

7<sup>th</sup> International Conference On Debris Flow Hazard Mitigation Colorado School Of Mines, Golden, and Visit to USGS

#### **United State of America**

08th to 18th June 2019

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#### **PURPOSE OF VISIT**

In December, 2018, the USGS and NBRO formalized this partnership with a signed Letter of Agreement (LOA).

This LOA outlined the details of training, research cooperation and specific invitational travel for NBRO staff members to the USGS office and attend the conference.

To ensure success of the USGS-NBRO collaboration and fulfill terms of the funding agreement with USAID/OFDA, USGS has invited four NBRO Officials to visit Colorado.













#### **NATURE OF THE VISIT**

Date	Activity
08/06/2019	Traveling to Denver, USA
09/06/2019	Field visit 1 – Rocky Mountain
	Debris Flow site
10/06/2019-	Conference at Schools of Mines,
13/06/2019	Colorado and Monitoring
	instrument installation training
	at USGS center
13/06/2019-	Field Visit 2 – Chalk Cliff Debris
14/06/2019	flow monitoring site
17/06/2019	Meetings with USGS
18/06/2019	Return to Sri Lanka



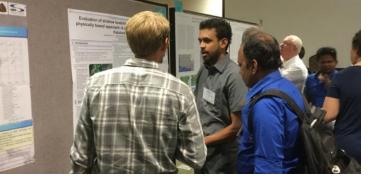


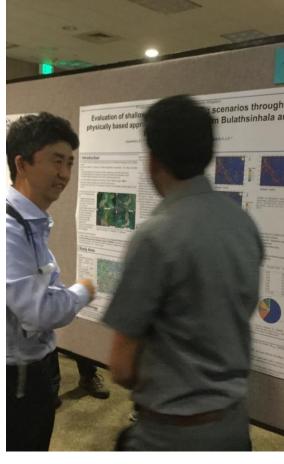


#### THE CONFERENCE

- The 7th International Conference on Debris-Flow Hazards Mitigation was held June 10 - 13, 2019 in Golden, Colorado, USA on the campus of Colorado School of Mines.
- DFHM7 aims to promote international cooperation, communication and exchange of knowledge among researchers and practitioners.
- The first DFHM Conference was held in San Francisco, USA (1997) and subsequent Conferences were held in Taipei, Taiwan (2000), Davos, Switzerland (2003), Chengdu, China (2007), Padua, Italy (2011), and Tsukuba, Japan (2015)









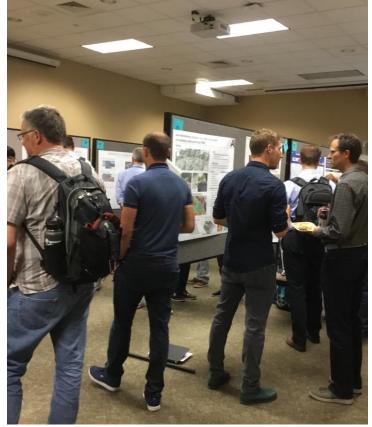




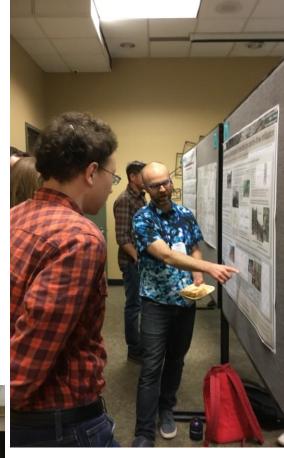


The purpose of this conference was to provide a forum for international researchers, engineers, and policy makers to:

- Exchange ideas and transfer knowledge between scientists, engineers, and policy makers
- Promote scientific advancement of debris-flow hazards, response, and mitigation
- Promote communication related to the outstanding needs for decreasing risk from debris flows















The delivered presentations have covered following major themes

- Debris-flow initiation
- Mechanics of debris-flow growth
- Debris-flow mobility
- Debris-flow deposits and fan morphology
- Physical and numerical modeling of debris flows
- Debris-flow monitoring and alert systems
- Applications of new technologies
- Forensic case studies of debris flows
- Prediction and assessment of debris-flow hazards and risk
- Emergency planning and response
- **Debris-flow mitigation**
- Role of disturbance in debris-flow initiation and mobility
- Data integration and sharing
- Needs of local government end users

Presented a poster on "Evaluation of shallow landslide-triggering scenarios through a physically based approach: A case study from Bulathsinhala area, Kalutara in Sri Lanka".



**DEBRIS-FLOW HAZARDS MITIGATION:** 

Mechanics, Monitoring, Modeling, and **Assessment** 

Edited by Jason W. Kean, Jeffrey A. Coe, Paul M. Santi, & Becca K. Guillen



https://dfhm7.csmspace.com/

7th International Conference on Debris-Flow Hazards Mitigation Evaluation of shallow landslide-triggering scenarios through a physically based approach: A case study from Bulathsinhala area, Kalutara in Sri Lanka

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Transient Rainfall Infiltration and Grid-based Regional Slope-stability analysis (TRIGRS) is a regional, physically based stability model which could be applied to predict shallow landslides. It is important to evaluate the accuracy of TRIGRS for the prediction of landslide locations using actual events before use the TRIGRS model for further applications. This study presents the application of TRIGRS for Bulathsinhala area, Kaluthara in south western part of Sri Lanka where the number of shallow landslides occurred on 26th May 2017 and many of those events transitioned into damaging and killing debris flows. A back analysis of that landslide event was executed to authenticate the model by using different methods and techniques for the definition of the input parameters. Reliability of the model was evaluated through comparison with the 2017 landslide inventory in the particular area and it was revealed that most of the actual landslides were occurred in the predicted area (FS<1) of the model. In order to quantify the effectiveness of the model, an index was proposed in the study called LR<sub>clus</sub> (landslide ratio for each predicted FS class). The obtained values of the LR<sub>class</sub> index realize the trustworthiness of the model which indicates the considerably higher value (60%) for the lowest stability class. With this particular manner, the output of the study could be used to implement more reliable land use management and development plans and resettlement procedures. Further the TRIGRS model is advantageous for susceptibility mapping and landslide flow path analysis, particularly when linked with various advanced applications using GIS spatial functions.











#### THE FIELD VISIT



Rocky Mountain National Park, June 9 ,2019

#### Field Trip 2

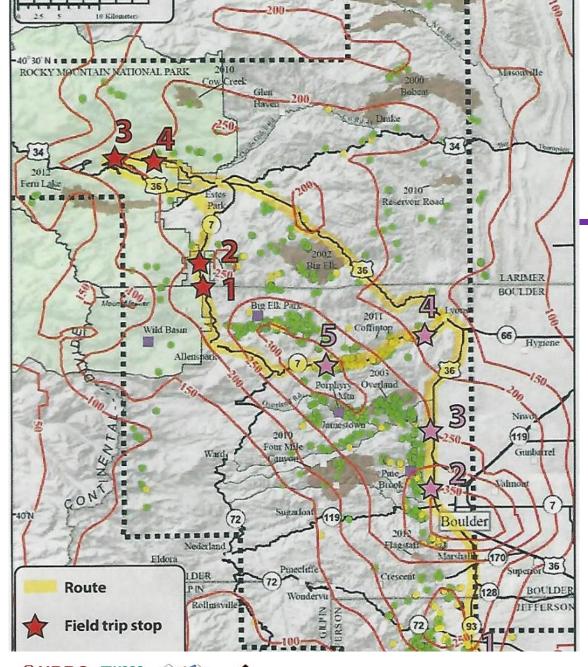
The chalk cliffs, June 13 - 14, 2019











## 1. ROCKY MOUNTAIN NATIONAL PARK

Diagram showing debris flows triggered by Sept.2013 rainfall. (A) Map of debris – flow locations (as well as rock, earth, and debris slides) overlain by cumulative rain fall from 10 sept.at 6.p.m to 13 Sept. at 6. p.m. Number of mapped debris flows was 1138.Number of mapped rocks, earth and debris slides was 212.

At the this filed trip, we were visited;

- Mount Meeker debris flow
- West Twin Sisters debris flow
- Hidden Valley

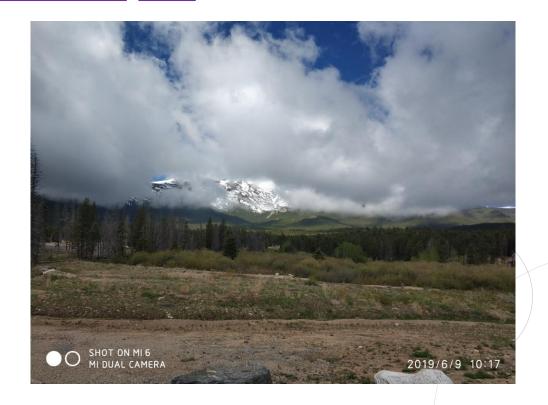


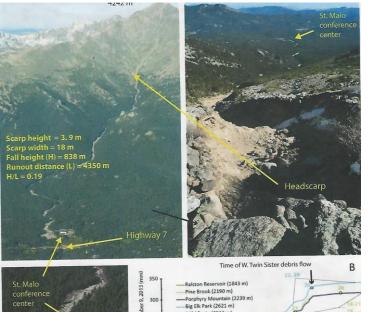


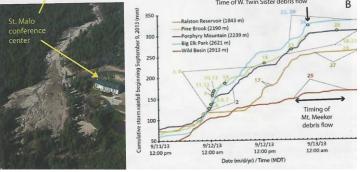




#### **MOUNT MEEKER DEBRIS FLOW**











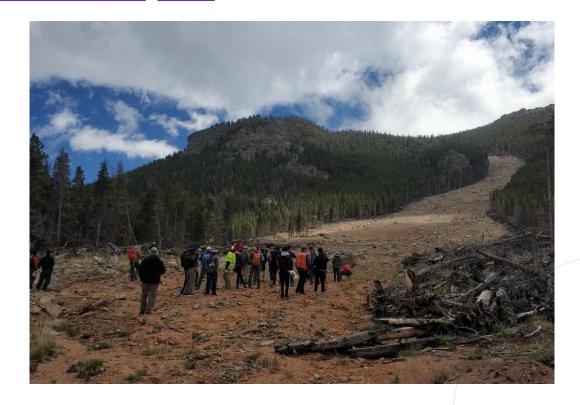


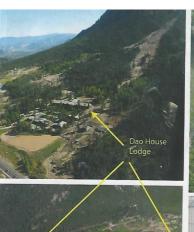


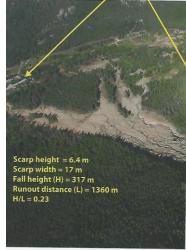




#### **WEST TWIN SISTERS DEBRIS FLOW**



















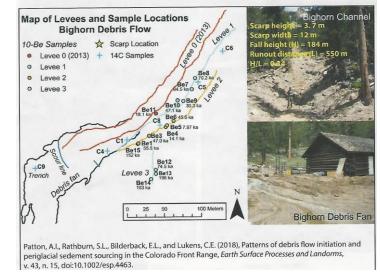


#### **HIDDEN VALLEY**





Stop 4: Bighorn debris flow

















pick up (bus leaves at 2 pm!)

ratigraphy

iscussion, safe zone (in case of rain)

- 5 Basin overview at camera station, steep h
- 6 Middle Station, active talus slopes
- 7 Active fan and stratigraphy at Chalk Cree

#### CHALK CLIFFS DEBRIS FLOW SITE

- The chalk cliffs are located at the southern base of Mount Princeton in the Swatch Range of the Rocky Mountains, in central Colorado.
- Chalk Creek, whose headwaters are located at the continental Divide, runs parallel to the cliffs in the valley between Mt. Princeton and Mt. Anterro before draining into Arkansas River.
- The USGS began research activities at the basin in 2002 and established a monitoring network in the upper reach of the catchment (0.06 km<sup>2</sup>) in May 2004.
- Currently, there are multiple stations in the watershed and on the fan dedicated to debris – flow process monitoring.

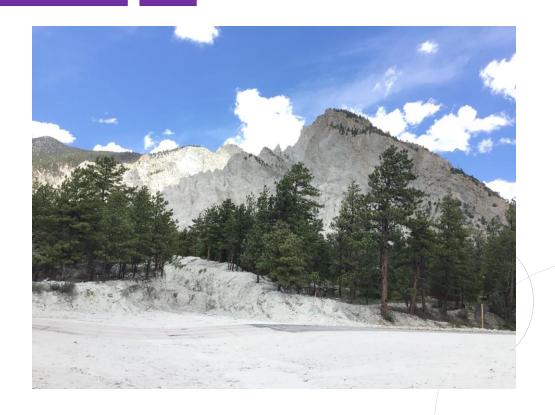








#### **CHALK CLIFFS DEBRIS FLOW SITE**

















### MEETING/DISCUSSION WITH USGS







# Research will emphasize key priority topics in Sri Lanka using USGS research techniques and technology:

- Improving regional thresholds for landslide initiation and issuing warnings
- Developing hazard assessments of landslide inundation and mobility
- Collecting perishable data following landslide disasters to advance research priorities.



### Spesific point discussed at the meeting and future benifits

- Mapping landslide features and deposits ,Workshop on mapping with lidar in Sri Lanka (WA-DNR)
- Modeling runout regional applications of LAHAR-Z
- Technical exchange between USGS Menlo Park/Golden and NBRO in Colombo
- Empirical re-analysis of existing threshold in different regions
- Hydrological monitoring and thresholds ,USGS visit to install new monitoring site near Aranayaka landslide
- Applications of TRIGRS for regional susceptibility assessments
- Possible technical training and analysis workshop for using ARC Collector on tablets











#### **TECHNICAL TRAINING ON LANDSLIDE MONITORING INSTRUMENTATION**









#### THINGS TO LEARN

- Rainfall estimation with Radar
- Recent vs. Antecedent Rainfall Index (ARI)
- Index of Rainfall Thresholds with Landslides
- Spatially Variable Triggering Condition
  - Soil Properties
  - Vegetation
  - Topography
  - Climate
  - Other environmental factors

Empirical rainfall thresholds not readily transferrable across geographical regions

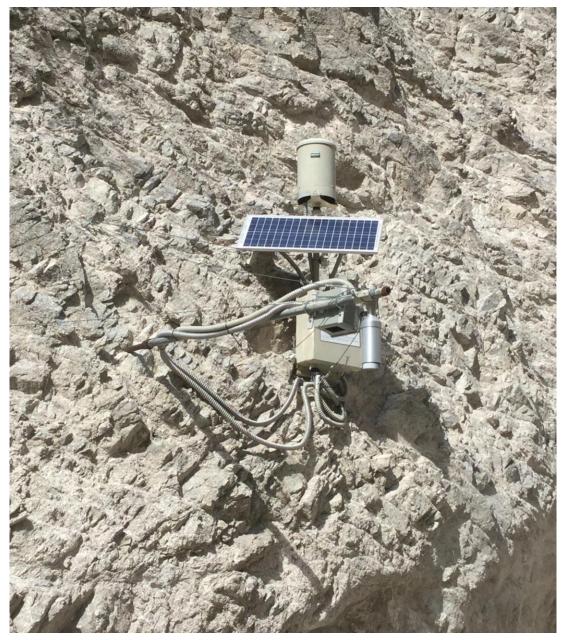












#### **FUTURE CHALLENGES AND RECOMMENDATIONS**

- ☐ NBRO research capacity should be improved to international standard.
- NBRO scientists should be trained internationally with the overseas experts such as,
  - United State Geological Survey
  - Eidgenössische Technische Hochschule (ETH) Zürich
  - China Mountain Research
- ☐ Research fields should be expanded to following paths
  - Modeling (computer / dynamic)
  - Runoff calculation
  - Instrumentation for Landslide initiation and runoff modeling
  - Specific threshold value calculation for regional base
  - Updating / modification of existing landslide hazard zonation procedure













- The government of Sri Lanka, Ministry of Disaster Management and National Building Research Organisation for granting approval and providing necessary facilities to attend this conference and technical field visits.
- United State of America and our hosts United State Geological Survey (USGS), specially, USGS Colorado.
- All international presenters and participants of 7<sup>th</sup> DFHM, for sharing their experience, knowledge and thoughtful ideas in subject domain.











## **THANK YOU**