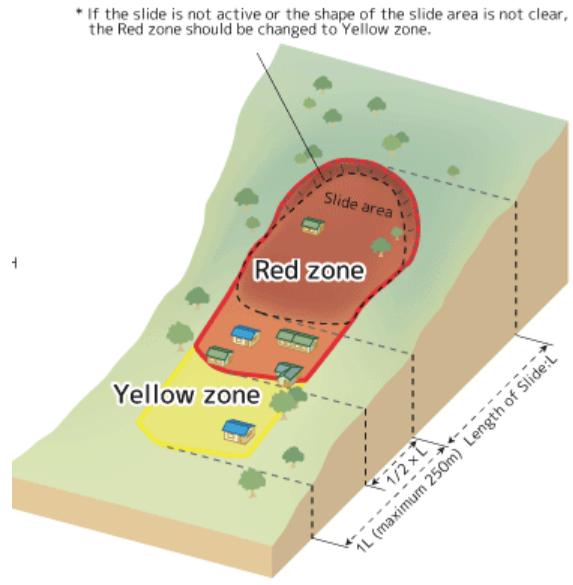


Figure 15: Yellow/red zone for slide

2. Yellow Zone and Red Zone for Slope Failure

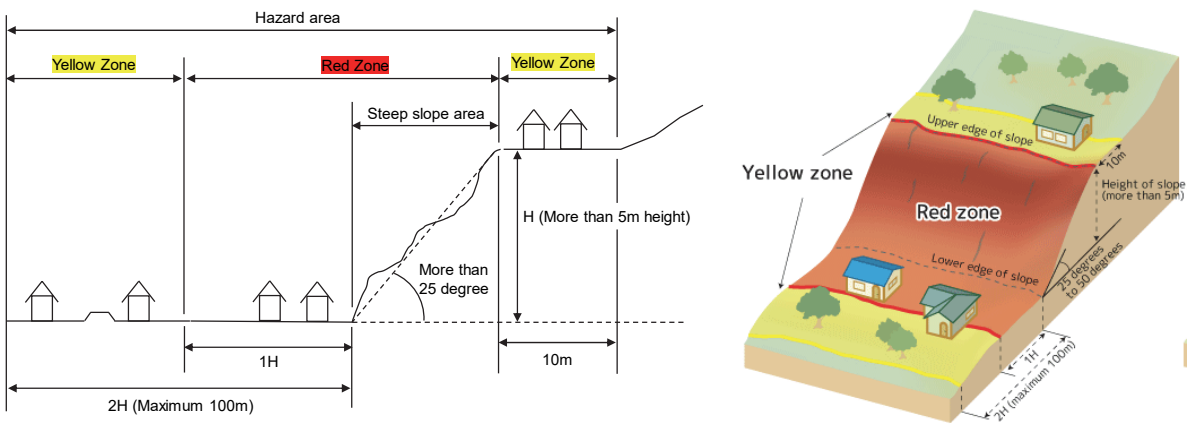


Figure 16: Yellow/red zone for slope failure

3. Yellow Zone and Red Zone for Debris Flow

The lower ends of the Yellow Zone and Red Zone for debris flow shall be determined based on the ground gradient or inclination from the profile of the target area. In addition, the width of the zone shall be determined based on spreading angles such as 30 degrees for Yellow Zone or 15 degrees for Red Zone. The concept of setting the Yellow Zone or Red Zone for debris flow is shown in the following figure.

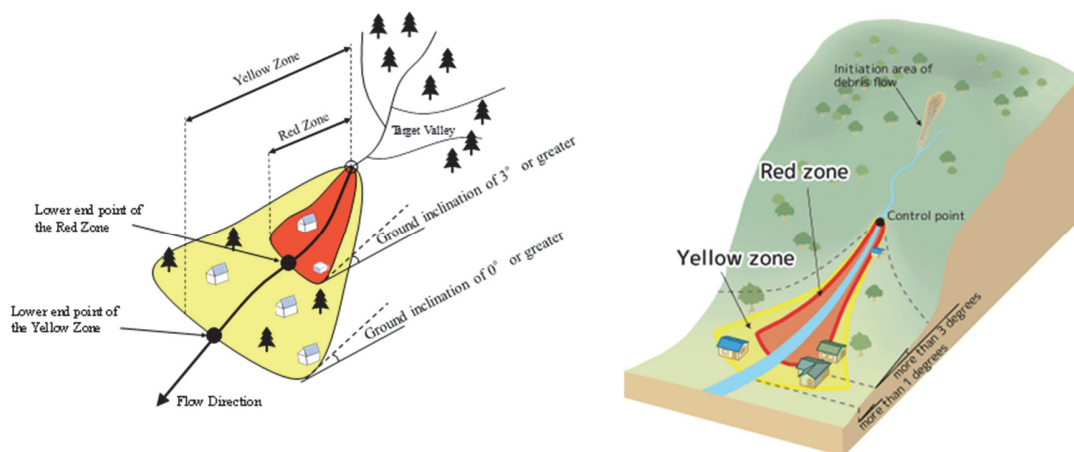


Figure 17: Yellow/red zone for debris flow

2.4. Categorized Zone based on Yellow/Red zoning and LHM

NBRO has developed and distributed Landslide Hazard Map (LHM), in which the area is divided into main four categories; “Landslide not likely to be occurred”, “Modest level landslide risk exists”, “Landslide risk might be existing” and “Landslide can be occurred”. There are fewer restrictions on “Landslide not likely to be occurred” areas, but in other zones, specific construction and structural guidelines need to be followed. However, due to the haphazard planning activities of the country, most of the landslide-prone categories consists of settlements.

The current hazard mapping activities do not consider the debris flow simulations. Therefore, possible debris flow areas are required to identify to incorporate the existing development guidelines. Accordingly, NBRO introduced a new Yellow/Red zone mapping concept for the area to simulate the landslide flow paths. In the concept, more detailed and site-specific hazard risk levels can be indicated to promote appropriate land use.

The Yellow/Red zone concept has four zones, “Restricted Zone”, “Prohibited Zone”, “Warning Zone” and “Development Zone”, which is similar classification with the flood-resilient guideline published by NBRO in 2003. The concept is only applied for the debris flow area, and the rest of the area is followed by the Landslide Hazard Map-based land-use guidelines. The following table shows the yellow/red zone and present LHM categories correlated with development zone categories.

Table 6: Categorized zones based on yellow/red and LHM

Development Zone Category	Yellow/Red Zoning (Applied for the Y/R zoning prepared area)	Landslide Hazard Map (Applied for the remaining area)
Restricted Zone	Red Zone (Sediment Disaster Hazard Area)	Landslides most likely to occur
Controlled Zone		Landslides are to be expected
Warning Zone	Yellow Zone (Special Sediment Disaster Hazard Area)	Modest level of landslide hazard exists
Development Zone	Else	Landslide not likely occur

i. Restricted Zone

The “Restricted Zone” is assigned for the lands identified as “Red Zone” and ranked in “Landslides most likely to occur (HR)” in LHM. Any construction or any development shall be prohibited in the zone and the zone is high probability for future landslide events. If any constructions are available in this zone should be relocated, with proper investigations. This land area should be kept as natural areas and required to monitor the environmental condition, water flow and hazard situation in detail manner. In future, this area shall be demarcated as sensitive area and control all kind of human impacts for the area. Landslide flow path area also considered into this zone and considering the feasibility studies, the land should be converted as green area for the settlement. It is required to have detail investigations and proper early warning systems for upper catchments before converting the area as green area.

ii. Controlled Zone

The “Controlled Zone” is assigned for the lands identified as “Red Zone” and ranked in “Landslides are to be expected (HR)” in LHM. This zone is considered as high-risk zone due to landslide events. Therefore, landslide risk should be mitigated through structural mitigation measures when people develop the land and/or construct new building in this zone. Aftermath, the area could be used for the low dense controlled development activities. In addition, this area should have proper early warning system. Detail building codes and designed should be followed by the developers in the area and if any construction didn’t follow the proper guideline, the authority shall be reported to the proper planning agencies to remove such construction by considering its’ impact to the area.

iii. Warning Zone

The “Warning Zone” is assigned for the lands identified as “Yellow Zone”. Development activities are allowed in this zone, but need to follow the resilient construction guideline which was published by the NBRO. This zone can have different building densities depending on the risk levels. However, entire zone should have proper early warning system and continuous awareness programs for the commuters and residents. Controlled land uses are allowed in the zone and management plan of each land uses should be monitored by the respective institutes.

iv. Development Zone

The “Development Zone” is assigned for the lands which are not identified as either Yellow zone or Red zone. This zone is demarcated by considering the importance of development and hazard levels. This zone can be used to develop any kind of constructions, but it should be adhered to the guidelines which are provided by the planning agencies like UDA, NPPD, etc. No resilient construction techniques are mandated for the zone, unless, if disaster management professionals were identified as disaster impacted area. If so, the retrofitting guidelines should be adhered for the constructions.

Based on this, the land area could be divided into main four sections and each section should be clearly monitored by the institute. Furthermore, these main zones could be divided into sub categories by considering the hazard zones and development zone.

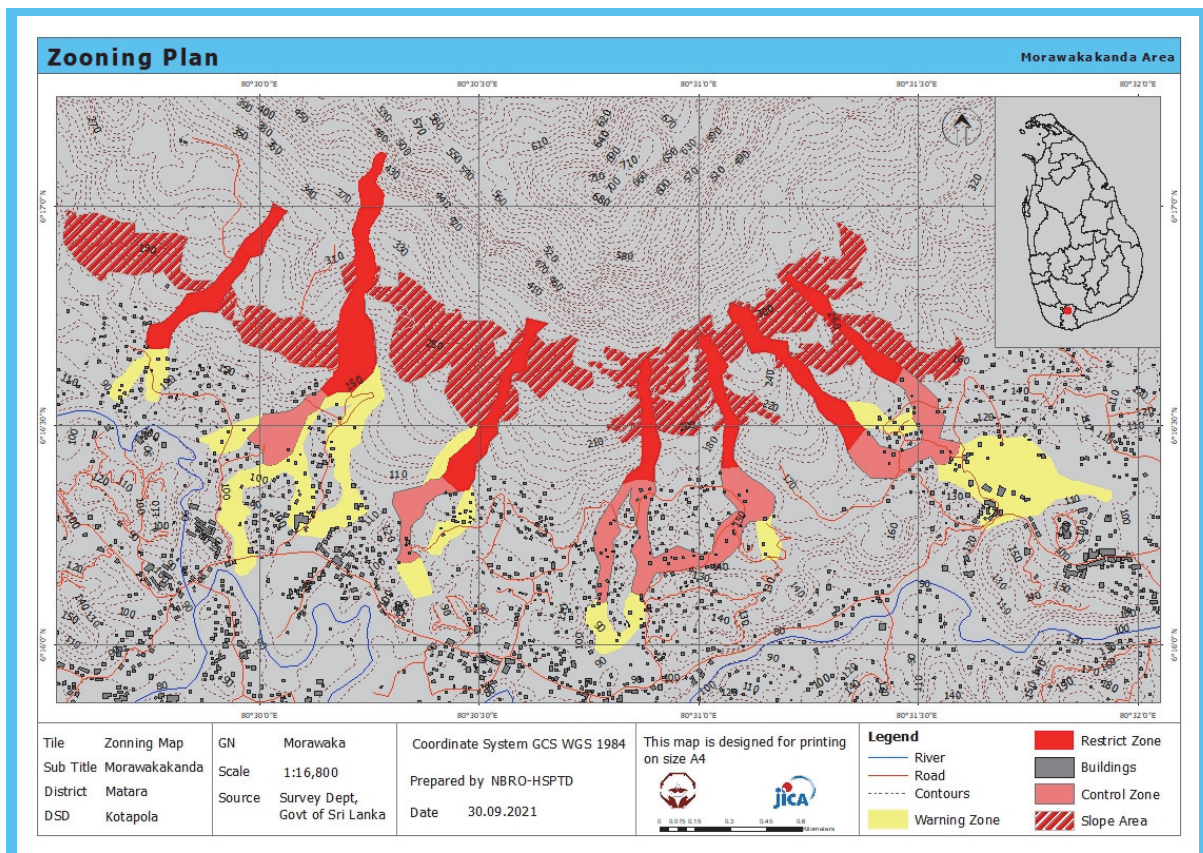


Figure 18: Zoning plan

2.5. Possible Land Uses for the Zones

The following table indicated the allowed and not-allowed land use activities in each zone.

Table 7: Allowed and not allowed land uses to the area

	Proposed Land use category			
	Development Zone	Warning Zone	Controlled Zone	Restricted Zone
Residential	Suitable for Use	Detailed Investigation	Not Suitable	Not Suitable
Retail & Commercial	Suitable for Use	Detailed Investigation	Not Suitable	Not Suitable
Office	Suitable for Use	Detailed Investigation	Not Suitable	Not Suitable
Industrial	Suitable for Use	Detailed Investigation	Not Suitable	Not Suitable
Parks/ Playgrounds	Suitable for Use	Suitable for Use	Detailed Investigation	Not Suitable
Agricultural	Suitable for Use	Suitable for Use	Suitable for Use	Detailed Investigation

2.6. Approval and Enforcement of the Land Use Plan

2.6.1. General conditions

Before doing any development activity need to get the approval from the local authority: Construction activities, Land use changes (Change of use), Land subdivision and amalgamation, and Infrastructure development.

- 1) Local authority should demarcate the boundaries of yellow zone and red zone physically
- 2) An emergency response plan should be in place for every community in yellow zone
- 3) NBRO and DMC should establish early detection instruments within the RedZone



Risk Assessment

3. Risk Assessment for Morawakakanda

The general concept of risk assessment for a landslide is to examine both the likelihood and adverse consequence of a landslide hazard, then thereby address risk in totality and finally compares the level of the resulting risk against predetermined standards, or other criteria to determine risk treatment and management prioritization. To simplify matters, this manual is not intended to cover the overall processes of hazard analysis (frequency and magnitude) to risk evaluation.

3.1. Database for Designated Yellow/Red Zones

The following table shows the criteria that used to assess the existing risk situation within red and yellow zone areas of Morawakakanda.

Table 8: Items for Database for Designated Yellow/Red Zone

Category	Item	
Basic information	District	
	DS Division	
	GN Division	
	ID No. (District code - GN P code- Landslide type - serial No.)	
	Name of PS	
	Landslide Type (Slope failure/Slide/Debris flow)	
	Area of Yellow/Red Zone (m2)	
Elements at risk	Number of facilities for vulnerable people	Facilities for the aged
		Facilities for physically handicapped persons
		Facilities for mentally retarded and disordered persons
		Kindergartens
		Maternity facilities
		Other similar facilities
	Number of evacuation places	
	Number of hospitals	
	Number of schools	
	Number of other important facilities	
	Traffic network	
Number of residential houses		
Impact of past sediment disaster	Land devastation situation (nothing/slight/significant)	
	Impacts of past sediment discharge on nearby facilities	
Local request	Request from residents and/or local authorities for risk reduction measures	
Countermeasures	Existing structural countermeasures	
	Existing non-structural countermeasures	
Land development plan	Presence of land development plan / land use plan	

3.2. Preparation of Data for Risk Evaluation

The relevant data for further risk evaluation is collected and assessed for each of the designated Yellow/Red Zones in accordance with the actual site-specific and local conditions, as sorted and listed below:

- a) Basic information
 - Yellow/Red Zone hazard maps (1:2,500 or 1:5,000 scale)
 - Location information (ID No., District, GN division, Landslide type)
- b) Information on important and vulnerable elements at risk
 - Number of facilities for vulnerable people
 - Number of evacuation places for a disaster
 - Number of public facilities except for road networks
 - Class of road networks
 - Number of residential houses, within red and yellow zones, respectively
- c) Information on impact of past landslide disasters
 - Land devastation situation
 - Impact of past landslide disasters on nearby facilities
- d) other information
 - Request of implementation of measures from residents and/or local authorities

3.3. Items for Risk Evaluation

The risk evaluation for each of the designated Yellow/Red Zones will be conducted in accordance with such items as given in Table 8, and then the level of risk for each of the designated Yellow/Red Zone will be evaluated as very high, high, moderate or low according to the total scores using the risk evaluation sheet shown in Table 9 below. Figure 18 shows a concept of risk evaluation for the target zone

Table 9: Items and Scores for Risk Evaluation for Yellow/Red Zone

Item	Maximum Score (Total: 100)
1) Number of facilities for vulnerable people	10
2) Evacuation places	10
3) Public facilities	10
4) Number of facilities of the above items 1) to 3) within the Red Zone	10
5) Traffic network	10
6) Number of residential houses within the Yellow/Red Zone	10
7) Number of residential houses within the Red Zones	10
8) Land devastation situation	10
9) Impacts of past sediment discharge on nearby facilities	10
10) Request from residents	10

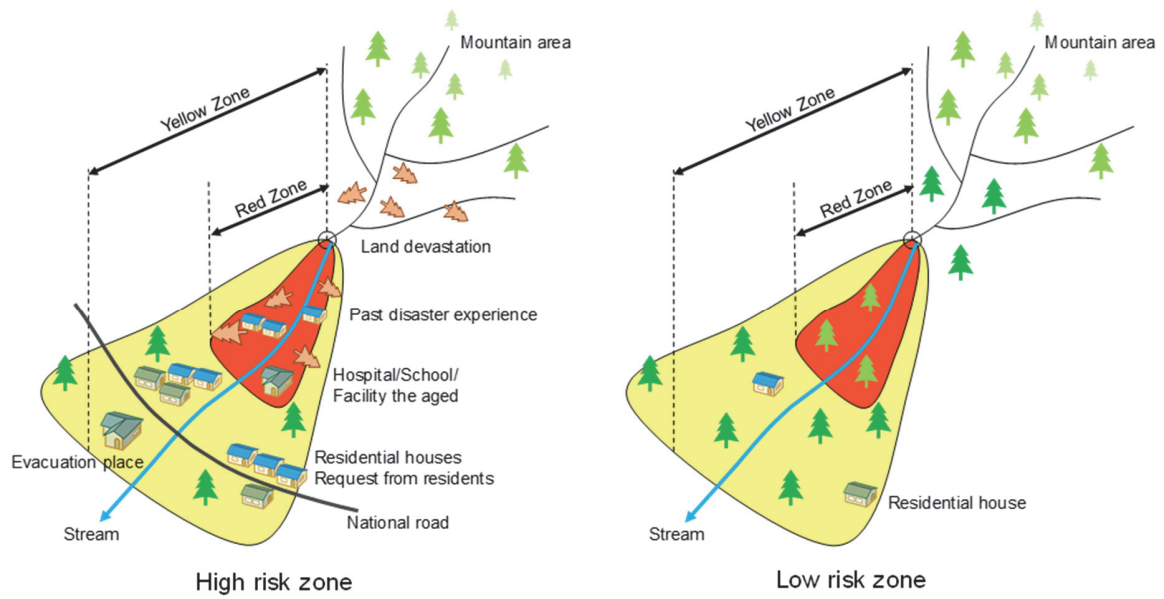


Figure 19: Concept of Risk Evaluation for the Target Yellow/Red Zone (for Debris Flow)

3.4. Risk Evaluation Sheet for Yellow/Red Zone

District	Matara			Prepared by			
GN Division	Morawaka			Organization	NBRO		
Landslide Type	<input type="checkbox"/> Slope failure	<input type="checkbox"/> Slide	<input checked="" type="checkbox"/> Debris flow	Date	10.08.2020		
Designation No.	Yellow Zone Debris Flow Zone 77						
Result of Risk Evaluation							
No.	Item	Max Score	Allotment Score			Evaluation Score	Remarks
			0	5	10		
1)	Number of facilities for vulnerable people	10	0			0	
2)	Evacuation places	10			10	10	School
3)	Public facilities	10			10	10	01 School
4)	Number of facilities of the above items (1to 3) within the Red Zone	10	0			0	
5)	Traffic network	10		5		5	Madampe-Deniyaya Road
6)	Number of residential houses within the Yellow and Red Zone	10			10	10	47 Residential Houses
7)	Number of residential houses within the Red Zones	10			10	10	20 Residential Houses
8)	Land devastation situation	10				0	
9)	Impacts of past sediment discharge on nearby facilities	10				0	
10)	Request from residents	10					
Total:		100				45	

Figure 20 Filled Risk assessment sheet for debris flow path in Morawakakanda

Explanation and Description:

- 1) Facilities for vulnerable people mean facilities for people who require assistance during a disaster, mainly including a) facilities for the aged, b) facilities for physically handicapped persons, c) facilities for mentally retarded and disordered persons, d) kindergartens, f) maternity facilities, and g) Other similar facilities.
- 2) Evacuation places mean whether evacuation shelters are present or not around or within the Yellow/Red Zone.
- 3) Public facilities include a) Important facilities such as hospitals and schools, and b) others rather than important facilities.
- 8) Land devastation situation means the relevant lands are significantly devastated due to sediment disasters and almost cannot be used, or are slightly devastated and can be used as farm lands or forest land.
- 9) Impacts of past sediment discharge on nearby facilities mean a) presence or absence of past sediment discharge and its impacts on nearby facilities if present.

The risk evaluation for each of the designated Yellow/Red Zones is carried out and rated on the basis of the selected ten (10) items, as explained above. The risk of each of the designated Yellow/Red Zones is scored using the risk evaluation sheet for yellow/red zone shown in Figure 17 and is further classified into four levels, namely, very high, high, moderate or low according to the total scores.

Table 10: Classification of Risk Level

Risk Level	Total Evaluation Score
Very High	75 and more
High	50 to 74
Moderate	25 to 49
Low	0 to 24

The designated Yellow/Red Zones is prioritized by considering these selected items, and this enables risk management, for example, further risk reduction measures, land use planning, to be considered according to priority or risk level. This will facilitate a rational and effective approach to risk treatment and management given the resources available.

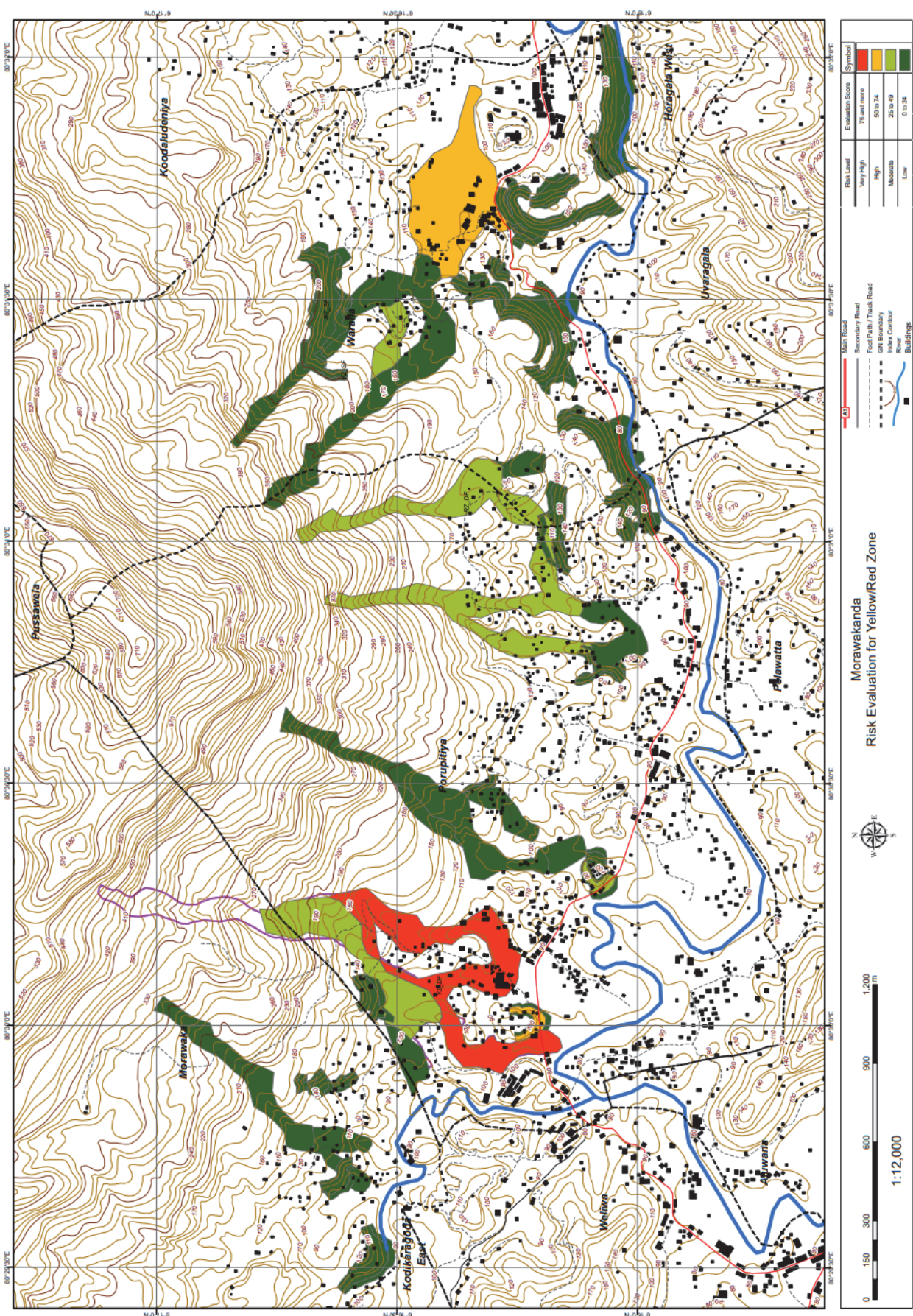
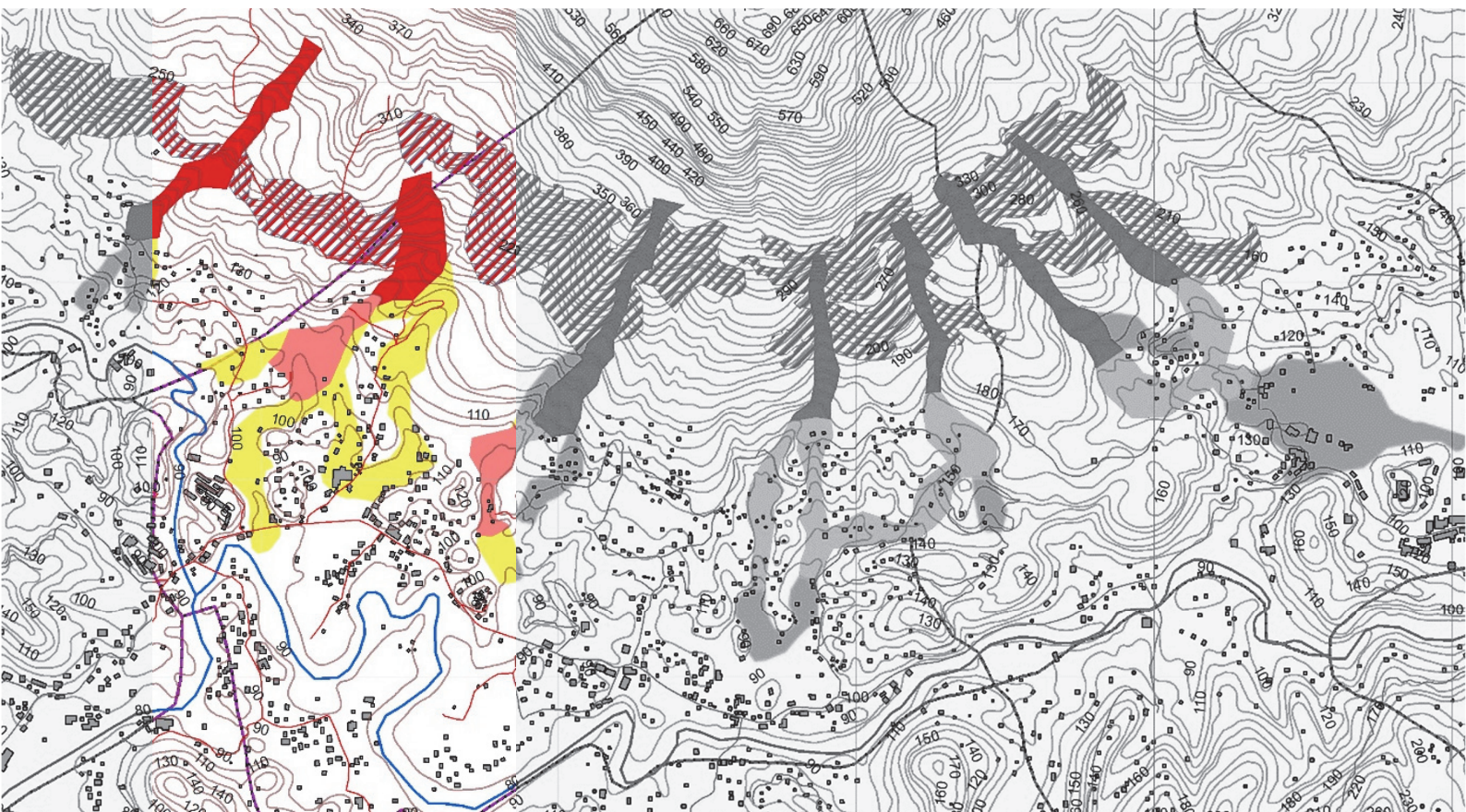


Figure 21: Risk Evaluation Map of Morawakkanda

4

Landuse zoning



4. Land Use Zoning Plan in Morawakkanda

As mentioned above concepts, the Yellow zone and Red zone of the target area were created by NBRO in 1:10,000 (Figure 10) and 1:2,500 scales (Figure 15). There are several potential debris flow-prone areas around the Morawakkanda. In this LSDRRP, only the stream of Morawakkanda and its surrounding area are considered. According to the hazard zoning, the debris deposition area in the 2017 disaster falls into the Red zone. The buildings located in the Red zone were destroyed by the 2017 disaster. The mudflow area falls in 2017 disaster into the Yellow zone. Most of the buildings including “Morawaka Keerthi Abeywickrama National School” are located outside of the Yellow zone, however, some houses and a tea factory are located in the Yellow zone. These areas still have potential risks in the Morawakkanda.

Current Land Use Map overlaying red and yellow zone in Morawakkanda is displayed Figure 14. In addition to the current land use displayed in Figure 14, those area covered as Red and Yellow Zone are required to follow the development restriction determined in this LSDRR.

The future land use pattern income could be categorized with the market values, and the below table can be used to estimate the price differences.

Table 11: Plantation crops in Morawakakanda Area

Plantation Crops	Distance (M)	Average production	Price per 1 kg/ Price per nuts	Current Land Use Extent	Future Land Use Extent
Tea		1500kg/ha/year	190		
Rubber		2800kg crepe/year/ha	250		
Paddy		3400kg/ ha/year	65		
Cinamon		1000kg/ha/year	1700		
Peper		390kg/he/year	950		
Coconut		6000 nuts/acres/ year	70		
Pinapple		33000 per acres	50		
Mangusteen		1000fruits per year (30-50yrs old tree)	20		
Agawood	2*2	2470 tree/hec			
Beattle		1000 sticks- 1200000	2000/1kg		
Puwak (පුවක්)	3*3	1100 per hec (3-4 bunches/one tree/year)	650/1kg		
කිතුල්		4-6l of sap for bottle of trecles	1500 per bottle		
		6-8l of sap for jaggery 1kg			
Dragon Fruit	2*2	10000kg/he/year	300 /1kg		
	3*3				
	1*3				
rambuttan	100-200 nuts per tree	35 tree/ acres (200kg/year/tree)			
Banana	3*3	1100plant/ha	365/ 1 kg		
Guvava	3*4	350kg per tree	200/kg		
Goraka	6*6/4*4		900/1kg		
Turmaric		20000-25000 kg/ha	6000/1kg		

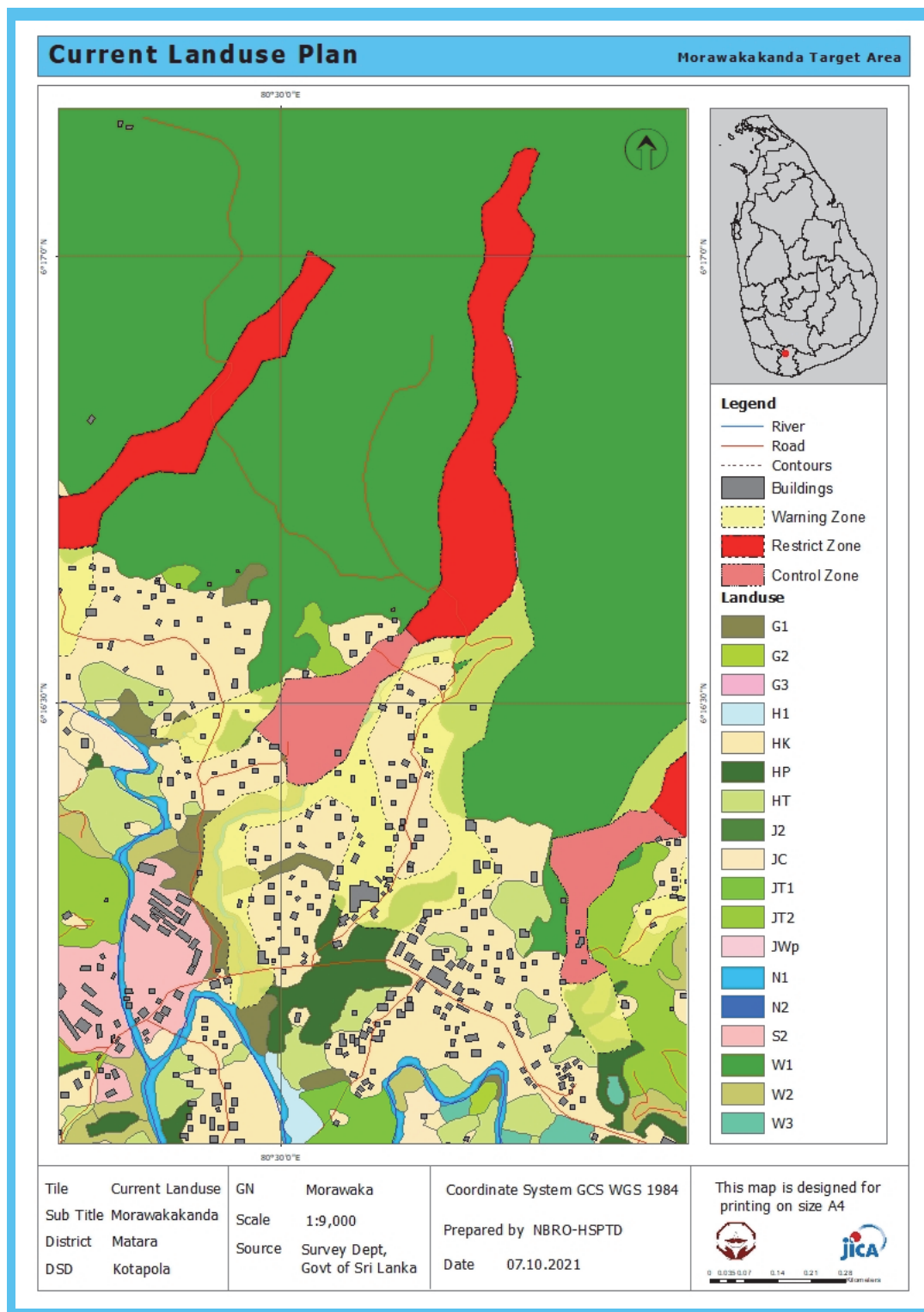
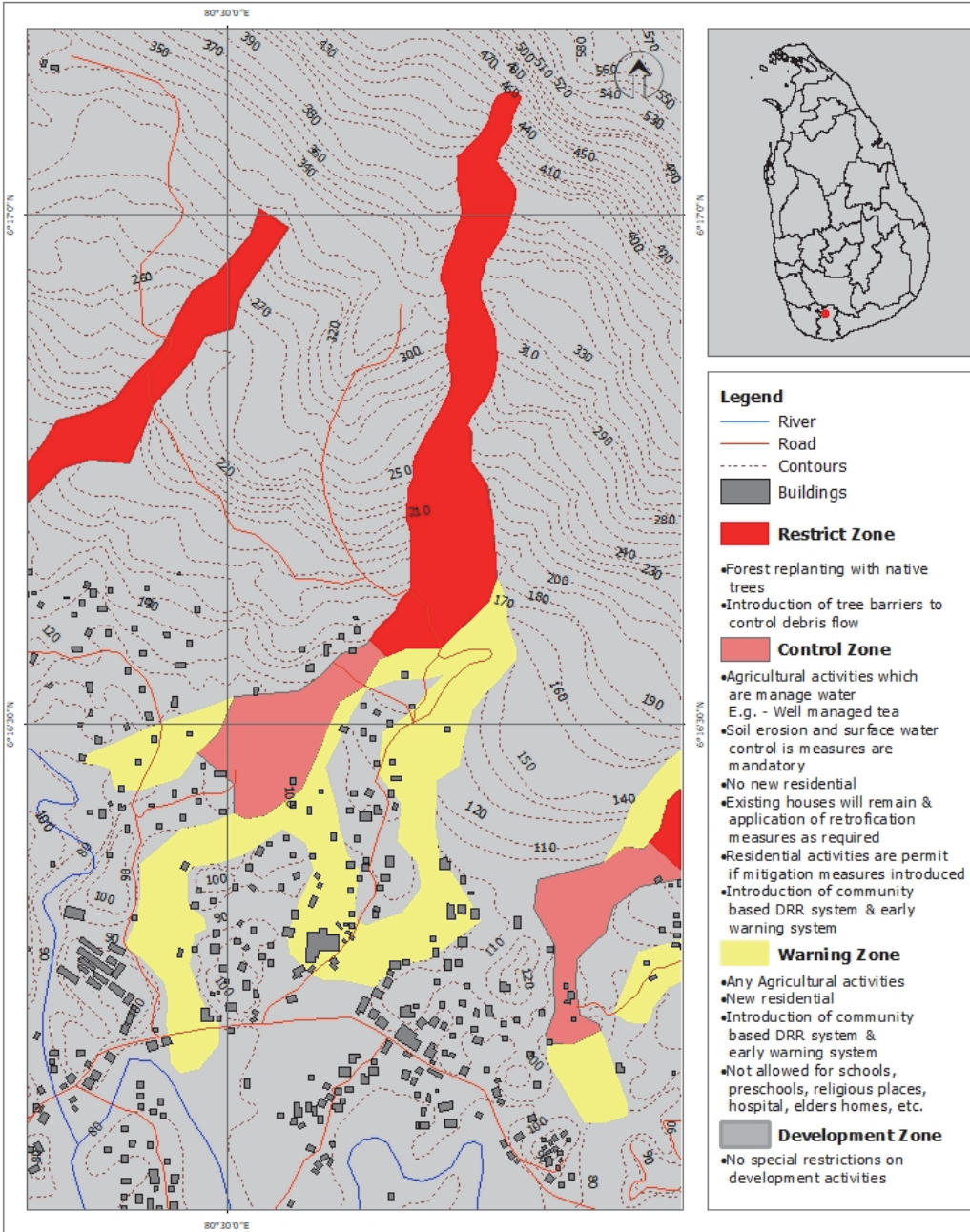


Figure 22: Current land use plan

Land Use Zoning Plan for Morawakkanda is shown in Figure 15. The four zone “Restricted Zone”, “Controlled Zone”, “Warning Zone” and “Development Zone” are illustrated on the map of the figure.

Landuse Zoning Plan

Morawakakanda Target Area



- Legend**
- River
 - Road
 - Contours
 - Buildings
- Restrict Zone**
- Forest replanting with native trees
 - Introduction of tree barriers to control debris flow
- Control Zone**
- Agricultural activities which are manage water
E.g. - Well managed tea
 - Soil erosion and surface water control is measures are mandatory
 - No new residential
 - Existing houses will remain & application of retrofication measures as required
 - Residential activities are permit if mitigation measures introduced
 - Introduction of community based DRR system & early warning system
- Warning Zone**
- Any Agricultural activities
 - New residential
 - Introduction of community based DRR system & early warning system
 - Not allowed for schools, preschools, religious places, hospital, elders homes, etc.
- Development Zone**
- No special restrictions on development activities

Tile	Zonning Map	GN	Morawaka	Coordinate System	GCS WGS 1984	This map is designed for printing on size A4 0 0.075 0.15 0.225 0.3
Sub Title	Morawakakanda	Scale	1:9,000	Prepared by	NBRO-HSPTD	
District	Matara	Source	Survey Dept, Govt of Sri Lanka	Date	07.10.2021	
DSD	Kotapola					

Figure 23: Land use zoning plan

4.1. Basic DRR Strategies for Morawakkanda

Restricted Zone

- Forest re-planting with native trees.
Use native plants to replant the degraded land. Nature based landslide risk mitigation project, a technical collaboration project of NBRO with Asian Disaster Preparedness Center (ADPC) have developed a plant manual to use for such kind of situation.
- Introduce tree barriers to control debris flow
Introduce tree line as a debris along the border of restricted zone and control zone. it may help to control debris to flow in to residential area to certain extent.
- Sabo structural facilities
- In consultation with the central government such as NBRO and Road Development Authority, debris flow prevention facilities such as Sabo dam, training dyke, channel works.

Controlled Zone

- Promote agricultural activities which are manage water (e.g. well manage tea)
- Soil erosion and surface water control is measures are mandatory.
- Not allow to new residential
- Existing housing will remain and application of retrofication measures as required. There are seven (7) houses in controlled zone in Morawakkanda.
- Residential activities are permit if mitigation measures introduced.
- Introduction of community based DRR system and early warning system.

Warning Zone

- It is suitable for any agriculture activities as well as to establish new residential also.
- Introduction of community based DRR system and early warning system
- Not Allowed for Schools, preschools, religious places, hospital, elder homes and so on.

Development Zone

- No special restrictions on development activities
- Regular development approval process will be taken in to consideration

4.2. Statistics in Yellow and Red Zone

The statistics are based on the filed survey in Morawakakdanda Target area which is conducted on 2021.08.08. by the NBRO, and the following information is utilized to plan relocation of housing, an evacuation drill, and a communication channel to disseminate early warning.

Table 12: Statistics in Yellow and Red zone

	Number of Housing	Number of Family (people)	Number of people who needs assistance to evacuate (infants, elderly, pregnant woman, people with handicap)
Restricted Zone	0	0 family (0 people)	No
Controlled Zone	2	2 family (7 people)	No
Warning Zone	37	37 family (148 people)	35 people

	Total Number of Housing	Permanent	Semi-permanent	Improvised
Restricted Zone	0	0	0	0
Controlled Zone	2	2	0	0
Warning Zone	37	37	0	0

Building Statistics

Morawakanda Target Area

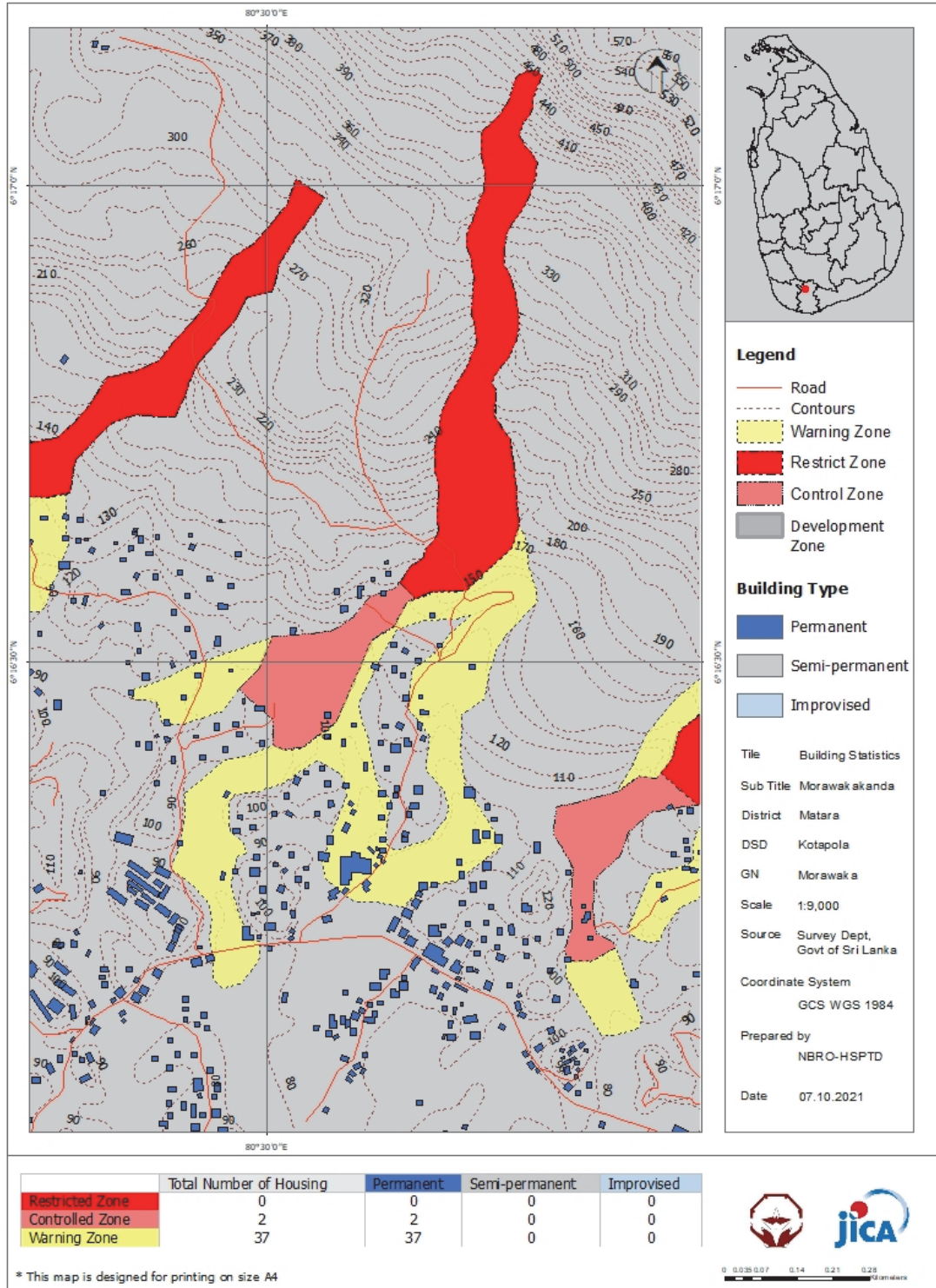


Figure 24: Building statistics



Structural Measures



5. Structural Measures

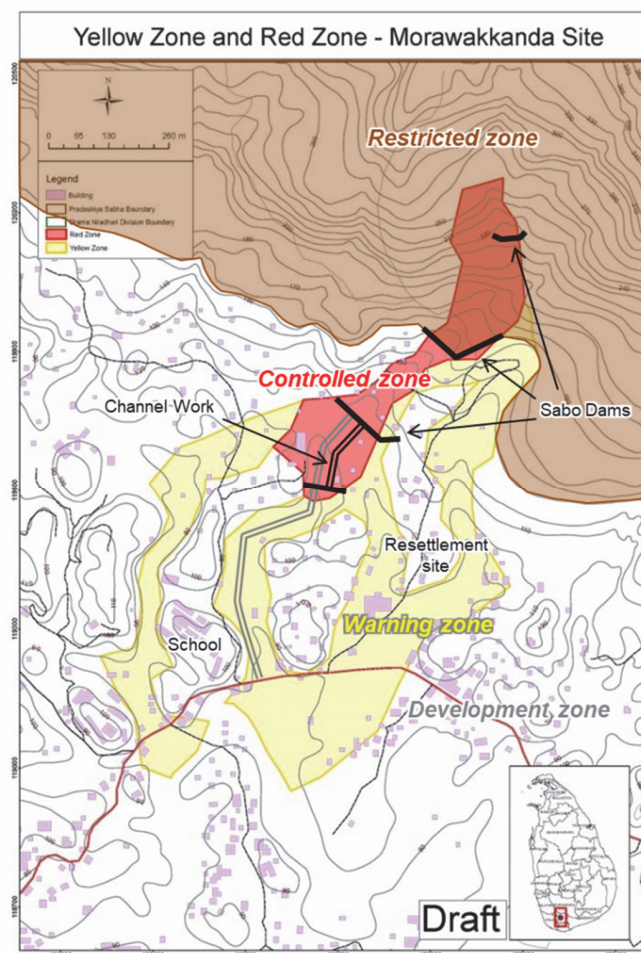
The major disaster type in Morawakkanda is debris flow. Reducing the risk of debris flow is important to secure the safety of residents and sustainable development in the area.

However, at the present, there is no experience practical structural measure against debris flow in Sri Lanka. It is expected to be introduced by central technical agencies such as NBRO. If appropriate structural measures are implemented in Morawakkanda, it is possible to lift the development regulation in the Red zone and restore the livelihoods of residents. In addition, the measure will lead to securing traffic on the national highway A17. It is a benefit not only for Morawakkanda but also for regional development.

Based on the Yellow/Red zoning map, “Restricted zone”, “Controlled zone”, “Warning zone” and “Development zone” will be designated according to the guideline. Upstream of Red zone shall be restricted zone where any construction and development are strongly restricted. Moreover, the highland area is already designated as forest conservation area so it is also designated as Restricted zone.

The lower Red zone shall be Controlled zone. Countermeasures are required for existing houses and new development. The government plans to construct some Sabo facilities in the stream.

Local government shall make efforts to strengthen early warning and evacuation system in both red and yellow zones with consultation of NBRO. Other area is for Development zone, where any construction and development are permitted if LAB/LAD are acquired in advance. Due to above condition, concrete plan of the structural measures cannot be proposed in this LSDRRP.



Generally, there are several structural measures against debris flow such as;

- 1) Sabo dam to directly capture debris from upper stream
- 2) Channel works to train the flow direction to the downstream
- 3) Ground sill to protect river bed erosion when debris flow occurs.

On the other hand, nature-based risk reduction measures such forest re-plantation is also effective to prevent new slope failure in upper stream and to fix unstable sediment in the stream. These measures should be applied in combination with the structural measures. Kotapola PS will cooperate with NBRO and other central agencies to apply the structural measures Morawakkanda.



Strengthening Early Warning and Evacuation

6. Strength Early Warning and Evacuation

6.1. NBRO Landslide Early Warning

NBRO Early Warning Centre (EWC) issues landslide warnings based on real-time observed rainfall data from NBRO automation rain gauge. Warning criteria and actions to take during the respective warning level is as shown in the following table. In addition to 24 hours rainfall, NBRO EWC considers Soil Water Index (SWI) which indicates how much water is accumulated in the soil since landslide is caused when water in the soil gets saturated by heavy rainfall. It is important to remember that there is cases that NBRO keeps the warning even if the rainfall become little since there is high risk of landslides due to high water saturation in the soil (high SWI).

Table 13: NBRO Landslide Early Warning Criteria and actions to take

Warning Level		24 hours rain fall	Actions to take
	(None)		
1	Watch	More than 75 mm	Be watchful on the possibility of landslide
2	Alert	More than 100 mm	Be on alert, prepare to evacuate
3	Evacuation	More than 150 mm	Evacuate to a safe location

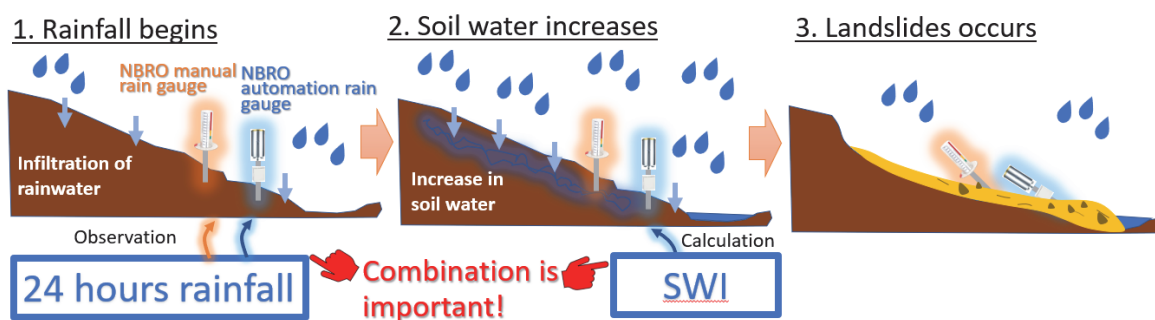


Figure 25: Cause of Landslide and Soil Water Index

After NBRO EWC transmits the warning messages to Disaster Management Center (DMC), DMC is in charge of disseminating the NBRO warning to DDMCU in Matara District, Kotapola DS division, Morawaka GN Division, and Emergency Community Committee in Morawakkanda as shown in the following figure.

Considering the landslide warnings, DDMCU (or DS division) issues evacuation order to local people. The local people living in Yellow/Red zones shall evacuate to safe place to comply with the section 7.(2) and (3). Certain dissemination of the landslide warnings and evacuation order shall be ensured through the awareness activities. NBRO will continue routine operation and maintenance of the rain gauge.

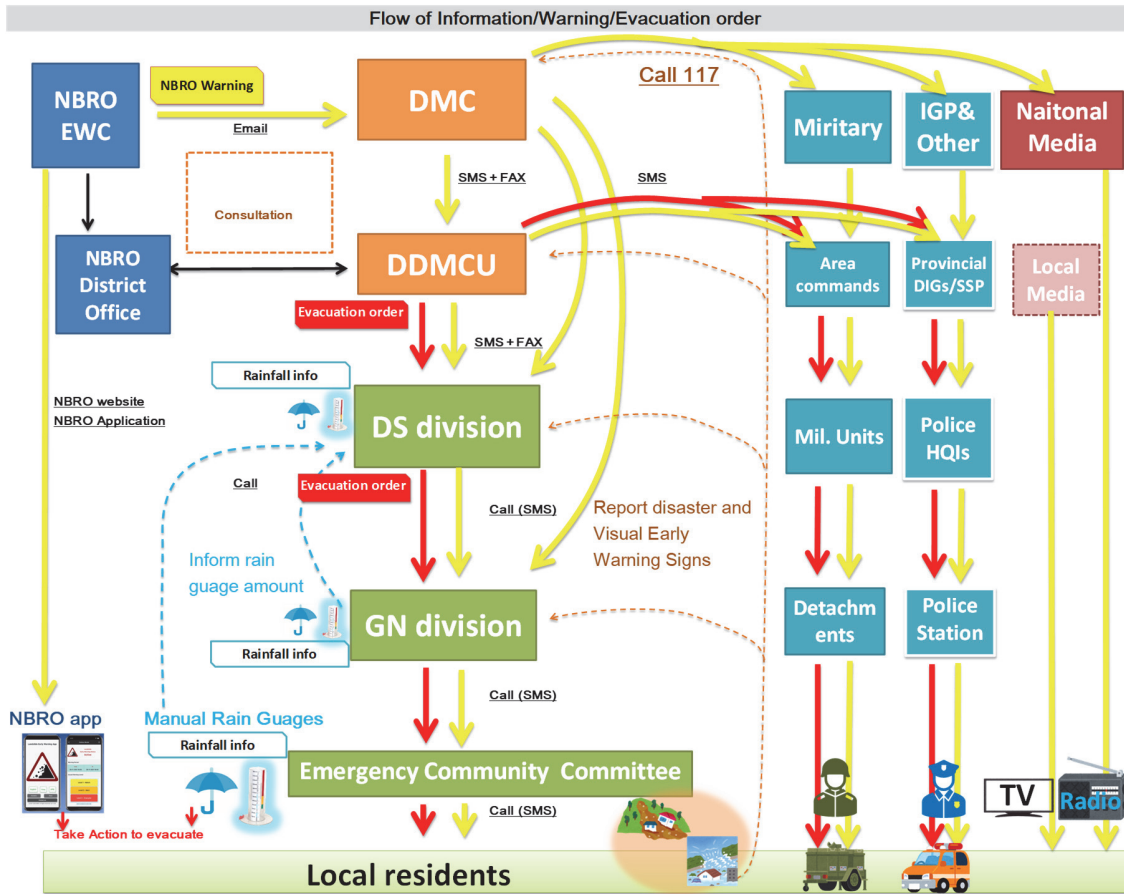
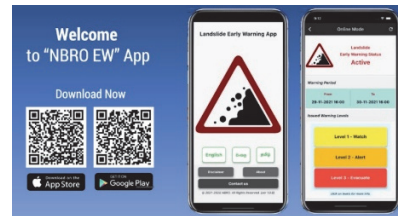


Figure 26: Dissemination flow of NBRO Landslide Early Warning and Evacuation Order

Although the direct Call/SMS comes to only focal people at respective level, the landslide warnings are also broadcasted by media and published on the NBRO websites (<https://www.nbro.gov.lk/index.php?lang=si>) and NBRO mobile application. Therefore, all residents can check the warning by themselves also. The real-time observed rainfall data by NBRO automation rain gauge (https://www.nbro.gov.lk/index.php?option=com_content&view=article&layout=edit&id=215&lang=en) is also available at NBRO website.



Community Based Early Warning

In addition to NBRO EW sent from EWC, a community-based approach on landslide early warning needs to be functioned. NBRO provided manual rain gauge cylinders to Secretary of Emergency Community Committee in Morawakkanda. Even if the level of NBRO EW sent through DMC is not at the same level, when observed rainfall by the manual gauges at the field exceeds the threshold, Disaster relief officer or the Emergency Community Committee shall inform the situation to Divisional Secretary and make decision to evacuate if it is over 150 mm per 24 hours. The local people shall start evacuation based on the local information since NBRO EW is not for site-specific area but the entire district. Emergency Community Committee shall inform the warning to the residents by call, SMS and oral communication to encourage evacuation.

6.2. NBRO Early Warning Communication Channel in Morawakkanda

The following figure is a NBRO Early Warning dissemination channel in Morawakkanda. The warning is mainly delivered by Calls and SMS. At least 57 households in Morawakkanda are covered through this channel at present. The residents who are not in the channel shall be informed that NBRO early warning information is available at NBRO EW application and website at awareness activities. In addition, as manual rain gauge is at house of Secretary of Emergency Community Committee. When observed rainfall by the manual gauges exceeds the threshold, the Emergency Community Committee shall inform the situation to their local communities and local governments. The local people shall start evacuation based on the information.

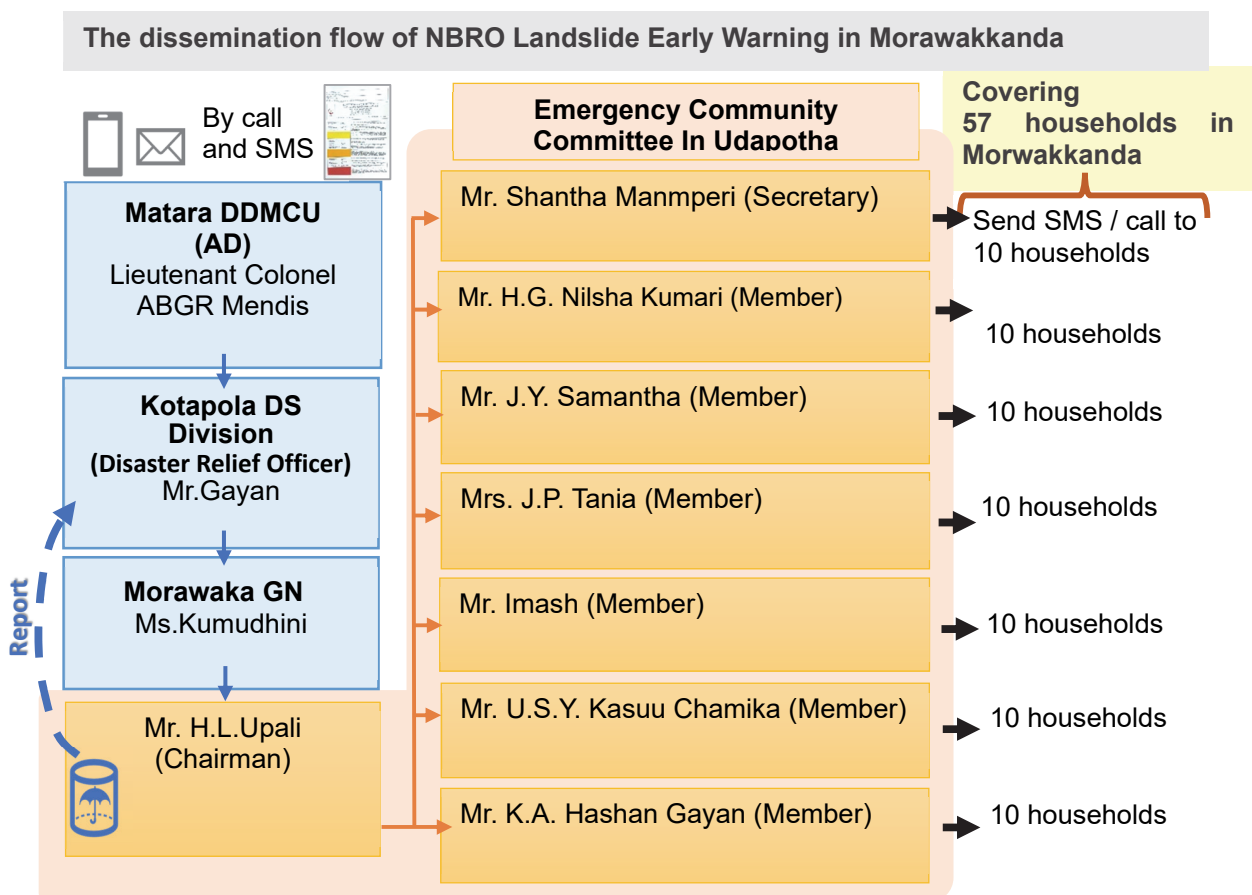


Figure 27: Contact information and the dissemination flow of NBRO Landslide Early Warning in Morawakkanda

6.3. Emergency Community Committee in Morawakkanda

Emergency Community Committee was newly established in Morawakkanda area in November 19th, 2021 with NBRO officers. The following is the committee members. NBRO manual rain gauge was also provided to the Committee, which is placed at the house of Secretary. He is also in charge of making a monthly record of the rain gauge and send it to NBRO EWC.



Table 14: Members of Emergency Community Committee in Morawakkanda

Position	Name	Role
Chairman	Mr. H.L.Upali	Contact person
Secretary	Mr. Shantha Manmperi	Manual rain gauge
Member	Mr. H.G. Nilsha Kumari	
Member	Mr. J.Y. Samantha	
Member	Mrs. J.P. Tania	
Member	Mr. Imash	
Member	Mr. U.S.Y. Kasuu Chamika	
Member	Mr. K.A. Hashan Gayan	

1. Mr. Shantha Manmperi
Secretary of Emergency Community
Committee

An automatic rain gauge managed by NBRO is at police station in Morawaka town.

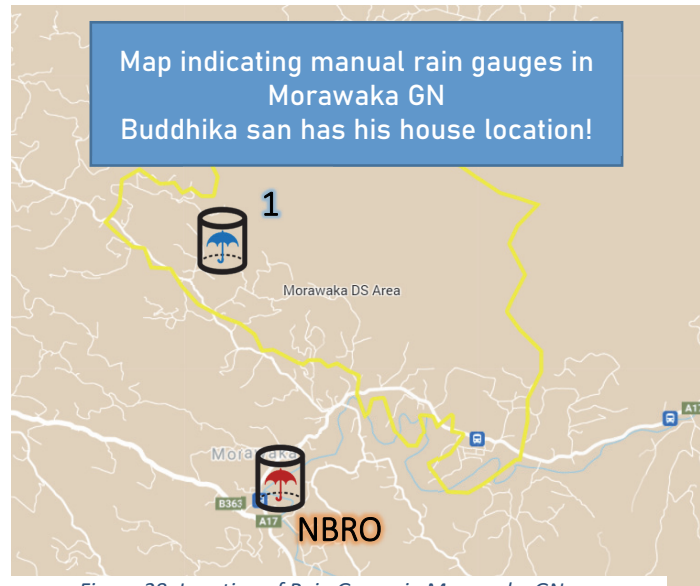


Figure 28: Location of Rain Gauge in Morawaka GN

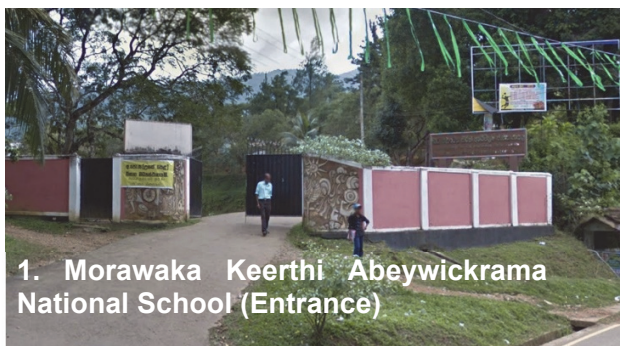
6.4. Securing Evacuation Place and Route

Evacuation places are designated on ahead. The evacuation places must be located outside of the Yellow/Red areas as well as other disaster risky areas. Safeness of evacuation routes shall be also considered when the evacuation places are designated. Information of the designated evacuation place, evacuation route and appointments are archived by DS division and DDMCU. Necessary appointments, such as generators, blankets and emergency provisions, shall be stored in the evacuation places.

The following issues regarding evacuation routes are identified at the workshop with Morawakkanda community members on November 2021 and March 2022. When there is a heavy rain, residents cannot reach to the school due to abundant roads and rain overflowing over the evacuation route. Therefore, residents would like to request other evacuation centers.

Table 15: Evacuation centres in Morawakkanda

Evacuation centres in Morawakkanda				
No	Place		Capacity	Issue
1	Morawaka	Keerthi	50	A road to access the school gets flooded during evacuation
	Abeywickrama National School	Households?		



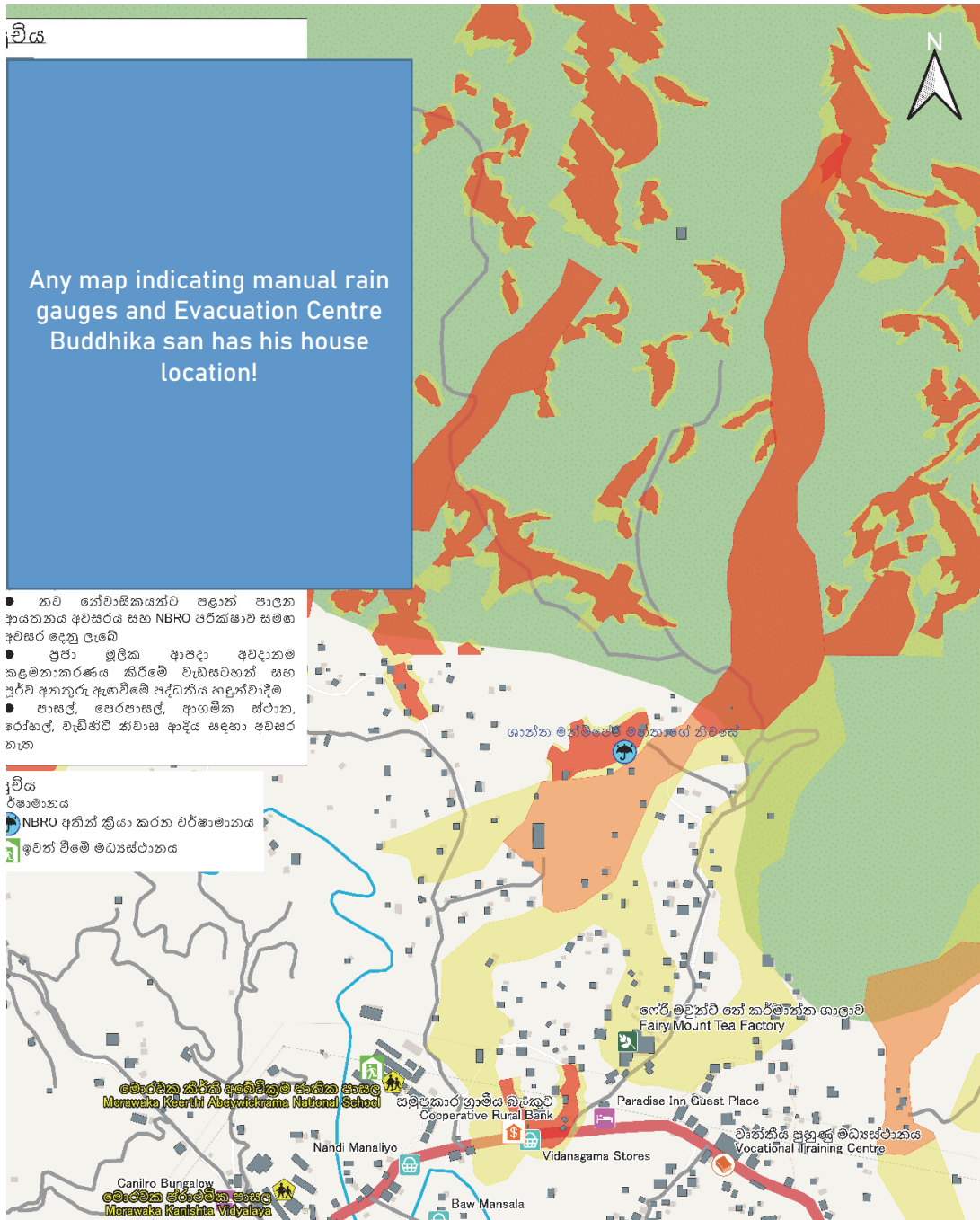


Figure 29: location of manual rain gauge and Evacuation Centre

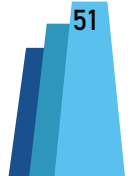
4.5. Awareness Activity for EW

In Morawakkanda, no evacuation drills are held by DDMCU. Early warning awareness program was held by NBRO in March 16th, 2022. Smooth and timely warning dissemination from NBRO and GN officers to local community through Emergency Community Committee shall be strengthened by the evacuation drill. Awareness activity is needed to train for local peoples to understand meaning of landslide hazard maps, NBRO landslide early warning, LRMS equipment warning and necessary preparedness. Necessary actions to strengthen early warning and evacuation are;

- Designation of safe evacuation places and routes considering landslide hazard maps with DDMCU and NBRO
- Procurement of necessary appointments in the evacuation places
- Awareness activity and evacuation drill once a year to ensure the warning dissemination and evacuation



Management plan



7. Management Plan

7.1. Land use management plan

The Restricted zone and Control zone should be free from the settlements, and it has high risk due to sediment disaster. The future land use plan should be aimed to convert the existing land uses in the Restricted and Control zone into forestry type land use categories.

7.2. The land value management plan

The council should be posed to implement a land value management plan for the Morawakakanda area by producing legal by-laws. These by-laws should be including the following key Articles.

Article 1: Principles.

- Public interests in land are superior to private interests
- Land-uses shall be in accordance with uses appropriate to an area's natural, social, economic, and cultural conditions
- Speculative investments in land shall be restrained
- "Appropriate burdens" shall be placed on parties profiteering from increases in land prices

Article 2: Land price

- Limited and vital resource for citizens and forms a fundamental basis for citizen activities.
- Price of land affects trends in population, industry, land-use, social capital, and facilities, and can change social and economic conditions.
- Land prices affect the public interests.

Article 3: Land use plan should be area specific.

- Land-use must be in accordance with uses appropriate to an area's natural, social, economic, and cultural conditions.

Article 4: Speculative investments shall be restrained.

- Some authorities have interpreted "speculative investment" as buying for the sake of selling at a later date.
- purpose of controlling the land market for a purported public good.

Implementation



8. Implementation

8.1. Action Plan

The implementation plan specifies the projects and the project budgets for implementation of land use plan, countermeasure facilities and strengthening early warning and evacuation system in the target area. The target years are also indicated with consideration of terms of PS councils. The main body of implementation is Kotapola PS with supports of DS Divisional Secretariat, NBRO, DMC, UDA and other central agencies

Action Plan for LSDRRP in Morawakkanda

No.	Item	Contents of the Measures	Responsible Agencies	Budget	Short Plan (to 2023)	Mid Plan (to 2025)	Long Plan (to 2030)
1. Implementation of land use plan							
1-1	Implementation of land use plan and regulation	Kotapola PS organizes stakeholder meeting to introduce land use regulation in Morawakkanda area in collaboration with DS Divisions	LA (DS Division)	to be assessed			
1-2		Kotapola PS organizes workshops in Morawakkanda in order to raise awareness of the local residents	LA (DS / GN)	to be assessed			
1-3		Kotapola PS develops By-law to implement the plan and the guide for development regulation	LA	to be assessed			
1-4		Kotapola PS promotes retrofitting of the existing houses in the control zone in cooperation with NBRO	LA/NBRO	to be assessed			
1-5	Up-scaling LSDRRP into the other area in PS	Kotapola PS expands LSDRRP into the sounding area based on Yellow/Red zoning provided by NBRO	LA (NBRO)	to be assessed			
1-6		Kotapola PS develops local disaster risk reduction plan in cooperation with Disaster Management Center and incorporate LSDRRP into the plan.	LA (DDMCU/NBRO)	to be assessed			
2. Risk reduction measures							
2-1	Construction of Sabo facilities as the measure to reduce debris flow risks	Kotapola PS officially requests NBRO or other concerned agencies to conduct technical study for Sabo facilities in Morawakkanda.	LA (NBRO)	to be assessed			
2-2		NBRO and other concerned agencies conduct technical study for Sabo facilities in Morawakkanda	NBRO	to be assessed			
2-3		Central government secure implement onstruction of Sabo facilities in Morawakkanda	Central Government	to be assessed			
2-4	Promotion of nature-based landslide risk mitigation project	NRBO implements nature-based landslide risk mitigation project in collaboration with ADPC.	NRBO (LA)	to be assessed			
2-5		Kotapola PS and GN introduce tree barriers along the border of restricted zone in order to prevent migration in the zone and to control the flow.	LA / GN	to be assessed			
3. Early warning and evacuation system							
3-1	Strengthening landslide early warning and evacuation system	DS Divisional Secretariat and NBRO sets up appropriate warning criteria using neighbor rain gauge station, and conduct workshop with GN	DS / NBRO (GN)	to be assessed			
3-2		Kotapola PS identifies the evacuation shelter in Morawakkanda area and equips necessary facilities with consultation of DDMCU	LA (DDMCU)	to be assessed			
3-3		Kotapola PS and DS Divisional Secretariat conducts community workshops and evacuation drills in cooperation with DDMCU	LA / DS (DDMCU)	to be assessed			

8.2. Role and Responsibilities of Concerned Agencies

The following figure shows interactions among LA, DS Divisional Secretariat, GN Division and NBRO in non-designated area by UDA. LA will revise the existing land use plan where land use plan was already developed or develop new land use plan where land use plan is not yet developed. Inputs such as disaster risk related information from NBRO and inputs such as community information from GN are provided to LA.

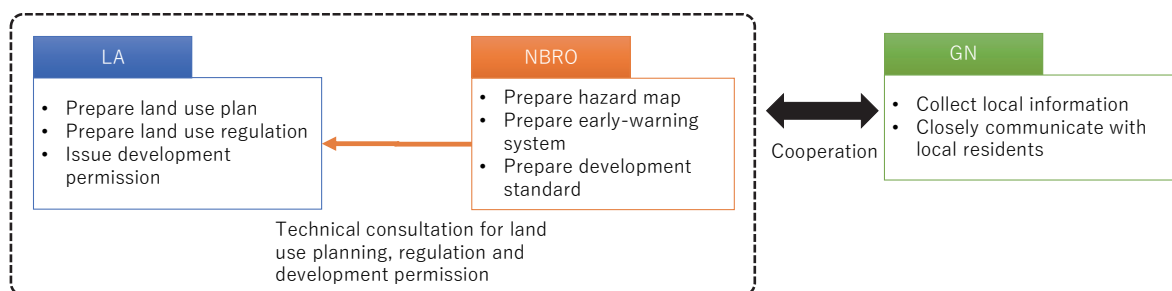


Figure 43: Interaction among LA, DSD, GND and NBRO

Roles & Responsibilities

Table 19: Roles & responsibilities

Organization	Role and Responsibilities
NBRO	<ul style="list-style-type: none"> ▪ NBRO prepare the sediment disaster hazard map based on the Guideline for Disaster Resilient Land Use Regulation/Development Standards. The map shows red/yellow zone (or 4 zones). ▪ Regarding to land use in high-risk area, NBRO prepares development standard, which is explained in the Chapter 4. ▪ NBRO helps early warning and evacuation system in high-risk area. The early warning system includes installment of rain gauge, alarm, evacuation plan and disaster drill and education together with DDMCU ▪ NBRO provides consultation to LA for land use plan and land use regulation based on the hazard assessment in the planning area. ▪ NBRO provides consultation to the local authority for development permission in red and yellow zone.
LAs	<ul style="list-style-type: none"> ▪ LA prepares development plan including land use plan as designated in the Town and Country Planning Ordinance. It is recommended to take into account the hazard map and development regulation prepared by NBRO in this process. ▪ The local authority issues development permission based on the development plan prepared by LA. It is recommended to take into account the hazard map and development regulation prepared by NBRO. If the development plan does not incorporate enough consideration about disaster risk management, it is recommended to add further land use regulation based on the hazard map by bylaw.
Grama Niladari	<ul style="list-style-type: none"> ▪ Provision of data

NBRO consultation menu

- Prepare hazard map
- Prepare early warning system
- Prepare development standard

- Inspect land use plan in the aspect of hazard and risk management
- Prepare draft land use plan
- Prepare land use plan and regulation in special projected area
- Hold workshop, seminar, etc. for local residences' understanding of hazard map and regulation
- Prepare evacuation plan
- Hold disaster drill and disaster education program for local people

LA

LA prepares development plan including land use plan as designated in the Town and Country Planning Ordinance. It is recommended to take into account the hazard map and development regulation prepared by NBRO in this process.

The local authority issues development permission based on the development plan prepared by LA. It is recommended to take into account the hazard map and development regulation prepared by NBRO. If the development plan does not incorporate enough consideration about disaster risk management, it is recommended to add further land use regulation based on the hazard map by bylaw.

GN

GN takes important role to collect information and facilitate understanding and communication with local people. As the hazard mapping is sensitive and influential to local people's life, it is important to have appropriate communication including workshop, seminar and inspection of hazard map between the relevant parties and public.

8.3. Monitoring and Verification

The monitoring and verification of the action plan is fully responsible of Badulla MC. Municipal council members will closely monitor the implementation of each item in the action plan, and necessary countermeasures will be taken by Kotapola PS.