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Asian Program for Regional Capacity Enhancement for
Landslide Impact Mitigation (RECLAIM)

Proceedings

Regional Meeting for Discussion and Promotion of Early Warning Mechanisms for Landslides in Asian Region (RECLAIM- III)

organized by

Asian Disaster Preparedness Center (ADPC)

in collaboration with

Norwegian Geotechnical Institute (NGI)

25 - 27 November 2009

1.0 Background

Asian Disaster Preparedness Center (ADPC) in collaboration with Norwegian Geo-technical Institute (NGI) has developed the Asian Program for Regional Capacity Enhancement for Landslide Impact Mitigation (RECLAIM) 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. RECLAIM is being implemented with the funding support from Royal Norwegian Ministry of Foreign Affairs over a period of four (4) years since 2004 with the aims to build the national capacity on landslide disaster mitigation by:

- Identifying cost effective methodologies and practices adopted by national partners
- Execution of Landslide Mitigation Demonstration Projects, (LMDPs) in several countries as a source of committing efforts and partly funds for applied mitigation, advocacy and awareness creation purposes.
- Through sharing of experience of partner agencies in target countries in Asia.

Phase I & II of the project was implemented in seven target countries namely; Bhutan, India, Indonesia, Nepal, the Philippines, Thailand and Sri Lanka. In this 3rd Phase of the program three new countries have been added namely Bangladesh, People's Republic of China and Vietnam to execute the project.

Phase III of the project, which was started in autumn 2009, focuses on the use of early warning systems for landslide prone areas, which have advanced fairly rapidly over the last years. The project will be implemented through gathering of data from existing approaches and through formation of joint working groups to identify critical factors for landslide initiation and disseminate knowledge to participating countries.

2.0 Objectives of the First Regional Meeting

- To share country experience on setting up different early warning systems for landslide risk reduction
- To discuss factors considered in establishing the mechanisms of landslide occurrence in partner countries
- Share the different mechanisms in monitoring of landslides and discuss approaches for predicting the behavior of landslides
- To discuss about the different landslide early warning systems and institutional set up existing in partner countries
- Form working groups to carry out program activities and develop action plans

(Refer **Annex I** for the Agenda of the Workshop)

3.0 Proceedings of the Third Regional Training Workshop

3.1 Inaugural Function

Opening session was started with the welcome speech by Dr. Oddvar Kjekstad, Advisor to the Norwegian Ministry of Foreign Affairs by welcoming RECLAIM partners to the first regional meeting under the phase III of the program. He gave a briefing about the program and the purpose of this regional meeting. Mr. N.M.S.I. Arambepola, Director, Urban Disaster Risk Management Team of ADPC has presented the objectives of the whole RECLAIM program and the achievements under Phase I & II during last 5 years.

He has also presented the activities carried out under phase I & II such as knowledge sharing on landslide risk management, learning from historical cases from partner countries, identify good practices, conduct national level training, implement landslide mitigation demonstration projects in selected countries, etc. Dr. Rajinder Bhasin, NGI followed Mr. Arambepola to explain the goals and objectives of the RECLAIM Phase III which is on promoting best practices for Early Warning of landslides in a changing climate scenario. He emphasized the need of forming joint working groups comprising of technical partners and participants from partner countries who will be working towards achieving project objectives. He also presented the concept of landslide early warning including factors considered in establishing landslide EWS in different countries.

Day - 1 (25th November 2009)

Country experience on status of setting up EWS for landslide risk reduction

The sessions began with sharing of country experiences on status of setting up EWS for landslide risk reduction. The presentations were based on the scale of operation (national, provincial & local), mechanism to collect data, way of getting rainfall data, how EWS operates and the challenges faced by each country with related to EWS for landslides.

It was noticed that most of the countries either do not have a proper EWS or at the initial stage of setting up of EWS for landslides at the moment. China is having a well established national wide early warning system which uses real time monitoring mechanisms to predict landslides. However all the partner countries were shown the importance of having a EWS for landslide risk reduction.

The summary of the status of EWS in each country is attached in **Annex II**.

Discussion on factors which are considered important in establishing the mechanisms of landslide occurrence in partner countries

An introductory presentation on factors and mechanisms of landslides was made by Dr. Rajinder Bhasin from NGI discussing:

- Ground conditions: rock, debris, earth
- Geomorphological Processes: tectonic uplift, fluvial erosion, deposition loading of slope, vegetation removal by erosion etc.
- Physical Processes: rainfall, earthquake, freeze and thaw,
- Man-Made: excavation at toe, deforestation etc.

He also shared the experience of using high tech instrumentation and monitoring of a large landslide in Norway.

Group Work 1:

The participants were divided in to two groups (Group 1- Bangladesh, Bhutan, Nepal, China & Group 2 – Indonesia, Philippines, Thailand, Vietnam, Sri Lanka) and asked to identify the mechanisms of landslides as per the following table.

Country	Type of landslide	Geotech material / formation	How data is obtained	Typical rainfall intensity	Geotech response to rainfall	Laboratory measurements	Field measurement

Detail table is attached in **Annex III**

Mapping and monitoring of landslides with the use of LIDAR has been presented with examples from Norway & Bhutan. The LIDAR uses laser source and detector to calculate the XYZ coordinates of the surface. This can be used in base map preparation for landslides, to measure displacement in landslides, flood plain mapping, natural resource management, etc. LIDAR survey helps to provide accurate results within very short time. However the cost of the instrument and the weight of the instrument are some barriers to use it widely as a method of mapping and monitoring of landslides.

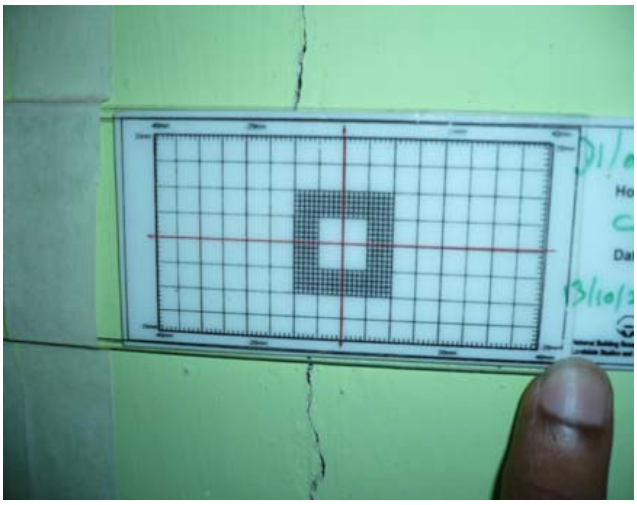
Day – 2 (26th November 2009)

Monitoring of landslides

Mr. R.M.S. Bandara from Sri Lanka presented the approaches for Monitoring landslide movement which are practiced in Sri Lanka. These includes scientific methods such as Extensometers, GPS, magnetic survey, inclinometers as well as community level practices such as Wooden pegs, crack

gauges, analyze using tilted trees, electric fence, etc.

Further he presented a locally developed crack monitoring gauge, a device which can be easy to use and is cost effective.



The crack-gauge developed by National Building Research Organization (NBRO), Sri Lanka has been used as the monitoring device in some studies and has confirmed its reliability for measuring in-plane displacements in severe conditions of landslide movements.

Group Work 2:

Based on the existing soil types in partner countries, the participants were divided in to 3 groups:

Group 1 – Colluvial,

Group 2 - Weathered metamorphic/sedimentary

Group 3 – volcanic

Each group was asked to identify the approach for predicting the behaviour of landslides in their respective countries as per the following table.

Country	Characteristic of formation	What are the visual Observation of the slope	What are scientific method can be used to monitor the slope movement	Proposed any innovative method and community level practices

Detail tables are attached in **Annex IV**.

Nepal & Bhutan categorized the soil type on landslide surfaces as both Colluviam & Weathered metamorphic/sedimentary where as other countries categorized their soil in to one of the above types.

Early Warning of Landslides

Mr. Atiq Kanin Ahmed, technical expert, ADPC made a presentation on "Institutional Arrangements and Setups for various types of Early Warning". In his presentation, he deliberated on approaches for Risk knowledge and monitoring, dissemination and response capacity. He supplemented the concept of early warning systems with national and regional case studies. The state of art practices in partner countries viz., Bangladesh, Sri Lanka and Vietnam were discussed in details. The administrative system, technology, dissemination, Pros & cons and challenges in implementation of EWS were shared by the participants during his session.

Mr. Tinnakorn Tatong, Department of Mines and Geology, Thailand presented "Community – Based Landslide Watch Networks in Thailand". The presentation included landslide hazard situation of Thailand, components of Community-Based Landslide Watch Networks, awareness activities related to landslide warning, organization structure of EWS, functions, roles and responsibilities of Geohazard Operation Center. The presentation illustrated various aspects of early warning systems for landslide. The session was followed by questions and answers.

Day - 3 (27th November 2009)

Group Work 3:

Day 3 was started with a group work on identifying institutional setup for Early Warning in each partner country particularly on the following areas:

- *What are the source agencies for landslide early warning in partner countries*
- *How is the Institutional set-up for early warning dissemination in partner countries; whether it is a local or central set-up, or a combination*
- *Information about the community participation including local stakeholders such as village community, schools and local police*
- *Role of participating agencies in relation to landslide early warning*
- *What are the challenges in dissemination of EW messages*
- *How to improve the existing mechanisms for EW*

Participants presented the institutional set up for EW system in their respective country and it appeared that most of the countries do not have a proper set up for EW with related to landslides where as some are currently practicing to some extent.

Details of Institutional set up for Landslide EW for each country is attached in **Annex V**.

RECLAIM III way forward….

Mr. Arambepola has presented the approach for implementation of RECLAIM III project activities in the coming years. It has been proposed to form two working groups comprising of partner countries with a chair person to coordinate respective group activities.

- **Group 1 - Recommending threshold values for Early warning System for Landslides**
  Member countries - Bhutan, China,, Indonesia, India, Sri Lanka, ADPC, NGI
  Chair person/Coordinator – Dr. Udeni Nawagamuwa, Sri Lanka

- **Group 2 - Collection,compilation and recommendation for landslide early warning approaches**
  Member countries - Bangladesh, Nepal, Pakistan, Philippines, Vietnam, Thailand, ADPC, NGI
  Chair person/Coordinator – Dr. Elmer B. Billedo, Philippines

Each working group has prepared their Terms of Reference (TOR) together with time line for execution of project activities (Details TOR for both groups is attached in **Annex VI**). The agreed main time line for 1st working group meeting was in the first half of 2010 and the 2nd Regional Meeting is in Autumn 2010.

4. Recommendations from the workshop

- Develop Memorandum of Understandings (MOU) with partner country institutions
- Provide opportunity for partners to learn from each other by arranging field visits to member countries
- Create electronic discussion forum to share experiences and concerns among RECLAIM III partners
- Consider the existing RECLAIM partner network as the regional platform for Landslide risk reduction

5. Snapshots of the workshop

Regional Meeting for Discussion and Promotion of Early Warning Mechanisms for Landslides in Asian Region (RECLAIM- III)

25-27 November 2009, Bangkok, Thailand

PROGRAM

25th Wednesday - Day 1	
8.30 - 9.00	Registration of participants
9.00 - 10.00	Inaugural session • Welcome Speech by Dr.Oddvar - NGI • RECLAIM – Program achievements under phase I and II by N.M.S.I.Arambepola – ADPC • Short introduction of participants
10.00 - 10.30	*Coffee/tea break*
10.30-10.45	Speech by Dr. Bhibhit Ratakul, Executive Director, ADPC
10.45-12.30	**Presentations of Country experience on status of setting up EWS for landslide risk reduction** - (10 minutes for each country) *The presentations will be based on the following (no need for power point presentations)* • *In what scale do you operate (national, Regional, Provincial, local)* • *What mechanisms you use to collect data* • *How do you get rainfall data for your studies* • *How EWS operates at various levels*

	• *What are the challenges*
12.30 - 13.30	*Lunch*
13.30 - 15.00	**Discussion on factors considered in establishing the Mechanisms of landslide occurrence in partner countries** Introductory presentation by Dr. Rajendra Bhasin, NGI • *What type of geotechnical materials exist in the most vulnerable slopes (hotspot areas) in each of the participating countries?* • *How do you obtain such data (what methodology is used)* • *What are the typical rainfall intensities in these vulnerable regions, e.g 10 mm/hour, or 100mm/day etc, meteorological data* • *What has been the observed geotechnical response in the slope to rainfall?* • *Is it creep, fast moving or sudden failure? Any type of laboratory or field measurements used in defining the geotechnical properties of the materials associated with such failure*
15.00 - 15.30	*Coffee/tea break*
15.30 - 17.00	Continuation of the discussion
26th Thursday – Day 2	
9.00 - 10.30	**Monitoring of landslides - Approach for predicting the behavior of slopes** Introduction to approaches for Monitoring landslide movement by Mr. Bandara/Dr. Nawagomuwa, Sri Lanka • *Rainfall (rain gauge data) –) What is the most optimum way for plotting the rainfall data(7 day, 5 day, 3 day)* • *Visual observations (movement of landslide)- what are the methods use* • *Innovative methods of monitoring the slope movement at local level*

	• *What experience partners have in observing the movement of slopes*
10.00 - 10.30	*Coffee/tea break*
10.30 - 12.30	**Discussion on Monitoring of landslides - Approach for predicting the behavior of landslides** • *continue the discussions on Monitoring of movement* • *Groundwater data obtained from pressure sensors (pore water pressure)* • *Monitoring of movement using data from displacement sensors (extensometer, inclinometers)* • *Ground vibration measurements obtained from geophones* • *Total station (GPS technology)*
12.30 - 13.30	*Lunch*
13.30 - 15.30	**Early warning of landslides** Presentation on setting up community level landslide EWS- Department of Mineral Resource (DMR), Thailand • *Experience in implementation and operation of a landslide early warning system* • *How data gathering can be done in target countries for developing a rainfall-landslide relations* • *Organization set-up for early warning system* a) *Monitoring and predicting* b) *Communicating alerts* c) *Response plans*
15.30 - 16.00	*Coffee/tea break*
16.00 - 17.00	**Continue discussion on Institutional set-up for early warning** Introductory presentation on Institutional set-up for early warning – ADPC facilitated

	regional early warning center. Early warning systems commonly consist of the following elements d) Monitoring and predicting e) Communicating alerts f) Response plans How the early warnings are being disseminated to the target users • *What are the source agencies for landslide early warning in partner countries* • *How is the Institutional set-up for early warning dissemination in partner countries; whether it is a local or central set-up, or a combination* • *Information about the community participation including local stakeholders such as village community, schools and local police* • *Role of participating agencies in relation to landslide early warning* • *What are the challenges in dissemination of EW messages* • *How to improve the existing mechanisms for EW*
27th Friday – Day 3	
9.00 - 10. 30	**Presentations on Goals and Objectives of RECLAIM III** by Dr. Oddvar/Mr. Arambepola • *Discussion on approach for implementation of RECLAIM III activities in countries.* • *What technical assistance will be needed?* • *How to record good practices*
10.30 - 11.00	*Coffee/tea break*
11.00 - 12. 30	Formation of working groups and identification of roles, Identification of Thematic areas

12.30 - 13.30	*Lunch*
13.30 - 15.30	Identification of program activities and developing an Action plan for next year. Discussion on the organization of next regional training (When are we ready? Where? What topics to cover?)
15.30 - 16.00	*Coffee/tea break*
16.00 - 17.00	**Concluding session**
17:00	Depart for a farewell boat dinner

Annex II

Status of EWS in partner countries

Country	Scale of operation	Mechanism to collect data	Way of getting rainfall data	How EWS operates	Challenges
Bangladesh	local	Geotechnical survey	Through rain gauges	Local authority with community (not well organized)	Less attention Less coordination among stakeholders
Bhutan	Not available				
China	National, Provincial & Local	Real-time monitoring (RTM)	China Meteorological Administration (CMA)	CMA provides the rainfall data to Ministry of Land Resources (MLR), and then MLR issue the nation-wide prediction on China Central Television	
Indonesia	National, regional & local	Field observation and monitoring	Meteorology, Climatology and Geophisics Body	Provide Landslide Assessment Potential Map and its recommendation to National Disaster Management Agency and Local Government by mail or through website	Less intensive of hazard education Less awareness of community
Nepal	Not available				
Philippines	National & Regional	Field geological assessment & community interviews	Local weather station (PAGASA)	Bottom to top approach (Barangay → Municipal → Provintial → Regional → National)	To adopt new techniques and formulate effective EWS

Sri Lanka	National	Field observation & monitoring	Through rain gauges	-technical organization issues the technical warning to DMC - DMC issues dissemination warning to relavent district secretaries - DS/DDMU to Div Secretary - Div secretary to GN & GN to community	Un availability of appropriate data, systematic coordination, technical failures
Thailand	Local & National	Field observation & monitoring	Through rain gauges	Through community participation to the local people and through national media at national level	
Vietnam	national	Through government agencies		Monitoring & prediction by technical institutions, alert by center commitee for flood & storm control	

Annex III

Mechanisms of Landslides

Country	Type of landslide	Geotech. Material/ formations	How data is obtained	Typical Rainfall intensities	Geotech. Response to rainfall	Laboratory measurements	Field measurements	Remarks
Bangladesh	*Debris flow *Translational slide *Rotational slide	*Tertiary rocks *Highly weathered sandstone *Jointed sandstone/ shale *Fragile shale	*Event based field survey and lab testing	*Yearly rainfall ranges between 1000-1500mm *Maximum 24 hours recorded rainfall is 425 mm	*Increase Pore Water Pressure *Development of tensional cracks *Expansion of joints	*Grain size *Shear strength *Angle of internal friction *Cohesion *Rock strength	*Rock types *Degree of weathering * Degree and density of discontinuities *Types and geometry of landslides *Vegetation cover *Human intervention	
Bhutan	Rotational/Translational/Debris Flow	Highly Fractured and fragile Carb Phyllite and Talcose Phyllite	Event based field survey and Lab Testing	250mm/hr for three hours in a day (Period from June to October)	Increase in Pore water pressure. Development of tensional cracks (Expansion of joints	Grain size analysis, Shear strength, Angle of friction and cohesion	Measurement of strike and of the rock formation, measurement of slope angle, slope direction, measurement of different sets of joints, joint spacing, ground water level, etc	

Country	Type of landslide	Geotech. Material/ formations	How data is obtained	Typical Rainfall intensities	Geotech. Response to rainfall	Laboratory measurements	Field measurements	Remarks
China	Rotation landslide	Hilly fractured shift limestone, sandstone	Field survey; rainfall gage; ridar	160 mm/day	Soften; Seapage	uu shear test; Circle shear test	Displacement Cracks	Rotation landslide
	Translational landslide	Medium hill; Fractured sandstone	Field survey; rainfall gage; ridar	200mm/day	Soften Pore water pressure Pushing	Shear test	Displacement Underground Water level; Pore pressure	Translational landslide
	Loess slump	Medium hill loess	Field survey; rainfall gage; ridar	30 mm/day	Soften Collapse	Shear test; Collapse test	DTM; Cracks Displacement; Moisture	Loess slump
	Debris flow	hilly deposit valley	Field survey; rainfall gage; ridar	200mm/day	Fragile	Grain size test	Flow velocity; Flow amount; Ground sound	Debris flow
	Shallow slide	Deposit; Soil Terrain	Field survey; rainfall gage; ridar	250mm/day	Pore water pressure; Soften; Seapage	Collapse test; Shear test; Plastic test; Grain test; Clay content; DTM	Saturated degree; Seapage velocity Pore water pressure	Shallow slide

Country	Type of landslide	Geotech. Material/ formations	How data is obtained	Typical Rainfall intensities	Geotech. Response to rainfall	Laboratory measurements	Field measurements	Remarks
Nepal	Rotational, Translational Topples, Debris flow	Deeply weathered/ Fractured rock and colluvial soil	Field observation with Geotechnical investigation	446mm in 24 hrs	Rise in pore pressure due to high intensity of rainfall	Grain size analysis and plasticity index,	Smith hammer test, discontinuity measurement	Age, slope condition, aspect, terrain, active tectonic activity
Philippines	Debris flow/earth flow, generally rotational slide	Highly weathered volcano-sedimentary rock sequences	Field geological assessment/ rainfall data from local weather bureau	300-400mm	Saturation+ fractured rock+ thick soil cover--failure	none	GPS located site/Strike+dip of fracture planes, direction of slide, volume of material, surface area affected by landslide	
Vietnam	Rotational landslide (slump), debris flow, rock fall	Weathered rock, residual soil, steep slope,	Field survey, remote sensing data, literature, previous studies	30-70mm/day (in 3-7 days) during rainy season	Mass movement	No	Deformation, volume of mass movement, Strike, dip, slope angle, intensity of joint, depth of overburden, water table, SPT values	
Sri Lanka	Debris flow, Rock fall/flows, creep, Slump-rotational, Cutting failure	Metamorphic weathered, soil, residual -- collovium	Visual observation, field test/lab test	75/24 hours	Tension cracks, Pore water increase, Water color changes, Bulging at toe	C′, ⌀, ⌀, soil classification, moisture content	Strike, dip, slope angle, intensity of joint, depth of overburden, water table, SPT values	

Country	Type of landslide	Geotech. Material/ formations	How data is obtained	Typical Rainfall intensities	Geotech. Response to rainfall	Laboratory measurements	Field measurements	Remarks
Indonesia	Rock fall	volcanic breccias	Visual and field observation, analysis of remote sensing data	No rainfall	-	Rock mechanic & physical properties	slope angle, Thickness, volume, area affected	
	creep	Clay & sand layers overlapping	Visual and field observation, analysis of remote sensing data	Over 209 mm/day	Over saturated caused decrease cohesion	Soil/rock mechanic & physical properties	Dip, slope angle, Thickness, volume, area affected	
	curved sliding	tuff	Visual and field observation, analysis of remote sensing data	Over 338.9 mm/day	Over saturated caused decrease cohesion	Soil/rock mechanic & physical properties	Dip, slope angle, Thickness, volume, area affected	
	Curved sliding & mudflow	Tuff	Visual and field observation, analysis of remote sensing data	54 mm/day for 3 days	Over saturated caused decrease cohesion	Soil/rock mechanic & physical properties	slope angle, Thickness, volume, area affected	
Thailand	Debris flow, rock fall	Granitic rock, sedimentary rock	Field survey: geological data, weather & climate data,	North, northeast, central: 1000-1500mm/y(May-Sept.)	Soil from sedimentary rock 330mm/2days ,	Soil engineering properties, rock mechanic	Drilling log, geophysics method (resistivity, seismology)	

			hydro, social and disaster data	South:2000-3000mm/y (June-Dec.)	Soil from granitic rock 1000mm/5days, 162mm/day, 110mm/day Soil from sedimentary rock 164 mm/day, 463mm/day	slope stability analyses		

Annex IV

Approaches for Monitoring Landslides

Group 1 - Colluvium Soil Type

Country	**Characteristic of formation**	**What are the visual Observation of the slope**	**What are scientific method can be used to monitor the slope movement**	**Proposed any innovative method and community level practices**
Bhutan	Colluviam	Sign of Slow movement in the Slope (Creep in the Slope) Tension Cracks Presence of cracks at the crown of the slope. Slope angle more than the sustainable angle of repose of the weathered materials.	Have appropriate means to measure the scale of movement and rate of movement. Monitor the visible cracks by constant measurements.	Install inclinometer at the landslide area. Install piezometer to check the ground water level. Monitor the cracks.
Nepal	Gravity deposit (up to 10m thick) consisting of rock fragments of near by country rocks such as granite, gneiss, schists, phyllites, slates, carbonates, sandstones, mudstones, shale	Tension cracks, sagponds, effect on trees, man made structures	extensometer, piezometer, rain gauges, GPS, LiDAR,	Pegs, crack scales, natural sprins, tilting of trees
Sri Lanka	Metamorpic weathered soil and rock boulders transported along the slope and deposited in the middle of the slope, poorly sorted/graded boulders and soil mixture	Tension cracks. Tilted tress/posts, bulging, muddy springs, subsidence	Extensometers, GPS, magnetic survey, inclinometers, piezometers, remote sensing	Wodden pegs, crack gauges, analyse using tilted trees, electric fence

Country	Characteristic of formation	What are the visual Observation of the slope	What are scientific method can be used to monitor the slope movement	Proposed any innovative method and community level practices
China	20-32o deposit, rock poorly sorted/graded boulders and soil mixture 10-30 m thick Rotation slide	Tension cracks. Tilted tress/posts, bulging, muddy springs, subsidence Pools and depression	Extensometers, GPS, magnetic survey, inclinometers, piezometers, remote sensing Total station	Ground sound Laser scanner
Vietnam	Thick layer of weathering crust, soft water-absorbed, breakable, cataclastic soil Weak resistance and cohesion of soils	Crack Slope angle > 15 Form of detrital cone Changes in position/direction… of materialson slope (trees, grass, telephone pole, fence,…)	Soilmoisture tube Automatic rain gauging station Extensometer, inclinometer Geophones GPS technology Pore water pressure.	Use of pegs Tilting tree

Group 2 - Weathered metamorphic/sedimentary Soil Type

Country	Characteristic of formation	What are the visual Observation of the slope	What are scientific method can be used to monitor the slope movement	Proposed any innovative method and community level practices
Bangladesh	Weathered/Jointed/fragile sandstone, siltstone and shale	Tensional/crown cracks Seepages/springs, reactive of old seepages/springs Movement of trees/fence/telephone or electric poles Change in slope morphology/bulging of slope Change in joints pacing	Extensometers, wooden pegs Clinometers Soil moisture measurement	Pore water pressure / groundwater table measurement Pressure plates
Bhutan	Weathered metamorphic/sedimentary Sequence	Sign of Slow movement in the Slope (Creep in the Slope) Tension Cracks Presence of cracks at the crown of the slope. Slope angle more than the sustainable angle of repose of the weathered materials.	Have appropriate means to measure the scale of movement and rate of movement. Monitor the visible cracks by constant measurements.	Install inclinometer at the landslide area. Install piezometer to check the ground water level. Monitor the cracks.
Thailand	Weathered rock granitic and sedimentary rock Shallow to thick residual soil Sandy clay …..Clayey	Rock/soil cracks, inclined trees, building crack	Extensometer, wooden pegs	Soil moisture meter, simple monitoring, installing wooden pegs

Country	Characteristic of formation	What are the visual Observation of the slope	What are scientific method can be used to monitor the slope movement	Proposed any innovative method and community level practices
	sand			
Nepal	Deeply weathered metamorphic rocks such as gneiss, schist, phyllites, slates mudstone, shale, sandstone, on steep slopes	Joint spacing, filling, opening, tension cracks, physical features such as trees, man made structures, orientation bedrocks and slope, nature of springs, landuse	extensometer, piezometer, rain gauges, GPS, LiDAR,	Pegs, crack scales, natural sprins, tilting of trees

Group 3 - Volcanic Soil Type

Country	**Characteristic of formation**	**What are the visual Observation of the slope**	**What are scientific method can be used to monitor the slope movement**	**Proposed any innovative method and community level practices**
Philippines	Alternating sequence of tuffaceous sandstone, siltstone and mudstone - generally horizontally layered and / or slightly tilted - cut by numerous subvertical fractures and joints Volcanic breccia and agglomerates - massive - layered - cut by numerous subvertical fractures and joints	In most cases, slopes greater than 45 degrees fail upon saturation Most of the landslide areas are partly vegetated by secondary growth trees Some have heavy load on top while some are disturbed at the foot of the slope Presence of waterways, normally negligible before the landslide event	CREEP - inclinometer - piezometer - Repeated GPS measurements of permanent markers located strategically on slopes FLOW - automated rain gauge SUDDEN/FAST - detailed geological mapping of steep slopes and riverways particularly on highly urbanized areas - digital/analogical modelling ROCK FALL - Engineered barring	Planting of fast growing and deep rooted trees (preferably those with large leaves) Continuing Information, Education and Awareness Campaign up to the grassroots level Training for EWS including capacitating and accreditation of the involved community

Country	Characteristic of formation	What are the visual Observation of the slope	What are scientific method can be used to monitor the slope movement	Proposed any innovative method and community level practices
			down of imminent rock fall	
Indonesia	Variation in lithology, permeability and cohesion. - loose material cause low cohesion - Direct overlapping of permeable and impermeable layers - Vulnerable to vibration	- Change in morphological condition (tilting, subsidence, steps feature) - Cracking of infrastructure building, i.e. bridge, road, drain channel, etc. - Titling of trees - Oozing and drying of spring	- Measurement of weathered rock or soil thickness - Mapping of crack zonation - Measurement of movement using GPS for certain period, i.e. every 7 days. - Extensometer connected to siren - Periodically material sampling for laboratory analysis	- Training of landslide hazard - Evacuation drill - Sharing amongst group within communities - contingency plan - Giving guidance in field observation
Norway	Mainly competent and incompetent rocks Metamorphic formations including gneiss, shales and schistose rocks	- Expansion of existing joints, - formation of new joints, subsidence, - water leakages	Monitoring systems on slope surface and subsurface include: Permanent GPS network Total station Ground-based radar with reflectors Five surface rod	-

Country	Characteristic of formation	What are the visual Observation of the slope	What are scientific method can be used to monitor the slope movement	Proposed any innovative method and community level practices
			extensometers Surface crackmeters Surface tiltmeters Single lasers measuring distance devices across tension cracks Geophones: micro-seismic network Climate station Piezometers, inclinometers LIDAR survey SAR interfrometry	

Annex V

Institutional set up for Early Warning

Country	Source agency	Institutional set up(local or central)	Stakeholders	Role of agencies	Challenges in dissemination	Recommendation to improve EW
Bangladesh	DMB & city development authorities	No formal set up	Community & local police	-Alert the people - evacuation to temporary shelters - Provide food and other facilities	-no proper institutional set up -only works in city areas -coordination among agencies	- Develop awareness among the local people -coordination among institutions - research on landslides and real time LEW system
Bhutan	Flood warning division of Hydrology & Meteorology Department	central	Community & district administration	Educate people	Risk villages are scattered and located in remote areas. So reaching the site is a challenge	Should start the EWS as a centralized system
China	Geological survey, meteorological agency, civil administration, local government, some special institution (big engineering project)	Combination of local & central	Local government, schools	Special person for each role	Precision and accuracy, awareness for the population	Invest more budget
Indonesia	National Disaster Management Agency, Geological Agency,	Combination of local & central	Community, school students, government	Source data Dissemination of	Supporting regulations Less early age	-prepare guideline of landslide risk map & understand geological

	Public Work, Meteorology,Climatology and Geophysic Body		agencies, NGOs	information Contingency plan Evacuation drill	education related to hazard Less awareness of community in hazard mitigation Cultural background and education Accessibility of area affected -- communication	information of hazard maps -coordination among institutions -increase capacity of govt officials & community members -involvement of media
Nepal	No specific agency	No set up	Community on adhoc basis		Lack of creating awareness for EWS among the people Lack of proper communication system in remote areas	Preparation of guidelines for EWS Establishment of Institutional set-up Preparation of LHZ Map Development of Information dissemination system among partner countries Sourcing of fund
Philippines	PAGASA	Central	Community, government institutions	Awareness campaign, mapping of risk areas, evacuate	Establishment of a scientific-based landslide prediction	Conduct more Information, Education Campaign

					and the formulation of an effective EWS - Proper land-use zoning -Political will	
Sri Lanka	NBRO & Dept of Meteorology	combination	Community, local government officials	-analysis of data gathered through communities -proper dissemination of warnings	-technical failures during a heavy rainfall -systematic coordination is lacking/to be improved - not available of the correct and appropriate data in the correct time	-SOP must be regularized. -responsibilities should be properly defined -early warning channel should be followed as defined, no SHORT CUTS -Availability of proper equipment and techniques -Maintenance of equipment -regularize the training and awareness programmes such as drills

						-technology should be simple and must be available for all
Vietnam	National center for Hydro-Metrological forecast, Vietnam Institute of Geosciences Mineral recourse (MONRE), Institute of Geophysics	Central	Community	Community alert	No proper system & techniques	

Annex VI

Working Group 1 - Recommending threshold values for early warning for landslides

Participating countries and agencies: Bhutan, China, Indonesia, India, Sri Lanka, ADPC, NGI

Activities:

1. collection of already available methodology in defining threshold limits for EW
2. Collection of data to define threshold limits (tepmlate will be prepared as follows)

Type of landslide/ source of info	Location and elevation	Ave rainfall	Date of occurrence	Effect of landslide	Rock type/ formation/ structure	soil type/ properties	Length of slide	thickness of slide mass	slope angle	closeness to active fault

Rainfall data (mm) days before landslide occured										
10	9	8	7	6	5	4	3	2	1	+1

3. share the data with other partner countries
4. comparison of the available techniques with other internationally recognized methodologies
5. Development of final threshold limits including claculations, analysis, clarifications, suitability
6. final submission

Time line

Activity 1: Jan 15th 2010
Activity 2: Feb 15th 2010
Activity 3: Feb 28th 2010
Activity 4: Apr 15th 2010
Activity 5: Sept 15th 2010

Activity 6: Oct 30th 2010

Working Group 2 Collection, compilation and recommendation of landslide early warning approaches (Bangladesh, Nepal, Pakistan, Philippines, Thailand, Vietnam, NGI, ADPC)

I. ACTIVITIES

A. MONITORING

1.Identify the landslide prone area (populated areas)

-In mountanous areas minimum two sets of raingauges: one automatic gauge at the catchment area (automated) and another one(manual) in the low lying area near the settlements

-In valleys and deltas one automatic gauge at the catchment area (automated) and another one(manual) in the low lying area near the settlements

2. Marked poles in the probable affected area.

River/flow gauge

3. Community-Based Landslide Early Warning System

Awarness and Education program, deputization, capacitating the community and the involvement of the community

B.PREDICTION

1. Based on previous experiences on threshhold values of the different geotechnical materials (input to be provided by GROUP 1)
2. Mapping of historical landslide events (GROUP 2)
    a. Local interviews (community experiences)
    b. Use scientific techniques (ex. Remote sensing interpretion, etc)

C. COMMUNICATION

1. Putting up of Loud speakers and manual sirens (ex. Bells, bamboos, others)
2. Electonic communications over GMS

D. RESPONSE

1. Drills and planning of evacuation routes
2. Identification of safe place for ecavuation
3. Mobilization of search and rescue

II. TERMS OF REFERENCE

A. Each member country will provide information (summarized) on BEST Practices for implementation of EWS base on the countries own experience on specific area (EO MARCH 2010)
    1. Geology
        a. Lithology, topography, geomorphology, hydrogeology, etc
    2. Rainfall data (laboratory measurements i.e. moisture content, etc)
    3. Geotechnical data (properties of colluvium, residual, soil, etc/ other parameters)
    4. Present land use (residential, agro-industrial, etc)

B. Countries without extensive experience on landslide EWS should propose areas of concern and identify their limitations (EO MARCH 2010)

C. Development of an effective EWS for all member countries

    1. Short term (identify vulnerable areas, give coordinates)
    2. Medium Term (trainings for geological mapping and rain gauge operation of the technical personnel and community)
    3. Long Term (cooperation of member countries)

D. All maps in GIS format (preferably map-info, Arcview)

E. First draft of the document by EO May 2010

III. Approach for executing

    1. Group meeting before submission (BO APRIL 2010)
    2. 2 Fieldworks (on experienced and inexperienced countries)

IV. By Email - correspondence

Regional Meeting for Discussion and Promotion of Early Warning Mechanisms for Landslides in Asian Region (RECLAIM-III)

25-27 November 2009, Bangkok, Thailand

List of participants

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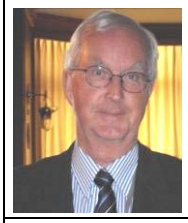
20	**Norway**		Dr. Oddvar Kjekstad Deputy Managing Director Norwegian Geotechnical Institute P.O. Box 3930, Ullevaal Stadion No-0806 Oslo, Norway	Tel: 47 2202 3000 Fax: 47 2223 0448 Email: oddvar.kjekstad@ngi.no and ok@ngi.no
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