National Building Research Organisation

Newsletter

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Technical Co-operation for Mitigation of Natural Disasters Due to Climate Change in Sri Lanka

In This Issue

Features

Norwegian Geotechnical Institute.......................... 03
NGI's Collaboration with NBRO.. 03

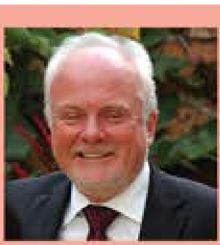
Phase one

Hands on Training Activities by NGI Experts 04
Hazard Assessment for Matale Subsidence Using SAR Images 04
Vulnerability Assessment in Ground Subsidence Prone Areas 05
Capacity Building – Official Training for NBRO at NGI, Oslo, Norway 06

Phase two

Drone Based Human Settlement Risk Assessment.................07
Benefits of Bi-Lateral cooporation between NBRO & NGI in the Regaional context...09
Donation of a Super Computer to NBRO for 3D Data Analysis 10
Field Investigation and Action Plan of the Oil Contamination in the Chunnakam Area............................... 11
NBRO-NGI Technical Collaboration 2016-2018.....................12

Dear Readers



We are pleased to be part of the second phase of the technical cooperation between Norwegian Geotechnical Institute (NGI) and the National Building Research Organisation. More than four successful years have passed since the Norwegian Embassy commenced supporting NGI to cooperate with the NBRO on disaster management.

We know that since the very inception the two parties have worked well together and facilitated the use of advanced Norwegian technology such as ground penetrating radars (GPR) and automatic weather stations which we believe have helped Sri Lanka in its disaster risk reduction efforts. We are happy that the GPR technology was used successfully in Matale where sink holes and cracks were observed in buildings. With GPR one could observe the development of sink holes which is the main cause of subsidence in the area. A tailor made high computing machine, which was recently handed over to the Minister of Disaster Management, will be used to analyze vast amount of data collected from various landslide prone areas in Sri Lanka. The high computing machine will make quick, accurate and efficient three-dimensional models of the mapped site in a Geographical Information System (GIS). I am happy to know that this project continues successfully, in the area of climate change and natural hazards.

Climate change impacts are intensifying and island nations like Sri Lanka are getting increasingly vulnerable to extreme weather. As an emerging economy, disaster risk reduction is becoming more and more important for Sri Lanka. As cities are growing larger, urban planning to withstand the impacts of natural disasters is important. Disaster risk reduction should therefore be an integral part of everyday decision-making and technical cooperation like this project will contribute to a more disaster resilient Sri Lanka.

I commend the Ministry of Disaster Management and the NBRO for the important work they do and thank our colleagues from Norwegian Geotechnical Institute for their support and cooperation. This cooperation is a very good example of how experience and knowledge successfully can be shared between institutions.

Thorbjorn Gaustadsaether
H E the Ambassador
Royal Norwegian Embassy, Colombo

We are privileged to welcome you to this special newsletter edition published at the milestone of initiation of Phase II of the collaboration between Norwegian Geotechnical Institute (NGI) and the National Building Research Organisation (NBRO); Hands-on technical co-operation for mitigation of natural disasters due to climate change in Sri Lanka.

Sri Lanka is becoming prone to many kinds of natural disasters and the loss of lives and property in the past decades has been increasing. Several initiatives have been taken by the Sri Lankan government through NBRO to mitigate natural disasters in the country. NBRO, as the prime research institute under the Ministry of Disaster Management of Sri Lanka, is therefore committed to disaster risk reduction and thus engaged in mitigation activities in the present context. Under this collaboration, we have been able to find many viable solutions to landslide and ground subsidence risk reduction through Phase I. We are expecting many more beneficial outcomes through the current Phase II initiated recently.

This newsletter presents a diverse number of articles on the background and work of NGI in the world, the different activities carried out in Phase I such as Subsidence Mapping project in Matale, Oil contamination monitoring programs in Chunnakam area, and Capacity Building program for NBRO staff in NGI, Norway, and also describes the plans proposed for GPR Assessment, Drone Photogrammetric survey, Risk Assessment on a 1:50000 scale and development of an early warning system for disaster risk reduction in Phase II of the collaboration.

Hence, we enthusiastically invite you to read and enjoy this newsletter edition. Further, we warmly welcome your feedback and ideas to incorporate in our future activities.

Best Wishes,
Eng. (Dr.) Asiri Karunawardane
Director General, NBRO

It is always a pleasure to work with the NBRO team. The Norwegian Geotechnical Institute (NGI) in Oslo, Norway has been collaborating with NBRO since 2012 on work related to mitigation of geo-hazards, building construction and transportation and environmental engineering. The project has been funded by the Royal Norwegian Embassy in Colombo, Sri Lanka. The focus areas of cooperation included the problems posed by landslides and subsidence in Sri Lanka. Significant outputs were obtained in Phase I of the project, which was concluded in early 2016. These include the development of early warning systems for some critical rainfall induced landslides in Sri Lanka. In addition, geotechnical investigations were performed using a state-of-the art NGI Ground Penetrating Radar (GPR) for mapping the subsidence problems in Matale. This GPR equipment has been procured by NBRO under the project and is being used for investigating ground sub-surface conditions for hazard mapping in Sri Lanka. Remote sensing using Synthetic Aperture Radar (SAR) was used to map the subsidence problems around the Matale area, which were then correlated with the ground conditions at site. Good correlation has been observed between the displacements observed through SAR interferometry and the ground surveys.

A new Phase of the co-operation between NBRO and NGI has been started where focus will be placed on expanding the early warning systems for landslides and carrying out GPR surveys in dams and dykes for limiting the hazards posed by floods, which will result in a safer society. In addition, advanced techniques, such as the use of Drones for mapping landslides, will be implemented to prepare 3-dimensional models of field sites. This will help in better land use planning, especially for the upcoming infrastructure projects in the country.

Best Wishes,
Dr. Rajinder Bhasin
Technical Expert, Norwegian Geotechnical Institute

Cover Photograph Aranayake Landslide site investigation by NGI and NBRO officials on 26th August 2016, Photo Captured by Dayan Munasinghe

Norwegian Geotechnical Institute

Dr. Rajinder Bhasin
Norwegian Geotechnical Institute

NGI is Norway's largest geotechnical specialist community and a leading centre of research and consultancy in engineering-related geosciences. It has a head office and laboratories in Oslo, branch office in Trondheim, avalanche research station on Mount Strynefjellet, subsidiaries in Houston, Texas, USA, and in Perth, Western Australia, as well as partnership agreements with well-established companies throughout the world. NGI has expertise within the fields of Offshore Energy, Building, Construction and Transportation, Natural Hazards, and Environmental Engineering. In Natural hazards, NGI assists industry, the authorities, police and land owners with expertise in handling every type of landslide, rock fall and avalanche. In environmental engineering, NGI identifies solutions and assists the authorities and industry in the clean-up of contaminated soil, rocks, sediments and groundwater. In the offshore sector, NGI is an internationally sought after geotechnical consultant in connection with exploration, development and operation of offshore fields, including foundation engineering and offshore wind turbines.

The core mission of NGI is to aid social development in Norway and abroad with research, consultancy and contributions to education in the field of engineering-related geosciences. NGI is an acknowledged meeting point for the public sector, technical experts and academia both in Norway and globally with regard to geotechnics. Through publication of research results, comprehensive lecture activities and participation on international expert panels, NGI actively contributes to further development and research within engineering-related geosciences.

At NGI applied research is practiced, which means that our results must be relevant and adopted by the market, and benefit society, industry and the public at large. Through direct assignments for industry in Norway and abroad along with allocations from the Research Council of Norway and participation in EU research programmes, NGI conducts research on relevant issues. The results of NGI's research are published and applied in practice to benefit Norwegian industry and society. NGI competes with other consultant engineers for ground survey assignments, as consultant engineers in geotechnics and engineering geology, environmental geotechnics, as well as landslide, rock fall and avalanche assessment and protection.

NGI has several ongoing assignments in the South and South-East Asian countries. In South Asia, NGI has been working in India, Bhutan, Bangladesh, Nepal, Myanmar and Sri Lanka.

ISO-certification - NGI is certified by BSI and holds and operates a Quality Management System, which complies with the requirements of ISO 9001:2008, and an Environmental Management System which complies with the requirements of ISO 14001:2004, for the scope of Research and development, consulting and services within the geosciences.

NGI's Collaboration with NBRO

Mr. Kishan Sugathapala
National Building Research Organisation

The ongoing institutional cooperation project between National Building Research Organisation (NBRO) and Norwegian Geotechnical Institute (NGI) titled 'Technical support for mitigation of natural disasters due to climate change in Sri Lanka' started in November 2012 and has achieved nearly three years of successful collaboration. The main aim of the project is to strengthen the capacity of NBRO and mitigate landslide and land subsidence impacts in Sri Lanka for the benefit of the people being affected by such disaster situations.

The project work is successfully continued after the Phase I and now the Phase II is being initiated. When looking back at the progress of Phase I, senior officials of the Ministry of Disaster Management including the Hon. Minister and the Secretary have appreciated the work performed specifically, the work on landslide early warning (installation of automated rain gauges), and the use of advanced equipment like Ground Penetrating Radar in performing geotechnical investigations; in identification of Karstic features of subsurface caverns in the ground subsidence prone areas, and monitoring the subsidence patterns through remote sensing techniques.

The extended cooperation aims at complimenting the work that NBRO will be performing in Sri Lanka, with international organizations on disaster risk reduction work in light of ongoing climate change. It is felt that there is an urgent need to build up new capabilities and take advantage of advanced technologies to understand natural hazards in a comprehensive manner. The collaborating institutions in Sri Lanka and Norway have discussed above this new initiative, and planed to utilize by pooling the available resources to reduce the risk of natural disasters in Sri Lanka. With this new phase of the collaboration, we are planning to use Drone Photogrammetric Survey and GPR assessment to develop methodologies in improving the scale of risk assessment and the early warning system for the benefit of the people in Sri Lanka in a future context.

Hands on Training Activities by NGI Experts in September 2015

Dayan Munasinghe, National Building Research Organisation

Two NGI experts, Dr. Rajinder Bhasin and Dr. Lloyd Turnbridge, visited Sri Lanka in September 2015 to continue investigations in Matale area to identify the land subsidence and landslides. They installed an automated rain gauge in the Divisional Secretariat Office at Naula to measure the rainfall and soil moisture once in 15 minutes and record the data. The automated rain gauges serve as early warning systems for rainfall induced landslides, and those were procured by NGI under the programme supported by the Royal Norwegian Embassy in Colombo. A total of 8 such systems had been installed in Elkaduwa, Matale DS office, Rattota (2), Walapane, Yatawatta and Naula.

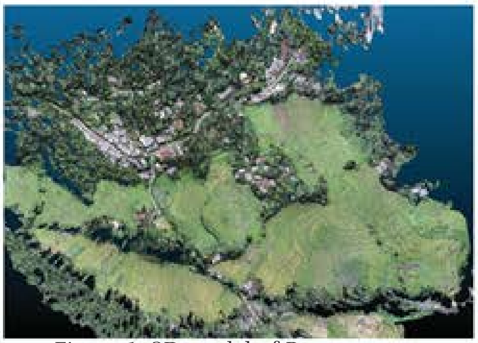


Figure 1: 3D model of Rattota area

In addition, the NGI experts brought a Camera Drone (UAV) last year to NBRO that can facilitate aerial survey and generation of 3-D imagery using its inbuilt GPS systems and cameras. This was used to fly-over landslide areas to capture a sequence of images with high location accuracy and acquired data was used by the NGI team to prepare Digital Elevation Models (DEMs). The NGI experts conducted a hands-on training session on the use of the drone and developed DEMs taking Rattota landslide-prone areas as an example. A final DEM on Rattota was created after processing the images. 3D image of the developed model is shown by figure 01.

Hazard Assessment of Matale Subsidence Using SAR Images

Eshi Wijegunarathne
National Building Research Organisation

Under NGI collaboration project, NBRO developed a new ground subsidence hazard susceptibility map which was generated from analysing the GPR surveys in Matale MC Area. In addition, Synthetic Aperture Radar (SAR) images were used to calculate the ground variations in Matale region.

Interferometric Synthetic Aperture Radar (InSAR) method was used to extract the surface deformation (i.e., average annual subsidence in mm/year) due to ground subsidence in Matale Municipal Council area. In this study, Matale Police Station was taken to be the reference point with known coordinates. The deformation field of the whole study area was observed through Persistent Scatterer Interferometry (PSI) in 2014.

The distribution of Persistent Scatterer (PS) points within the study area is shown in Fig. 02 in which the scale gradating from yellow to dark red represents increasing deformation rates i.e. increasing ground subsidence rates. The colour scale indicating green and blue points are where there has been little or no change in the subsidence rate. PS with positive velocities indicated in blue colour shows the upward surface deformation motion where the subsidence rate has reversed, while negative deformation rates reflect movements downward where the subsidence is increasing.

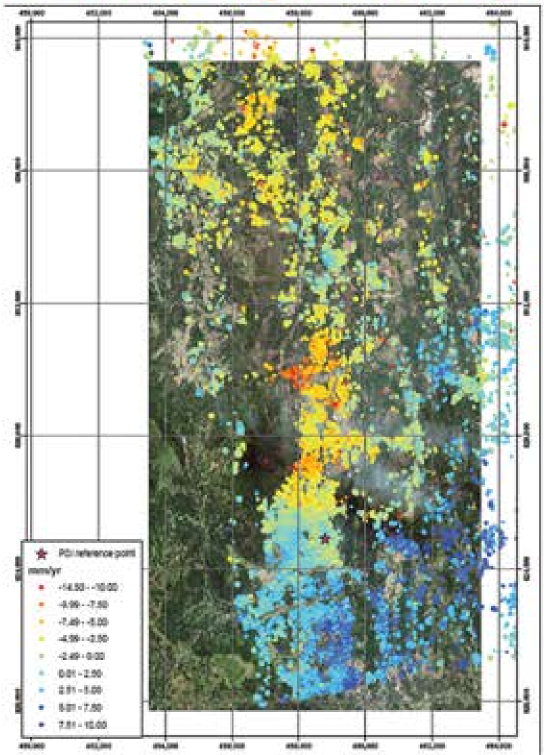


Figure 2: Deformation observed in 2014 from Persistent Scrattener points identified in the area of Matale MC

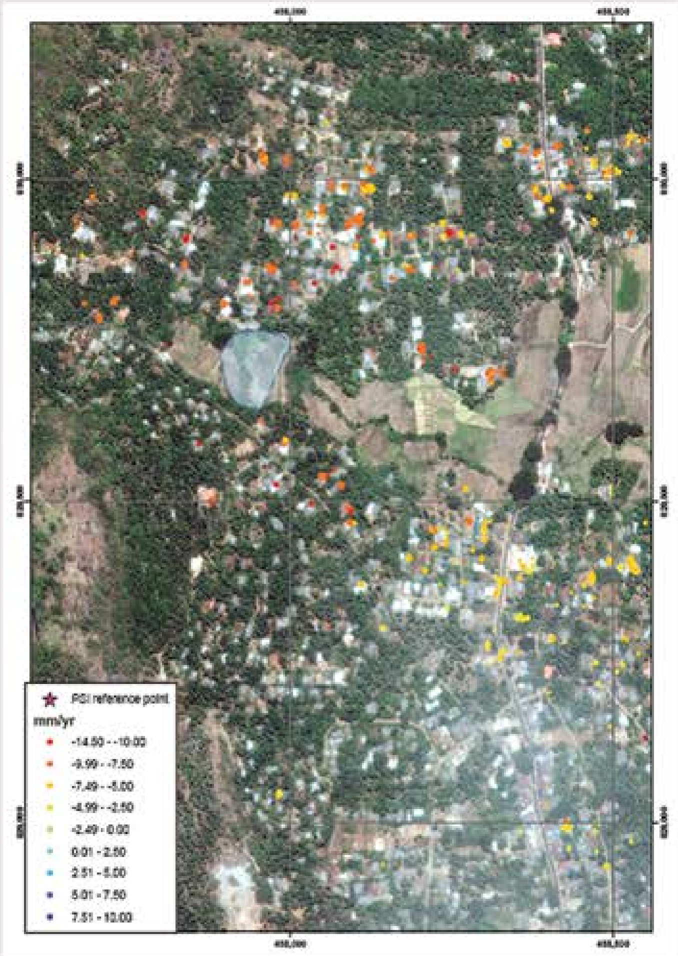


Figure 2. 1: Deformation observed in year 2014 for the PS identified in Matale MC area

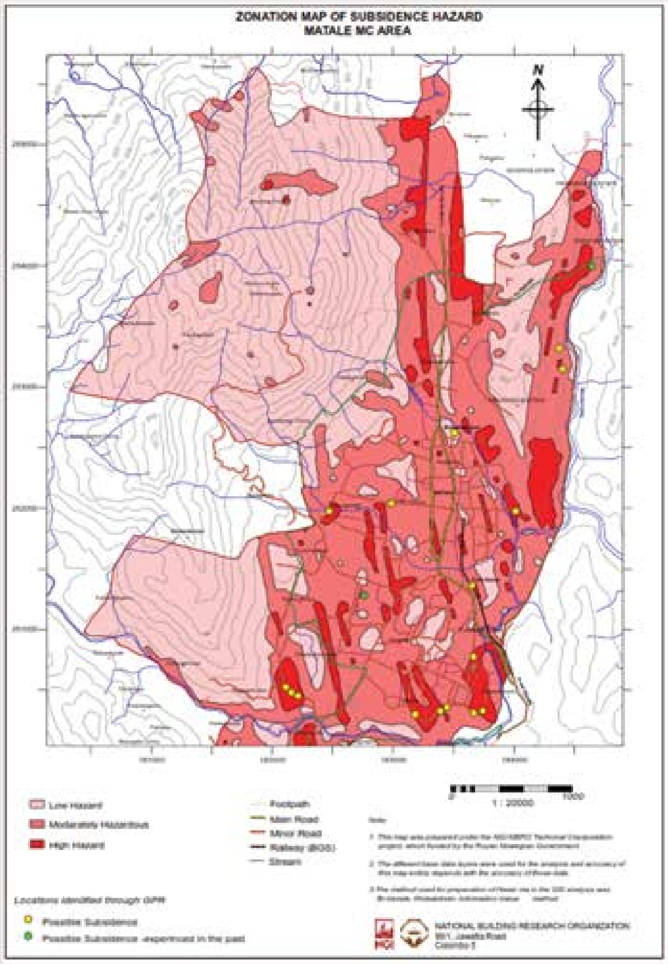


Figure 3: Zonation Map of Ground Subsidence Hazard in Matale MC Area

PSI derived subsidence rates were found to be in the range from -14.50 to 10 mm/yr. The area of increasing subsidence is larger than that of decreasing subsidence. InSAR analysis reveals that the higher subsidence rates are in the central part of the study area.

The Subsidence Hazard Zonation map for Matale MC Area is shown by Fig. 2.1. This map was compiled by taking the results of SAR Interferometry survey, GPR survey and taking into consideration the Geological features of the area.

As shown in Fig. 3, the ground subsidence hazard zones range from low hazard areas in pink, through medium hazard areas in red, to areas of high hazard in dark red colour. Matale city center and its immediate vicinity marked in dark red indicate high hazard while Aluviharaya, Harasgama, Kalduwela and Dodamdeniya show low hazard level. Further, other locations identified as having the possibility of ground subsidence hazard are indicated by yellow and green colour points.

Vulnerability Assessment in Ground Subsidence Prone Areas A Case Study: Matale Municipal Council Area

Eshi Wijegunarathe and Dayan Munasinghe
National Building Research Organisation

Several incidents of ground subsidence were recorded in the Matale Municipal Council Area and it became necessary to assess the vulnerability of the settlements for developing a resilient built environment. Therefore, under the NGI and NBRO collaboration, a study was conducted to assess the vulnerability of the community in Matale Municipal Council Area. This study discusses the vulnerability assessment methodology used and the results from Matale Municipal Council Area. Two types of vulnerability assessment methods were developed; community based and computer based.

Community based vulnerability assessment describes the community ideas and how they feel uncertainity on their buildings and territory. The data were obtained through a community survey, which was conducted by systematic random sampling in the Matale Municipal Council Area. Technical assessment is technical evaluations based on available secondary data and its analysed outputs.

Based on the analysis, the following recommendations were made to reduce the vulnerabilities of Matale Municipal Council Area.

1. Vulnerability assessment provides details of vulnerable elements of the city. These elements will be damaged or destroyed when they face any hazard event.

2. As for the planning purposes, indicators of increasing vulnerability should be minimized whereas indicators of decreasing vulnerability should be maximised.

3. In order to reduce the vulnerability of the city, the Matale MC should

a. Improve the knowledge of the community on;
   i. Hazard, and
   ii. Building construction methods/ techniques
b. Improve the drainage network;
   i. Maintain the natural drainage network
   ii. Repair and maintain the man-made drainage networks
c. Improve the governance pattern;
   i. Monitor the building regulations in the existing buildings
   ii. Strictly follow the building construction standards/ UDA guidelines for the buildings/ reservations
   iii. Control the development over steep slope areas/ follow the NBRO guidelines.
   iv. Promote low and medium-rise buildings such as walk-up apartments for city limits and control the land fragmentation.

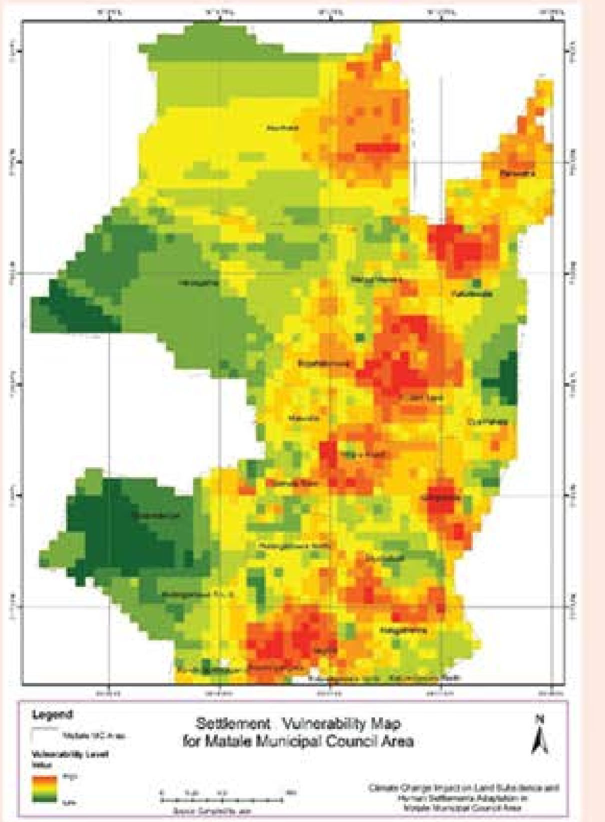


Figure 4: Map of settlement vulnerability for Matale MC Area based on primary and secondary data

Capacity Building – Official Training for NBRO at NGI, Oslo, Norway

Madara Dissanayake, National Building Research Organisation

NBRO is the technical arm of the Ministry of Disaster Management and the research & development institute which aims at overcoming and preventing various disaster situations. Having a multi-disciplinary team of expert scientists, NBRO has been able to provide answers for many such emergency situations of national importance with promising results. Geological hazards caused by hydro-meteorological factors such as landslides, slope failures, rock falls & ground subsidence is one such aspect that is highly focused on by NBRO.
NGI is a national center for geotechnical and related research in Oslo, Norway. The institute applies research results to engineering practice for the benefit of Norwegian industry and society, and encourage personnel development (develop their expertise in related areas) and assist in the education of new specialists.
Technical cooperation of NBRO with NGI started in November 2012 initially for a 2 year period to enhance the professional and technical capacity of NBRO in assessing and identifying the ground subsidence and landslide hazards in Matale area. A Ground Penetration Radar (GPR) system was donated to NBRO for subsurface investigations to identify ground subsidence hazard and several automated rain gauges were installed in strategic locations to monitor the rainfall, soil moisture, temperature and other parameters necessary for assessing ground conditions in problematic areas.
Under the technical coorperation of NBRO with NGI, four scientific officers were trained between 06 and 14 January 2016 in NGI on various technologies and instruments which could be helpful for disaster risk reduction.

The team included Mr. K N Bandara, Dr. Padmakumara, Mrs. Madara Dissanayake and Mr. Dayan Munasinghe.
Resource persons of NGI were; GPR techniques - Dr. Kong and Mr. Pawel; Remediation of oil contaminated areas - Mr Paul Cappelen; Risk Assessment methodologies & Drone based 3D mapping activities - Dr. Rajinder Bhashin.

Training on Ground Penetrating Radar (GPR) system

The training included
Principles of GPR technology and its uses such as applications in a variety of media, including rock, soil, ice, fresh water, pavements and structures.
Use of GPR to detect subsurface objects, changes in material properties, and voids and cracks.
Hands on training using GPR.
#Interpretation of GPR results on subsurface geological formation and variations, environmental field; detecting contamination oil and salinity.

Presenting the Risk Mapping process and methodologies

3D mapping by using drone technology
The training on use of risk assessment methods of geo-hazard covers, description of terminology; danger, hazard, risk, quantification of risk, vulnerability categories, assessment of vulnerability, risk management process, and risk mitigation and etc.

Study on oil contamination issues in groundwater and remedial measures

The field visit covered how NGI involves in site investigation, ground water monitoring, and remediation of contaminated soil, ground water and marine sediments.

NGI explained use of biological organisms in the remediation of oil contamination.

Geological formation in Indoor stadium/Olympic cavern hall

Norway's surface consists of exposed rock. The NGI has used this feature to convert a mountain cavern to a tunnel and a sport center. Olympic stadium at Lillehammer is constructed under an exposed rock. The stadium was built in 1991 and used in 1994 for Winter Olympics. Above the rock the team could observe several human settlements, stands without any risk.

Laboratory visit

NGI has a well equipped laboratory for soil and rock testing and environmental laboratory for soil, leachate, contaminant testing with good health, safety measures and security. Very interesting advantage in the training was familiarizing and obtaining concepts on the design of the laborat system.

This enabled the trainees to incorporate many items of NGI laboratory for the laboratory complex under construction at NBRO.

Other lessons learnt from NGI

NGI carries out research, applies the findings in their consultancy projects and publishes their research findings maintaining a good cooperation with national and international organizations.

NGI also conducts research studies on development of design of equipment and maintain their own repair work in their own workshops.

PHASE II

Drone Photogrammetric Survey

Drone - based post landslide risk assessment in Niyadigala human settlements

Anuruddha Vijekumara, National Building Research Organisation

Unmanned Aerial Vehicle (UAV) or Aerial survey by a drone is a new technology that can be used in disaster management activities (disaster response, relief operations and risk assessment) which is safer, faster and more efficient than traditional methods.

NBRO being the focal point for landslide risk management in Sri Lanka, the new UAV technology is very useful for landslide risk management activities. One such activity was the "Drone based risk assessment for human settlement for victims of the Niyadagala landslide in Balangoda".

Niyadigala landslide triggered on 3 May 2016, between 16.15 -17.00 Hrs. The landslide is a large scale debris flow that occurred in Niyadagala, Pabahinna in Ratnapura District (476985.99 m E, 744040.48 m N). Approximate length of the landslide is about 1.5 km while the length and height of the main scarp are about 50 and 29 m respectively.. Landslide flowed through the "Pannil Oya" valley, destroying the Niyadigala Arannasenasana Temple.

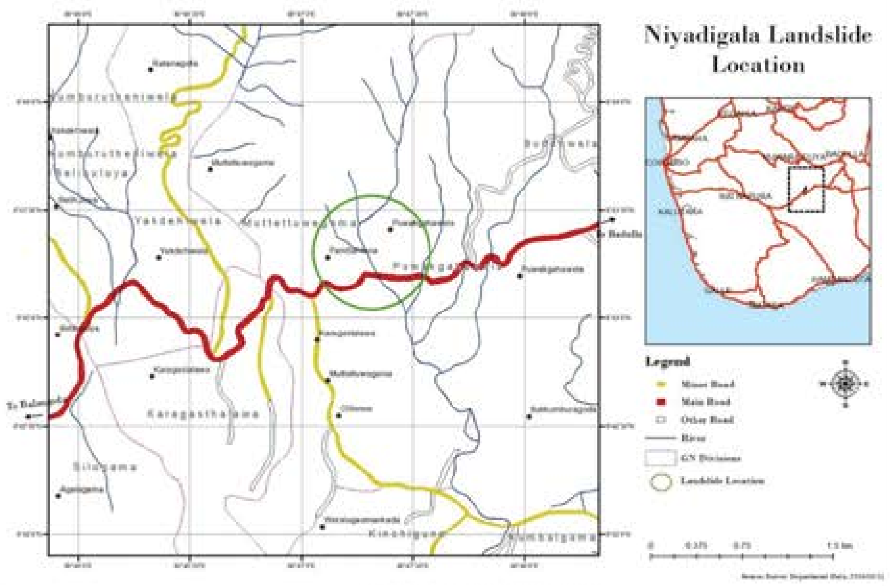


Figure 5: Location Map

Following activities were carried out in the field to achieve the objectives.

1. Flying the drone over the area and village downstream
2. Generating a 3D model and a Digital Elevation Model (DEM)
3. Generating new contours (after landslide) and obtaining previous contours
4. Estimating height changes before and after the landslide
5. Digitizing new human settlement map of risk areas on the debris flow path

Activity 1: The mapping drone was flown over the landslide area and the village area to map out the area

The drone was flown over from mid-point of landslide and around 370 geotag aerial photographs were captured. The air survey details are given bellow;

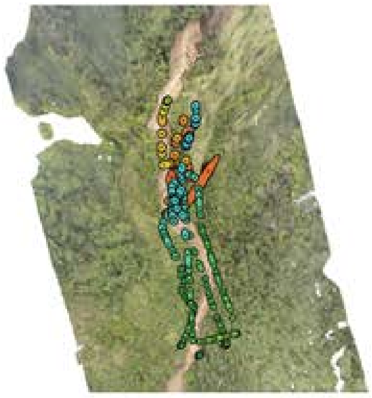
Over Landslide path

Number of images:	279	Camera stations:	265
Flying altitude:	267.35 m	Tie-points:	36935
Ground resolution:	0.0528841 m/pix	Projections:	173433
Coverage area:	0.318033 sq km	Error:	2.13587 pix

Over the settlement

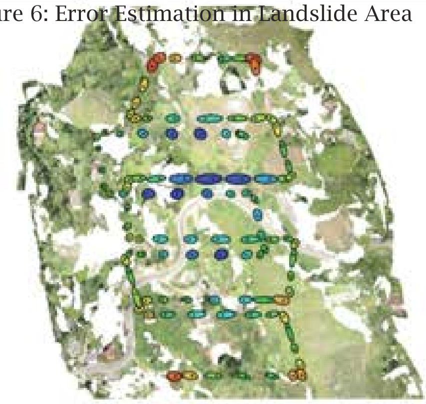
Number of images:	103	Camera stations:	103
Flying altitude:	128.505 m	Tie-points:	21828
Ground resolution:	0.0484771 m/pix	Projections:	78491
Coverage area:	0.167408 sq km	Error:	2.72435 pix

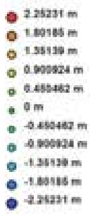
The drone flow path details over the landslide and settlements are given below. The color variation shows the error estimation of the air photos. The average camera location errors at both locations were 5m.



X error (m)	Y error (m)	Z error (m)	Total error (m)
1.799930	3.078669	3.438323	4.953788

Figure 6: Error Estimation in Landslide Area





X error (m)	Y error (m)	Z error (m)	Total error (m)
3.438053	2.020538	1.073991	4.129920

Figure 7: Error Estimation in Settlement Area

Activity 2: Generating 3D Model and DEM

The images were aligned to generate 3D models. DEM was derived based on the model. The cross sections of the impact area (before and after landslide) were generated.

Figure 8: Slope variation in Landslide Path

Figure 9: Slope variation from landslide to human settlement area

The average slope gradient from landslide to Niyadigala temple was 33%. Figure 9 illustrates the slope gradient from landslide to the temple. Another section was developed from deposit area to human settlement area as illustrated by Fig. 10 and the slope gradient was 18.5%. The distance from the deposit area to the nearest house along the valley is 600m.

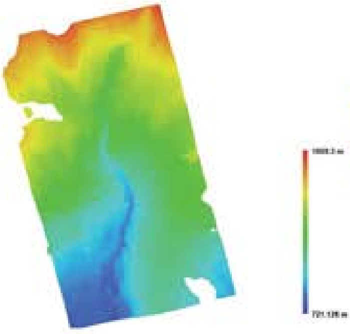


Figure 10: DEM - Settlement and Landslide area

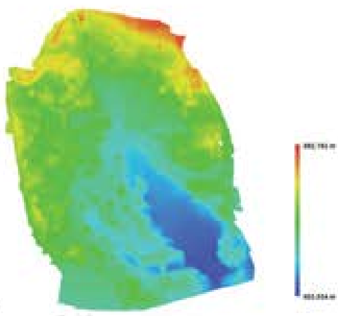


Figure 11: DEM - Settlement and Landslide area

Activity 3: Generating new contours (after landslide) and obtaining previous contours

The contours were generated primarily from newly generated DEM (after landslide) and previous contours were obtained from secondary sources.

Activity 4: Estimating height changes before and after the landslide

Soil mass changes were calculated based on two DEMs shown in Fig. 10. In the map, blue colour represents soil loss areas, and yellow and red colours represent soil deposit areas. Maximum soil loss height was 64m and maximum soil deposit height was 6m.

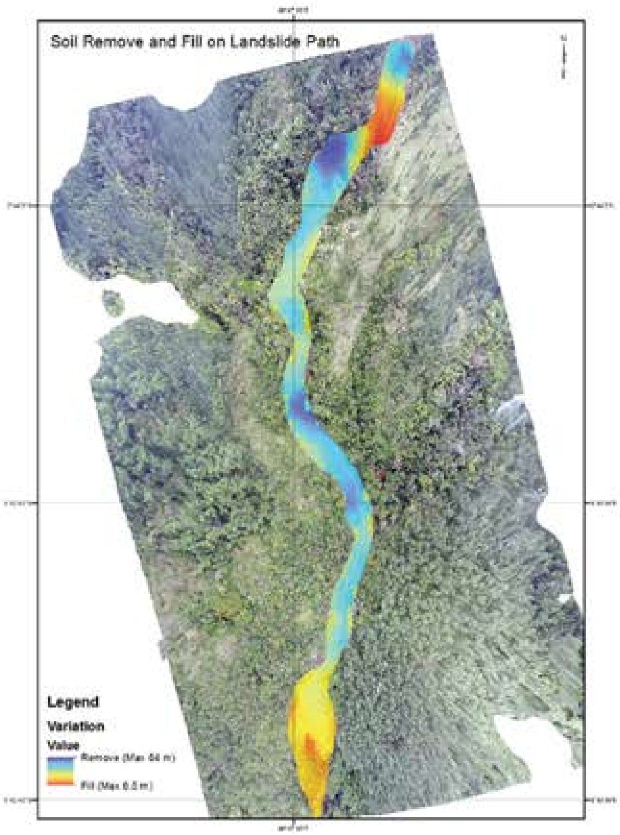


Figure 12: Soil loss and fill along the landslide path

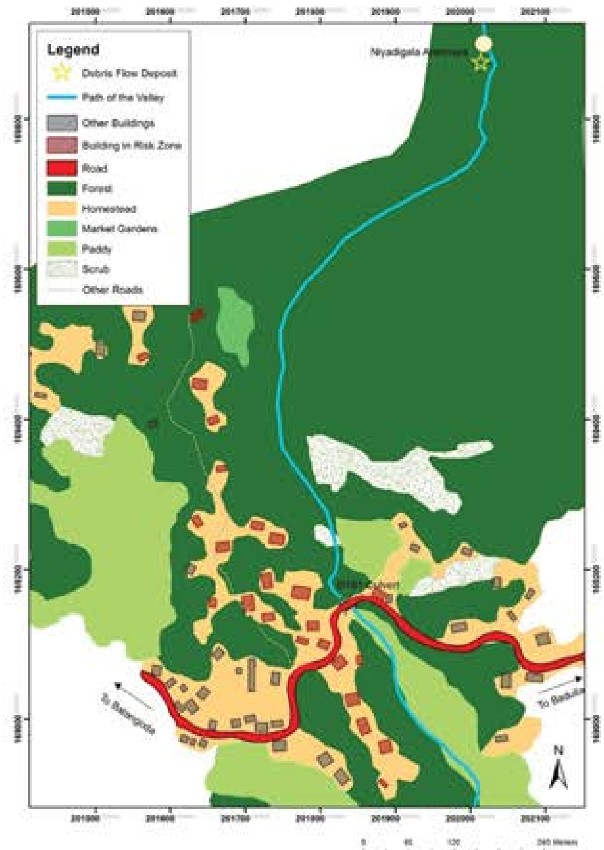


Figure 13: Layout map of the settlement area

Activity 5: Digitizing new human settlement map of risk areas on the debris flow path

An orthophoto was generated from the drone and it was digitized to identify the human settlements in risk areas. Figure 13 illustrates the 23 buildings in danger if the stagnated debris flow moves further down.

With the activities performed above, the following was summerised;

1. The landslide slope gradient was 33% and from landslide deposit to settlement area slope gradient is 18.5% and settlement is 1.0 km away from the landslide deposits. The main land use type between landslide deposit and settlement area is forest.

2. Soil mass movements were calculated by using Digital Elevation Models created from the existing and previous contours. According to the calculation, highest soil loss height was 64 m and highest soil fill height was 6.5 m. The deposit area (near temple) height was 6m.

3. Landslide deposit and nearest building distance is 600m along the valley. There are some buildings located downstream of the slope area. If the debris deposit moves further down, 23 buildings and A5 main road are in danger.

As per the observations, NBRO UAV/Drone team was able to recommend Disaster Risk Reduction measures to be followed within a shorter period of time with more efficiently and precisely.

Benefits of Bi-Lateral Cooperation between NBRO & NGI in the Regional Context

N.M.S.I.Arambepola
Technical Advisor, Asian Disaster Preparedness Center(ADPC), Thailand

The incidents of landslides, other types of mass movements and flash flooding have accounted for considerable human losses, damage to social and economic assets, natural resources, and environment in many countries in Asia. During the past few years, such events have had significant negative impact on the development initiatives, poverty reduction goals in countries such as Bangladesh, Bhutan, India, Indonesia, Nepal, Myanmar, Philippines, Thailand, Sri Lanka, Vietnam etc. Despite advances in science and technology, losses continue to result in human sufferings, property losses and sentimental degradation. As population increases and societies become more complex, the economic and societal losses due to such events will continue to rise. Increasing anthropogenic activities in the mountain areas also add to the existing vulnerability of communities living in landslide prone areas.

The extreme weather events are associated with climate variability as well as climate change. Climate change has the potential to increase multiple risks in countries in different ways: from higher sea levels and storm surges; from heavier rainfall or rainfall that is more prolonged than in the past; and from increased river flows, including instances through increased glacial melt. The IPCC Working Group II noted that heavy precipitation events are very likely to increase in frequency and will augment the multi-hazard risk scenario in most of the countries. Hence it has become a notable fact that the ongoing climate change associated impacts may significantly contribute to more frequent rain-induced landslide events in many countries in Asia.

Landslides are frequent and more widespread disasters than any other types in many parts of Asia. However, they are not so significant in terms of deaths and economic losses. The inadequate attention to the landslide problem may be due to the fact that landslide events have not brought dramatic socio-economic consequences compared to other major events such as earthquakes and floods reported in the region. At the same way, there are limited efforts in understanding the technical aspects of landslide problems and to develop cost effective landslide mitigation solutions as a remedy. Information needed for implementation of such initiatives aimed at understanding the social, economic, environmental and technical dimensions, have not yet been fully taken up by the professionals in many countries. The reason may also be due to the lack of involvement and encouragement by key players of developmental planning to obtain the services of relevant technical experts in decision making. This also contributed in no or little efforts in integrating risk sensitive land use and land management practices in the process of development planning in landslide prone areas. As a result the environmental degradation within the landslide prone areas have exponentially increased during the recent past. However, still there are very little efforts by the DRR institutions in Asia to evaluate and analyze correctly the widespread impacts of landslides to national economy and environment and to propose sustainable solutions.

Therefore, Asian Disaster Prepardness Center(ADPC), Thailand in collaboration with Norwegian Geo-technical Institute (NGI) has developed the Asian Program for Regional Capacity Enhancement for Landslide Impact Mitigation (RECLAIM) in year 2005, with the idea of promoting a dialogue between decision makers and professionals about the theoretical and practical aspects and issues related to landslide hazard mitigation in Asia. The program activi ties are designed to be implemented involving national partners from Bangladesh, Bhutan,Nepal, Phlippines, Myanmar, India, Indonesia, Thailand, Sri Lanka, Vietnam etc. The program recived funding support from the Royal Norwegian Government for implemeting various activities in different beneificiary countries and organizng networking events during last 12 years.

The Regional program aims to build the national capacity on landslide risk management by

· Identifying cost effective methodologies and good practices adopted by national partners
· Sharing of experince of sound practices, challnges, difficulties etc. In landslide risk management.
· Promoting capacity building, training & knowledge management interventions
· Organization of networking events among partner agencies in target countries in Asia for sharing & lerning.

The 1st RECLAIM Regional workshop and the Regional Training Course were held in Colombo and Bandarawela Sri Lanka in June 2005. The larger landslide risks in the participating counties in RECLAIM program seems to be due to a number of factors. The most important one is the increased vulnerability of population living in prone areas, in terms livelihood of inhabitants, unsafe living conditions, buildings, infrastructure, changes in land use

Participants of the 1st RECLAIM Regional workshop organized in Sri Lanka in 2005

etc. Lack of resources for planning and mitigation actions and lack of knowledge to make correct and timely decisions for landslide risk minimization is another reason. Even if such technical knowledge and know-how is available, it may be dispersed through different sources without an operational procedure for sharing information on sound practices widely. Attitude change is the primary challenge in order for behavioral change to occur subsequently in landslide risk management practice. The regional implementing partners NGI and ADPC have demonstrated the ways and benefits of sharing and lerning among the RECLAIM network partners.The particpating countries have stressed the need for continuity for actions for sharing with and lerning from each other, which is the reason for countinued efforts of NGI and ADPC under RECLAIM during past 12 years.

After the 1st Regional Training in Sri Lanka, it was felt that it is essential for the regional partners to develop bi-lateral cooperations with technically resourceful national institutions manadated with landslide disaster risk management to enhance the knowledge and skills of local professionals on hazard mapping, investigation, instrumentation, EW, structural mitigation etc. Especially this is a very important aspect for building resilience of communities threatened by landslides in terms of reducing the casualties and destruction due to potential events in future. NGI has extensive experience in all the areas of landslide risk mitigation practice, as well in developing rainfall prediction models to predict landslide initiation & EW as a better prepardness measure. The transfer of such knowledge can be maximized if agencies such as NBRO can develop close technical collaboration with NGI & ADPC for provid ing the technical expertise. It will not only help to transfer state of the art of landslide risk management and control but also it is useful in demonstrating the cost effectiveness of the risk management practices.

Therefore, NGI has initiated a bi-lateral program for technical cooperation with the financial support of the Royal Norwegian Embassy in Sri Lanka to provide trainng and capacity building suppor to professional staff attached to NBRO, while continue to provide resource inputs to the RECLAIM platform. Both agencies actively participate in RECLAIM events and continue to have interaction with RECLAIM partners at Regional level. The theoretical and prac tical knowledge gained through the NGI and NBRO colloboration provided very useful inputs to RECLAIM program implementation. They have provided good case studies on various aspects of landslide risk minimization such as landslide EW, Instrumentation, landslide hazard modeling & mapping, strutural mitigation etc. In RECLAIM regional meetings more value has been added by sharing the practical experiences gained in implemention of the bi-lateral program between NGI and NBRO. The experience has been systematically documented and shared with other country partners during regional networking events organized by ADPC under the RECLAIM Regional platform.

Field demonstration of mapping techniques during the field visit

Donation of a Super Computer to NBRO for 3D Data Analysis on 29 August 2016

The NGI specialist team brought an Analyzing Computer for data analysis and 3D mapping to NBRO. This computer is a special technical equipment with very fast processing abilities. NBRO arranged a handing over ceremony to receive this valuable equipment, where the NGI team ceremonially handed over the technical equipment to NBRO.

A tailor made high speed computing machine was handed over to the Minister of Disaster Management. This will be used by the NBRO in Colombo to analyze vast amount of data being collected from various landslide prone areas in Sri Lanka. The high speed computing machine will create quick and efficient three dimensional models of a mapped site in an accurate manner in a Geographical Information System (GIS) platform.

Handing over ceremony of the Super computer to Hon. Anura Priyadarshana Yapa, Minister of the Ministry of Disaster Management by Knut Nyfløt, Charge de affairs of Royal Norwegian Embassy, Colombo.

Field Investigation and Action Plan of the Oil Contamination in the Chunnakam Area, Jaffna Peninsula, Sri Lanka

Isuri Weerasinghe
National Building Research Organisation

There has been increasing concern regarding possible oil contamination of the groundwater aquifer over the past several years in the Chunnakam area on the Jaffna Peninsula. It was identified that the suspected source of the contamination is a power plant. Local experts have been working on this issue for some time and several groundwater samples were analysed.

NGI was invited by NBRO to visit Jaffna with local experts and to carry out a field survey to obtain a comprehensive overview of the area and the issues. The goal of this visit was to localize potential sources of contaminants, gather available information, assess previous studies carried out and propose a plan for further action and possible remediation of the water wells. The NGI team visited Sri Lanka from the 26th of May to the 1st of June 2015. The visit was carried out under the on-going NBRO – NGI technical cooperation, supported by the Royal Norwegian Embassy in Colombo.

As per the technical report issued by NGI on field investigation and recommended action plan in the Chunnakam area, there were three suspected source areas identified as possible oil contamination from the power plants: Oil tanks at the abandoned CEB (Ceylon Electricity Board) power plant, Area named "oil pool" by local population, located where a new power grid was built in 2012, and Area north of Northern power plant where surface contamination was identified in 2012.

NGI visited these areas and inspected the power plants and surrounding groundwater wells which were reported to be contaminated. A thin calcareous layer was observed on the surface of the water that could be misinterpreted as oil contamination. Chemical analyses and field observations (including qualitative sampling) did not reveal any severe oil contamination of the wells that were inspected. There was no indication of recent oil spill during the brief field visit. However, small oily remnants and information from locals and satellite photos indicate that contamination might have occurred until 2012.

According to the report, NGI recommended the following action plan:

- Use of polypropylene absorbents to confirm over a longer time period whether there is oil in the wells in the area or not.
- Soil sampling and chemical analysis to identify potential sources.
- If soil sampling shows serious levels of contamination, further action is recommended:
  - Infiltration tests to understand transport of contaminants from the surface.
  - ERT (electrical resistivity tomography) study to locate caverns.
  - Drilling and installation of groundwater wells. The results will then be used to decide whether remedial measures are required and which remediation techniques are suitable: Soil: Excavation and deposition at waste disposal site is recommended.
  - Groundwater: Pump and treat with oil separators or natural degradation are recommended at this stage.

Even though the reported oil contamination was not observed during the preliminary field investigations, there are other and more significant threats to the groundwater quality in the Chunnakam area, especially high concentration of pesticides, nitrates, bacteria in addition to saltwater intrusion from the sea. NGI recommended that a general assessment of the water quality in the whole Chunnakam area (and not only around the power plants) should be conducted, and that adequate measures need to be taken to protect the local population from consuming polluted water.

NBRO - NGI Technical Collaboration 2016-2018

Dayan Munasinghe
National Building Research Organisation

Technical Cooperation between NBRO and NGI was extended for 2 years.

Main objectives of the programme extension are:

- Training NBRO officers in newer technologies for landslide risk reduction
- Strengthen the Disaster Risk Management Sector through remote sensing techniques

The following activities will be implemented in this period in order to acheive above objectives:

1. Assessment using Ground Penetrating Radar
2. Risk assessment using Image Processing
3. Development of Early Warning Systems

Assessment using Ground Penetrating Radar (GPR)

The main three components planned under this activity are:

1) Result verification of ground subsidence and building survey in Matale:

Ground subsidence map of Matale was developed under Phase I of the Hands-on Technical Cooperation project with NGI. This map will be handed over to relevant technical institutes to facilitate developing proper land use management plans thus avoiding future ground subsidence risks in Matale. Building surveys will be carried out in identified subsidence zones; remedial measures will be developed, and local community will be trained to monitor the hazards. New collaboration on this aspect is considered.

2) Borehole Survey

Borehole surveys will be conducted using the GPR equipment. NGI will fabricate new borehole antennas for NBRO and those will be used in scanning with GPR.

3) Dam Leakage Survey

GPR equipment can be effectively used to find weak points in an earthen dam. It is threfore, planned to conduct GPR surveys on existing earthen dams in the country and provide recommendations to relevant stakeholder institutions.

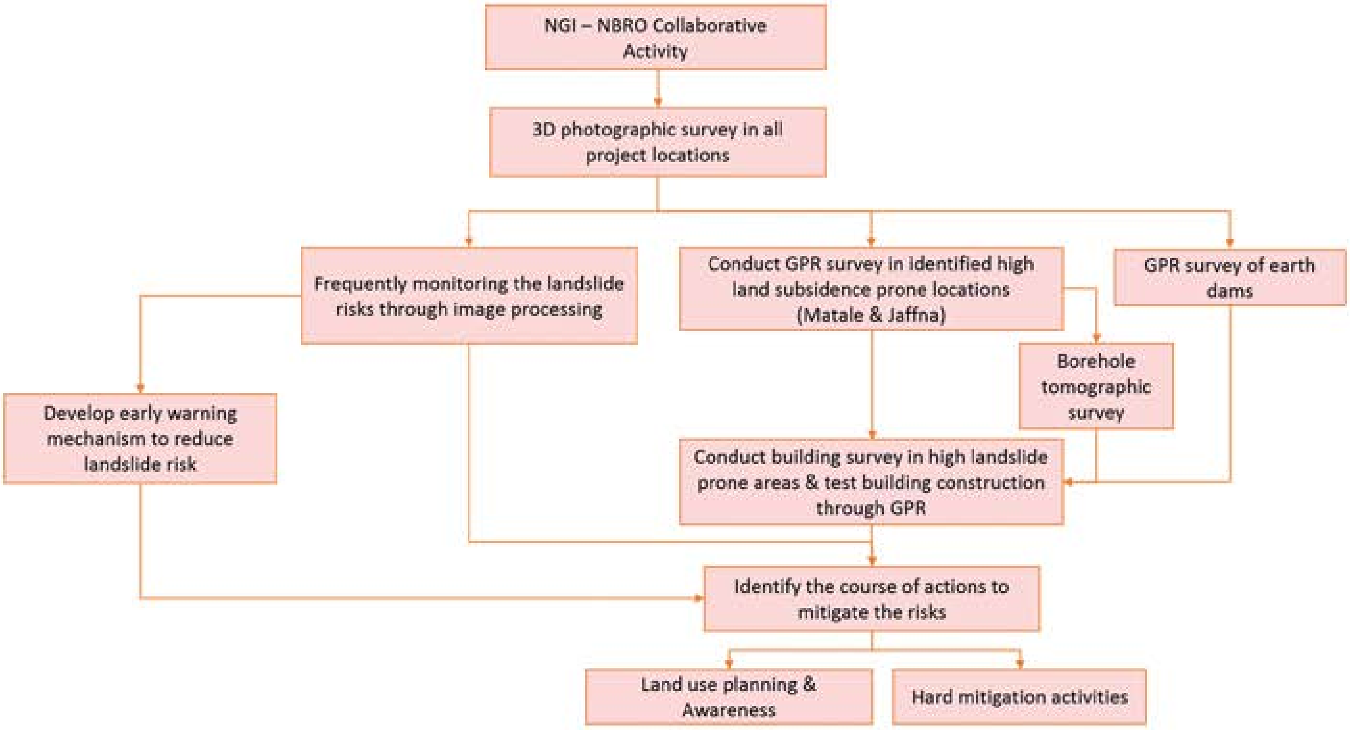
Risk Assessment using Image Processing

Remote sensing and image processing are emerging fields of interest in the disaster management sector.These techniques permit expediting tasks such as damage assessment, impact assessment of settlements, and development of digital elevation models (DEM) within a short time period and permit investigation of inaccessible areas through image processing. They further facilitate area calculation of different land uses in a short time and help making sound decisions in the development of land use plans. In this context, the present risk mapping programme in landslide prone areas will be reviewed and modified to conform to relevant international standards and practices. NBRO will develop the risk mapping methodology initially and it will be reviewed by NGI experts.

Development of Early warning Systems

In Phase I, NGI donated to NBRO eight automated rain gauges which have multi data logging capacity. NBRO uses a network 150 automated rain gauges installed in strategic locations in central highlands for landslide early warning. Data from the network will be analysed and developed into specific data formats for easy issuing of early warnings. The risk assessment outputs will be used to enhance the early warning mechanism.

The comprehensive methodology of activities can be described by the following figure.



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