METEOR: Final Report on DAC Stakeholder Training

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Authors: S. Ghosh, M. Huyck

Session summaries based on presentations and material from Charles K. Huyck, Paul Amyx, Michael Eguchi, Georgiana Esquivias, Nicole Paul, Dr. Annie Winson, Dr. Christopher Sampson, Dr. Claire Dashwood, Dr. Roxana Ciurean

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Prepared by: Contributors		
Name(s): Ghosh, S Huyck, M.	Signature(s):	Date(s): 29 March 2021
Approved by: Project Manager		
Name: Smith, K.	Signature:	Date: 7 April 2021
Approved by: UKSA IPP Project Officer		
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Abbreviations

Acronym	Description
BGS	British Geological Survey: An organisation providing expert advice in all areas of geoscience to the UK government and internationally
CIC	Commercial in Confidence
DEM	Digital Elevation Model
DMD	Disaster Management Department: Prime Minister's Office of Tanzania focused on disaster risk
DRM	Disaster Risk Management
DRR	Disaster Risk Reduction
EARS	East African Rift System
EDP	Engineering Demand Parameter
EO	Earth Observation
FATHOM	Provides innovative flood modelling and analytics, based on extensive flood risk research
GCRF	Global Challenges Research Fund
GEM	Global Earthquake Model: Non-profit organisation focused on the pursuit of earthquake resilience worldwide
GIS	Geographic Information System
HOT	Humanitarian OpenStreetMap Team: A global non-profit organisation the uses collaborative technology to create OSM maps for areas affected by disasters
ImageCat	International risk management innovation company supporting the global risk and catastrophe management needs of the insurance industry, governments and NGOs
IPP	International Partnership Programme
M	Magnitude, of earthquake
METEOR	Modelling Exposure Through Earth Observation Routines
NDRRMA	National Disaster Risk Reduction and Management Authority, Nepal
NSET	National Society for Earthquake Technology: Non-governmental organisation working on reducing earthquake risk in Nepal and abroad
ODA	Official Development Assistance

Acronym	Description
OMDTZ	Open Map Development Tanzania
OPM	Oxford Policy Management: Organisation focused on sustainable project design and implementation for reducing social and economic disadvantage in low-income countries
OQ	OpenQuake
PMO	Prime Minister’s Office of Tanzania
UAV	Unmanned Aerial Vehicle
UKSA	United Kingdom Space Agency
WHE	World Housing Encylopedia
WP	Work Package

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1. METEOR Project Introduction

1.1. Project Summary

Table 1: METEOR Project Summary

Project Title	Modelling Exposure Through Earth Observation Routines (METEOR): EO-based Exposure, Nepal and Tanzania
Starting Date	08/02/2018
Duration	36 months
Partners	UK Partners: The British Geological Survey (BGS) (Lead), Oxford Policy Management Limited (OPM), SSBN Limited International Partners: The Disaster Management Department, Office of the Prime Minister – Tanzania (DMD), The Global Earthquake Model (GEM) Foundation, The Humanitarian OpenStreetMap Team (HOT), ImageCat, National Society for Earthquake Technology (NSET) – Nepal
Target Countries	Nepal and Tanzania for "Level 2" results and all 47 Least Developed ODA countries for "Level 1" data
IPP Project	IPPC2_07_BGS_METEOR

1.2. Project Overview

At present, there is a poor understanding of population exposure in some Official Development Assistance (ODA) countries, which causes major challenges when making Disaster Risk Management decisions. Modelling Exposure Through Earth Observation Routines (METEOR) takes a step-change in the application of Earth Observation exposure data by developing and delivering more accurate Levels of population exposure to natural hazards. METEOR is delivering calibrated exposure data for Nepal and Tanzania, plus 'Level 1' exposure for the remaining ODA Least Developed Countries (LDCs). Moreover, we are 1) developing and delivering national hazard footprints for Nepal and Tanzania; 2) producing new vulnerability data for the impacts of hazards on exposure; and 3) characterising how multi-hazards interact impact upon exposure. The provision of METEOR's consistent data to governments, town planners and insurance providers will promote welfare and economic development and better enable them to respond to the hazards when they do occur.

METEOR is co-funded through the second iteration of the UK Space Agency's (UKSA) International Partnership Programme (IPP), which uses space expertise to develop and deliver innovative solutions to real world problems across the globe. The funding helps to build sustainable development while building effective partnerships that can lead to growth opportunities for British companies.

1.3. Project Objectives

METEOR aims to formulate an innovative methodology of creating exposure data through the use of EO-based imagery to identify development patterns throughout a country. The stratified sampling technique harnessing traditional land use interpretation methods, modified to characterise building patterns, can be combined with EO and in-field building characteristics to capture the distribution of building types. The associated protocols and standards will be developed for broad application to ODA countries and will be tested and validated for both Nepal and Tanzania to assure they are fit-for-purpose.

Detailed building data collected on the ground for the cities of Kathmandu (Nepal) and Dar es Salaam (Tanzania) will be used to compare and validate the EO generated exposure datasets. Objectives of the project look to 1) deliver exposure data for 47 of the least developed ODA countries, including Nepal and Tanzania; 2) create hazard footprints for the specific countries; 3) create open protocol; 4) develop critical exposure information from EO data; and 5) build the capacity of local decision makers to apply data and assess hazard exposure. The eight work packages (WP) that make up the METEOR project are outlined below in section 1.4.

1.4. Work Packages

Outlined below are the eight work packages that make up the METEOR project (Table 2), including the lead organisations and a brief description of what each work package covers. ImageCat is leading WP.8: Sustainability and Capacity-Building, which focuses on sustainability and capacity-building, with the launch of the databases for Nepal and Tanzania while working with in-country experts.

Table 2: Overview of METEOR Work Packages

Work Package	Title	Lead	Overview
WP.1	Project Management	BGS	Project management, meetings with UKSA, quarterly reporting and the provision of feedback on project deliverables and direction across primary stakeholders.
WP.2	Monitoring and Evaluation	OPM	Monitoring and evaluation of the project and its impact, using a theory of change approach to assess whether the associated activities are leading to the desired outcome.
WP.3	EO Data for Exposure Development	ImageCat	EO-based data for exposure development, methods and protocols of segmenting/classifying building patterns for stratified sampling of building characteristics.
WP.4	Inputs and Validation	HOT	Collect exposure data in Kathmandu and Dar es Salaam to help validate and calibrate the data derived from the classification of building patterns from EO-based imagery.

WP.5	Vulnerability and Uncertainty	GEM	Investigate how assumptions, limitations, scale and accuracy of exposure data, as well as decisions in data development process lead to modelled uncertainty.
WP.6	Multiple Hazard Impact	BGS	Multiple hazard impacts on exposure and how they may be addressed in disaster risk management by a range of stakeholders.
WP.7	Knowledge Sharing	GEM	Disseminate to the wider space and development sectors through dedicated web-portals and use of the Challenge Fund open databases.
WP.8	Sustainability and Capacity-Building	ImageCat	Sustainability and capacity-building, with the launch of the databases for Nepal and Tanzania while working with in-country experts.

2. Introduction

METEOR held online training sessions for participating stakeholders in the project's pilot countries, Tanzania and Nepal: a training workshop for stakeholders in Tanzania, and a pre-workshop session with stakeholders in Nepal. A future, full stakeholder training will be held in Nepal presenting the same material in as the pre-workshop training to municipal emergency managers, but in much more depth. The METEOR Stakeholder Training sessions aimed to develop the capacity of end users in Tanzania and Nepal. The sessions had the added benefits of allowing METEOR team members to directly present some of the project's outputs, take questions from the stakeholders, and receive feedback. Training materials including presentation slides, videos and video transcripts were provided to the participants and are also publicly available on the METEOR website (https://meteor-project.org/training-materials/).

Training protocols for conducting in-country training for both Tanzania and Nepal were developed and delivered in September 2019 (M8.7/CIC). The contents of the training protocols were prepared with input from consortium partners and formed the framework for the training component of the METEOR project. These training protocols were designed to cover the various METEOR products for intended technical and nontechnical/policy users with their assumed capacity. Through the course of the project with the feedback received during meetings and learning events, the final stakeholder trainings focused on 1) introducing the users to various hazard, exposure and vulnerability products developed by the METEOR project; 2) multi-hazard risk modelling framework; and 3) application of seismic modelling and scenario walkthrough.

This document presents the process of implementing the stakeholder training protocols in the two pilot countries of Tanzania and Nepal. The goals of these training meetings were to

- Inform the participating stakeholders about the METEOR products and their use
- Improve capacity of institutions and organisations in Tanzania and Nepal to achieve Disaster Risk Reduction (DRR) and Disaster Risk Management (DRM) objectives
- Serve as a model and provide guidance to the 45 additional ODA countries to adequately utilise training protocols in broader capacity building strategies

3. Tanzania Training: 25-26 February 2021

The METEOR Tanzania Stakeholder training took place on February 25th and 26th, 2021 in Dodoma. Due to COVID 19 travel restrictions, the training was held virtually as a combination of in-person participation of METEOR partners based in Tanzania, in-person participation of invited Tanzanian Stakeholders, remote participation of invited Tanzanian Stakeholders, and remote participation from non-Tanzanian based METEOR partners.

3.1. Sessions Main Agenda

The METEOR Stakeholder Training Workshop was designed to introduce the participating stakeholders to the exposure data and hazard modelling outputs of the METEOR project for Tanzania. The sessions included both live-streamed and taped presentations, depending on the time zones of the speakers. All sessions, both live-streamed and taped, were followed by live discussions, allowing stakeholders to participate and ask questions. Training materials, listed in this report after each corresponding technical training session summary, have also been provided to the participants through the METEOR website to allow for review and reference.

3.2. Day 1 (25 February 2021)

Agenda

- Formal introduction of the METEOR team and project to the online stakeholder participants by Colm Jordan and Kay Smith from BGS
- Review of training materials available on the platform and summary of what participants could expect from the coming training sessions, led by Nicole Paul from GEM
- Open discussion and questions from participants
- Seismic modelling & scenario walkthrough training session, presented by Nicole Paul
- Time for open discussion and participant feedback

Participants

AM Online METEOR attendees: Kay Smith (BGS); Annie Winson (BGS); Vitor Silva (GEM); Emanuel Kombe (HOT); Charles Sokile (OPM)

AM Online NON-METEOR attendees: Mdathiru Abubakar (World Food Programme); Devyani Gajjar (Open University); Venla Aaltonen (Resilience Academy); Enock Molla, Sisahau Ahmada; Siajabu Msafirji; Abbas Kitogo; Innocencia Sigfrid

AM Attendees on location in Tanzania:

- DMD-PMO**:** Charles Msangi; Col Jimmy Said; John Kiriwai; Abigael Marwa; Alex Ndimbo; Ally Mwantima; Mahulu Butondo; Eugenia John; Ewald Bonifasi; Esta Samson; Consolata Mbanga; Valentina Sanga; Wilfrida Ngowi; Numpe Mwambeja; Nyamagory Kitwara; Yona Benjamini; Japher Mtengwa; Edna Chibwana; Nuru Gagu; Saidi Chotimbao; Godfrey Sanga; Edga Sanga; Saidi Chotimbao
- OMDTZ/HOT: Innocent Maholi; Emanuel Kombe; Hawa Adinani
- Other stakeholders: Alex Masanja (Geological Survey of Tanzania); Aminiel Mshana (DarMAERT); Africos Mattogoro (Ministry of Natural Resources and Tourism); Jeremiah Regera (Ministries of

Livestock and Fisheries); Henry Mchome (Ministry of Water); Godrey Mwangole (Ministry of Lands); Bernard Abraham (Dodoma Regional Office); Elias Lipko (Tanzania Meteorological Agency); Charo Mangare (Fire and Rescue Force); Haika Mgonja (Ministry of Finance); Jonston Wenston (Tanzania Res Cross); Shukuru Njati (TARURA); Ecklesia Sironga (Ministry of Works and Transport); Emmanuel Experious (Ministry of Agriculture); Risper Koyi (VPo); Java Myulla (E-Government Agency); Marry Ponela (Ministry of Mining)

PM Online METEOR Attendees: Kay Smith (BGS); Colm Jordan (BGS); Annie Winson (BGS); Nicole Paul (GEM); Vitor Silva (GEM); Hawa Adinani (HOT); Will Evans (HOT); Charles Sokile (OPM)

PM Online NON-METEOR Attendees: Mdathiru Abubakar (World Food Programme); Devyani Gajjar (Open University); Venla Aaltonen (Resilience Academy); Nicholaus Mwageni (Ardhi University); Erick Tamba (SUA); Imma Mwanja (OMDTZ); Sisahau Ahmada; Doreeen Shedrack; Abbas Kitogo

PM Attendees on location in Tanzania: all same as AM list

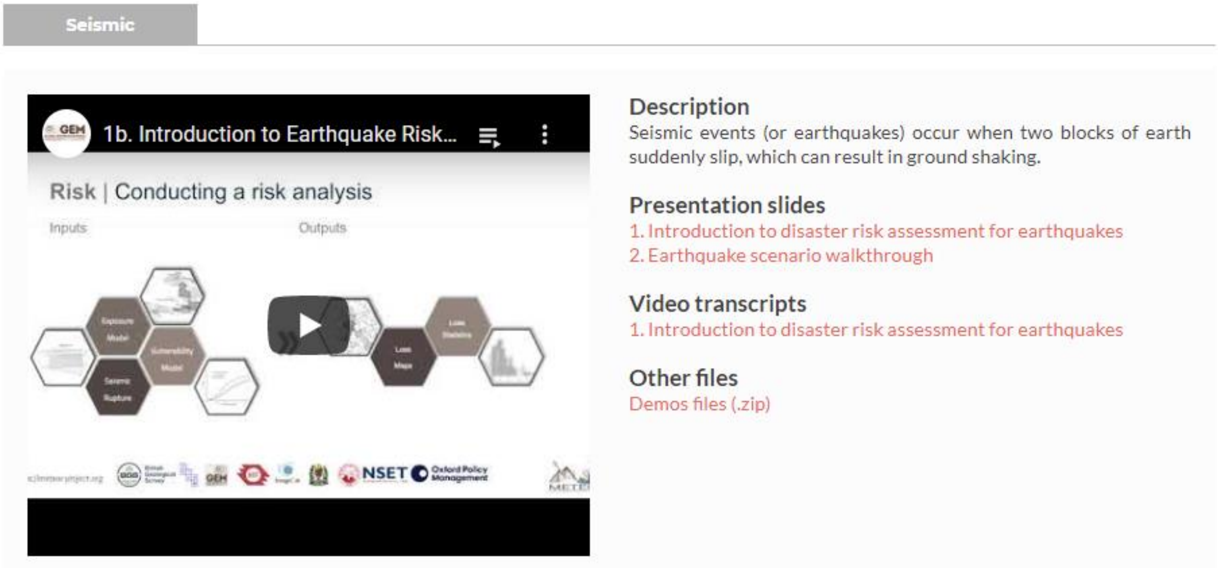
Technical Training Session Summaries

Seismic Modelling & Scenario Walkthrough, led by Nicole Paul, Global Earthquake Model (GEM)

Scenarios are used in disaster risk reduction to stimulate conversation, increase understanding, and help provide actionable information that can be used to prepare for certain risks and inform decisions about adaptation or mitigation. An example of an earthquake scenario was used within this session to facilitate discussion and understanding about how individual organisations might prepare for and respond to such an event, although learnings could equally be applied to other hazards (such as from floods or volcanoes). Earthquakes have been prevalent in Africa, particularly along the East African Rift System (EARS), which crosses through Tanzania. There have been 3 recent significant earthquakes on Tanzanian soil: M6.5 in Nkansi in 2000, M5.9 in Bukoba in 2016, and M6.0 in Dar es Salaam in 2020. Of these earthquakes, the 2016 Bukoba earthquake was the most damaging, due to a combination of the large magnitude and close proximity to inhabited areas. Although the M6.0 Dar es Salaam earthquake was a higher magnitude, the epicentre was sufficiently far offshore that the ground shaking onshore was relatively low. However, this seismic source could produce larger magnitude earthquakes in the future. Within this session, a hypothetical question was posed: "What if the Dar es Salaam earthquake had been stronger?" To illustrate this further, a scenario seismic hazard and risk model was developed and its resulting risk metrics (e.g., number of damaged or destroyed residences, economic losses, disruption to utilities) were presented. Questions for the purpose of discussion around the scenario example included:

- Where is your ministry based, and what role would your ministry have in the response?
- Who would the first responders be?
- What information might they need?
- What would the strategy be to offer shelter for up to 300,000 people?
- What data might benefit the response?
- What are the protocols to gain access to that data?
- How would response to an earthquake differ from a response to floods?
- What areas of Dar es Salaam would be most impacted?

Training Materials: Seismic Hazard and Earthquake Scenario



Introduction to Earthquake Risk

Video URL:

https://youtu.be/GzzSmMNoi-k?list=PL08aqbvcszvQbYHmvRHanx7bGxXZ-IOfj

Presentation Slides

1. Introduction to disaster risk assessment for earthquakes

2. Earthquake scenario walkthrough

Video Transcripts

1. Introduction to disaster risk assessment for earthquakes

Other Files

1. Demos files (.zip)

3.3. Day 2 (26 February 2021)

Agenda

- Exposure Modelling training session, led by Charles K. Huyck from ImageCat
- Volcanic Modelling training session, led by Annie Winson from BGS
- Flood Modelling training session, led by Christopher Sampson from Fathom
- Multi-hazard Risk Modelling training session, led by Annie Winson
- Time for open discussion and participant feedback

Participants

AM Online METEOR Attendees: Kay Smith (BGS); Annie Winson (BGS); Colm Jordan (BGS); Nicole Paul (GEM); Vitor Silva (GEM); Charles K. Huyck (ImageCat); Mike Eguchi (ImageCat); Paul Amyx (ImageCat); Georgiana Esquivias (ImageCat); Shubharoop Ghosh (ImageCat); Charles Sokile (OPM); Christopher Sampson (Fathom)

AM Attendees on location in Tanzania:

- DMD-PMO**:** Charles Msangi; Col Jimmy Said; John Kiriwai; Abigael Marwa; Alex Ndimbo; Ally Mwantima; Mahulu Butondo; Eugenia John; Ewald Bonifasi; Esta Samson; Consolata Mbanga; Valentina Sanga; Wilfrida Ngowi; Numpe Mwambeja; Nyamagory Kitwara; Yona Benjamini; Japher Mtengwa; Edna Chibwana; Nuru Gagu; Saidi Chotimbao; Godfrey Sanga; Edga Sanga; Saidi Chotimbao
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AM Online NON-METOR Stakeholder; Denvyani Gajjar (Open University); Mdathiru Abubakar (World Food Programme); Enock Molla; Sisahau Ahmada; Erick Tamba; Fadhili Mtengela; Domina; Msilikale

PM Online METEOR Attendees**:** Kay Smith (BGS); Annie Winson (BGS); Nicole Paul (GEM); Vitor Silva (GEM); Colm Jordan (BGS);

PM Attendees on location in Tanzania:

- DMD-PMO**:** Charles Msangi; Col Jimmy Said; John Kiriwai; Abigael Marwa; Alex Ndimbo; Ally Mwantima; Mahulu Butondo; Eugenia John; Ewald Bonifasi; Esta Samson; Consolata Mbanga; Valentina Sanga; Wilfrida Ngowi; Numpe Mwambeja; Nyamagory Kitwara; Yona Benjamini; Japher Mtengwa; Edna Chibwana; Nuru Gagu; Saidi Chotimbao; Godfrey Sanga; Edga Sanga; Saidi Chotimbao
- OMDTZ/HOT: Innocent Maholi; Emanuel Kombe; Hawa Adinani
- Other stakeholders: Alex Masanja (Geological Survey of Tanzania); Aminiel Mshana (DarMAERT); Africos Mattogoro (Ministry of Natural Resources and Tourism); Jeremiah Regera (Ministries of

Livestock and Fisheries); Henry Mchome (Ministry of Water); Godrey Mwangole (Ministry of Lands); Bernard Abraham (Dodoma Regional Office); Elias Lipko (Tanzania Meteorological Agency); Charo Mangare (Fire and Rescue Force); Haika Mgonja (Ministry of Finance); Jonston Wenston (Tanzania Res Cross); Shukuru Njati (TARURA); Ecklesia Sironga (Ministry of Works and Transport); Emmanuel Experious (Ministry of Agriculture); Risper Koyi (VPo); Java Myulla (E-Government Agency); Marry Ponela (Ministry of Mining)

PM Online NON-METEOR Stakeholders: Denvyani Gajjar (Open University); Sisahau Ahmada

Technical Training Session Summaries

Exposure Session, led by Charles K. Huyck of ImageCat with Paul Amyx, Michael Eguchi, and Georgiana Esquivias, ImageCat

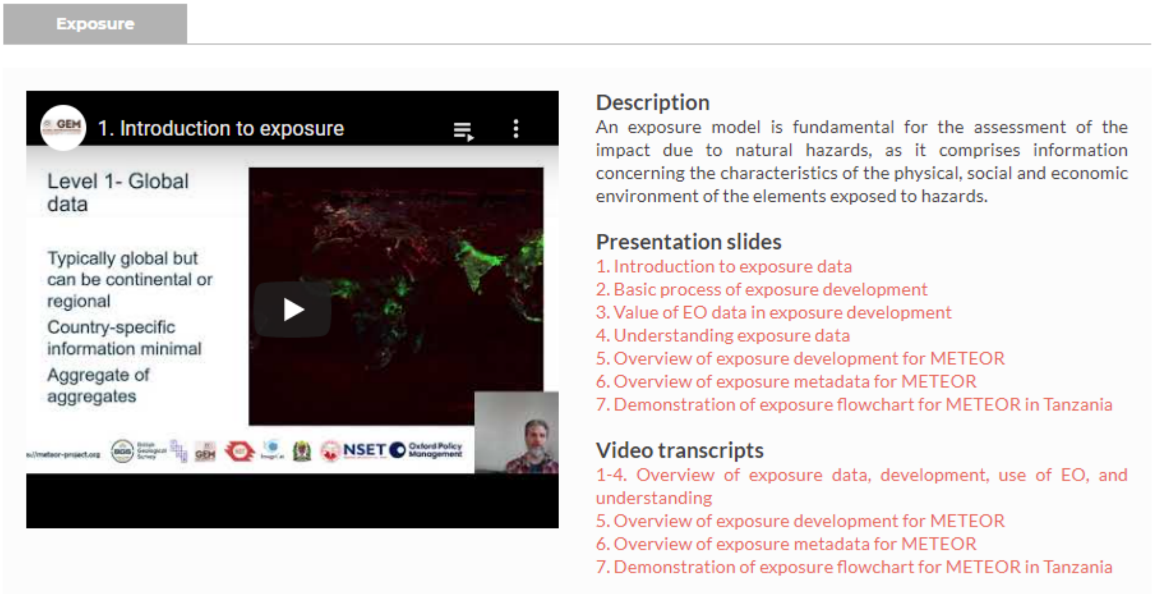
The training began with the introduction of exposure data and its uses in the loss estimation process. The explanation included topics such as the levels of exposure data, spatial resolution, building vulnerability attributes, replacement costs, vintage, challenges, and expectations. The process of developing exposure data consists of five steps: 1) collecting census data; 2) estimating building attributes; 3) refining spatial distribution; 4) estimating the number of buildings; and 5) estimating replacement values. Earth Observation data, referred to as EO, plays an important part in developing exposure data. Using EO does, however, come with some challenges. Understanding exposure data was the next topic of training, including an introduction to some of the contributions of the METEOR project to exposure development science and a discussion of metadata and the various levels. Participants learned what they should do when they receive exposure data on a project, and how to tell if it is of value.

Michael Eguchi led the next part of the exposure training, Heuristic Evaluations of Construction Patterns for Generating a Level 1 Exposure Database. This section introduced key concepts relating to building vulnerability and development of country-specific mapping schemes. This included how to identify typical construction materials/systems and Bangladesh was used an example area.

Paul Amyx led an overview of the exposure metadata, including the purpose of the metadata, how the metadata content is derived, and what format the metadata is stored in. This included discussion about useful information that can be found in the metadata.

Georgiana Esquivias led the audience through the flowcharts that were used for gathering data for the Tanzania Level 3 exposure data development. The flowcharts used included population, structural distribution, number of buildings, dasymetric mapping, replacement cost, building height, and building area. Understanding the flowcharts is valuable, as they assist in organising metadata collection and processing step review and they can enable future researchers to update or refine the exposure database as a whole or finely tune an individual section with improved data.

Training Materials: Exposure



Introduction to Exposure

Video URL:

https://youtu.be/AFuHJzfRbuk?list=PL08aqbvcszvR8VSy2znTarUsmzpIrCXsF

Presentation Slides:

1. Introduction to exposure data
2. Basic process of exposure development
3. Value of EO data in exposure development
4. Understanding exposure data
5. Overview of exposure development for METEOR
6. Overview for exposure metadata for METEOR
7. Demonstration of exposure flowchart for METEOR in Tanzania

Video transcripts:

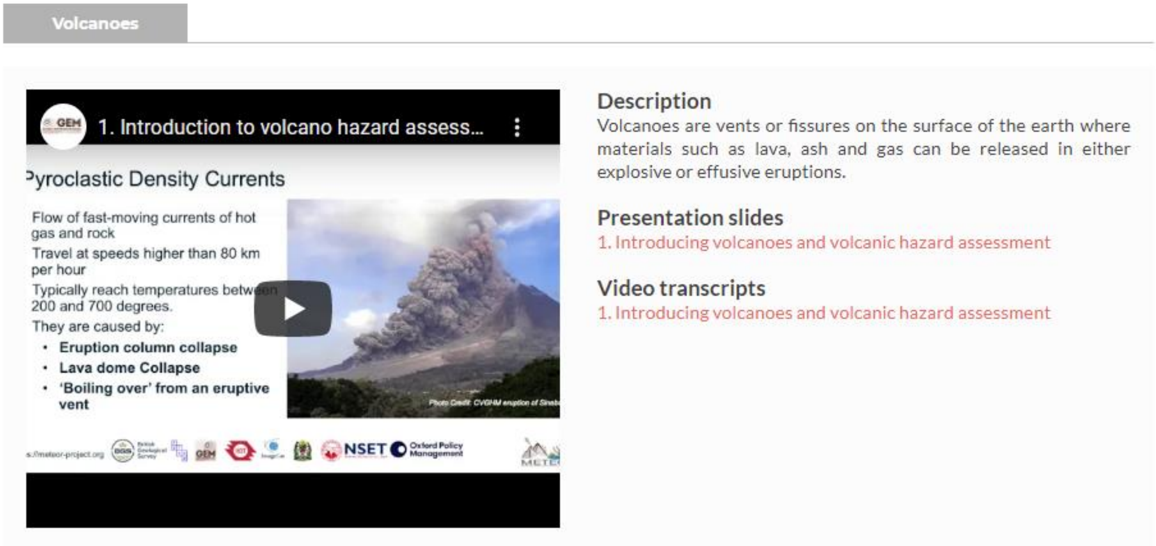
1-4. Introduction to exposure data, Basic process of exposure development, Value of EO data in exposure development, Understanding exposure data

5. Overview of exposure development for METEOR
6. Overview for exposure metadata for METEOR
7. Demonstration of exposure flowchart for METEOR in Tanzania

Volcanic Modelling, led by Annie Winson, BGS

The Volcanic Modelling training began with a video explaining the basics of volcanos, including details of eruptions, volcanic hazards, and hazard management. The METEOR project modelling initially required the following inputs- eruption history, volumes of deposits, DEM (10 or 30m), particle size distribution, plume height, wind speed/direction, and duration of particle column. The modelling was focused on 6 active volcanos in Tanzania: Ol Doinyo Lengai, Meru, Igwisi Hills, Ngozi, Kyejo, and Rungwe. Populations that live around the volcanos in Tanzania face certain hazards. The two primary hazards are pyroclastic flows and ash fall, with a secondary hazard of lahars. Volcanic hazard management is vital, with academia and the scientific community creating a base of knowledge and data that can inform governmental bodies' creation of contingency plans, disaster warning systems, disaster preparedness, and land-use planning. The METEOR team modelled volcanic hazard in Tanzania, Tephra2® Simulations, and Lahar and PDC basin modelling. The Rungwe Tephra2 simulations were used as examples to discuss uncertainty. In this case the uncertainties were: 1) the eruption history is not complete; 2) future source parameters and wind conditions are likely to vary; and 3) the Tephra2 makes an assumption that the input parameters are representative of the average conditions over the peak eruption duration and that most of the tephra is ejected in a short duration explosive event. As a last example, Annie showed Lahar and Pyroclastic basin modelling results.

Training Materials: Volcanic Modelling



Introduction to Volcano Hazard Assessment

Video URL: https://youtu.be/wkvYjXwh84I

Presentation Slides

1. [Introducing volcanoes and volcanic hazard assessment]()

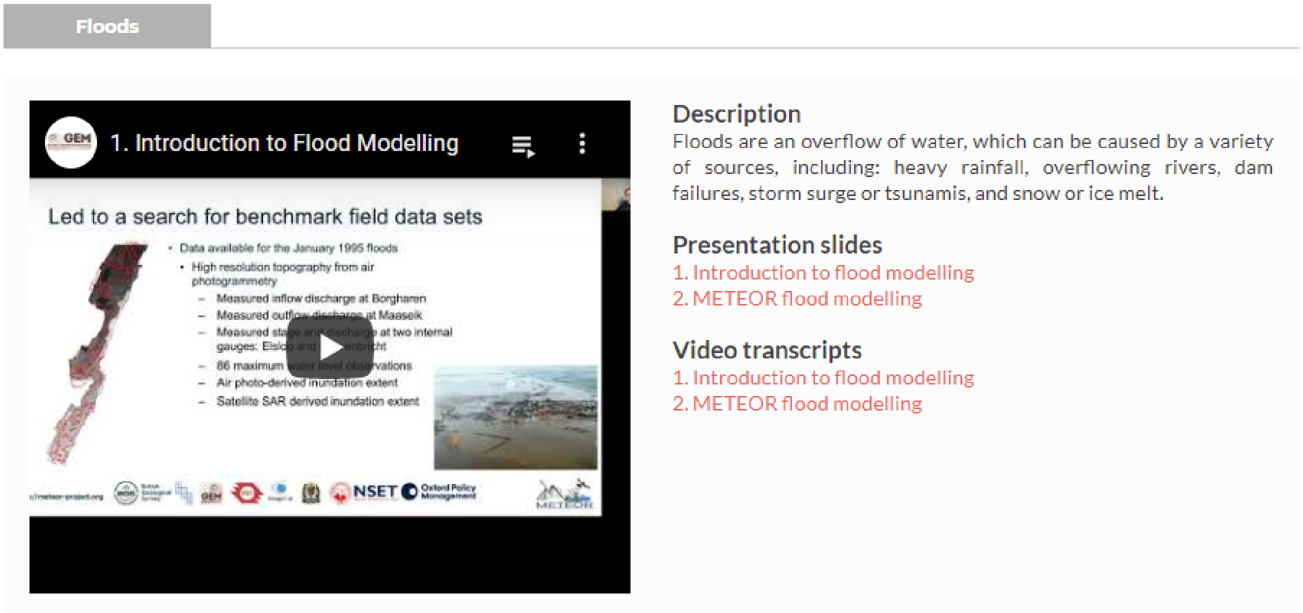
Video Transcripts

1. [Introducing volcanoes and volcanic hazard assessment]()

Flood Modelling, led by Christopher Sampson, Fathom

The Flood Modelling training began with an explanation of flood modelling and a brief history. A flood model is a "computer-based simulation of flood inundation, (but) more specifically, a simulation of large, low-amplitude, shallow water waves". Flood modelling had relied on analytic solutions and laboratory data. In 2000, modelling and modelling needs were felt to be well understood and it was being applied to real world applications. At this time high resolution data was required, it was always computer limited, and the models needed large amounts of data although the data often had errors or was often missing. Data for large areas, from cities to continents, were often not available and would need to be simulated. Topography data was a key breakthrough in the field and led to a search for benchmark field data sets. This led to the application of multiple models and some new recognitions: simple models were functioned as well as complex models, increasing model resolution was a better way to improve skill, terrain data accuracy and resolution is more important than physics, and floodplain inundation is, to first order, a simple gravity-friction balance. These realisations led to the conclusion that a new modelling approach was needed, one that was more data focused, with finer resolution, and capturing larger areas, and that were faster and higher performing. It was also recognised that more simple models work better "when fit for the data". This led to a discussion of how contemporary flood models work and what data they need. The River Severn in the UK was used as an example of using modelled data versus radar. The use of dynamic models versus GIS data was then discussed. In conclusion, many large-scale river flows can be represented by simplified shallow water physics. Given finite computing resources, model skill is improved more by increasing resolution than improving the physics. Highly resolved models are now possible. ~ 1 - 2 m over whole major cities (where data permits). ~30 - 100 m over whole continents (using globally available data). Lastly, the process of fusing models, ground and space data is yielding new insights into surface water dynamics.

Training Materials: Flood Modelling



Introduction to Flood Modelling

Video URL: https://youtu.be/LyRcfxIVsb8?list=PL08aqbvcszvRCG4blOhhOXSpT4VZM9HuY

Presentation Slides

1. Introduction to flood modelling
2. METEOR flood modelling

Video Transcripts

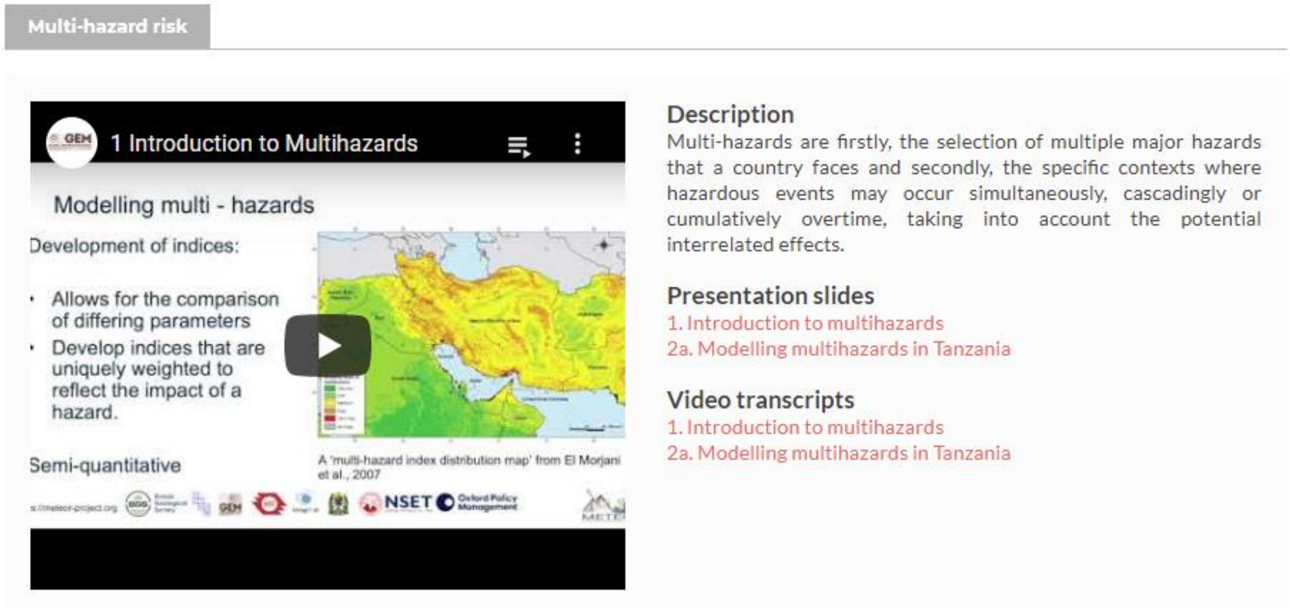
1. Introduction to flood modelling
2. METEOR flood modelling

Multi-Hazard Risk Modelling, led by Annie Winson, British Geological Survey (BGS)

The Multi-hazard Risk Modelling training began with an introduction to Risk Modelling and its complicated nature. Topics such as the importance of understanding multi-hazards, the type and scale of multi-hazards, methods for modelling multi-hazards, and visualizing multi-hazards were covered. Multi-hazards have considerations for modellers that single hazards do not: 1) Hazards may be related to each other, and cumulative (cascades); 2) The impacts on elements at risk can be different for differing hazards and occasionally opposing; 3) The differences between hazard characteristics and therefore the methods used to observe and monitor them; and 4) Any of the existing measures of hazard quantification need to be adapted to allow for comparison of multiple hazards. There are also various types of multi-hazards: independent, triggering, change conditions, compound hazard, and mutual exclusion. Another consideration is spatial and temporal scales. A modeller must standardise a single hazard data to a common measure by either classifying the hazards or developing indices. This decision determines whether a model is qualitative, semi-qualitative or quantitative. Defining frequency thresholds allows for the classification of hazards and therefore an equivalency between hazards. Development of indices and key modelling variations were discussed, as was visualising both single and joint multi-hazards. Annie summarised with the following points: 1) There are different types of hazard interrelations and scales of hazards; 2)The comparison of hazards is difficult due to different process characteristics; 3)Classification and index schemes can help to overcome this problem; 4)There are many existing multi-hazard models that have been designed to address differing variables – it is therefore important to assess these parameters before apply or designing a model; and 5) Visualising multi-hazards is non-trivial and may require different outputs for different end users purposes.

The next section of training was about METEOR's modelling of multi-hazards for Tanzania. Modellers on the METEOR team used five methods for modelling: 1) testing existing methodologies;2) the Greiving Model; 3) the Kappes Model; 4) expert Elicitation and weighting, developing protocols for modelling METEOR data; and 5) and sensitivity testing. Two models were used to test the data: Greiving (2006) and Kappes (2012). Value was found in the results of both models, so a hybrid of the two was ultimately used by the METEOR team for Tanzania. There are set protocols for modelling multi-hazards within the METEOR project, as well as sensitivity analysis. In summary-1) The METEOR project has produced single hazard assessments (earthquake, volcano and flood) and exposure data for Tanzania; 2) METEOR reviewed existing multi-hazard models and tested two differing models, using draft data from Tanzania; 3) These models did not quite fit the needs of the METEOR project and so the team created a hybrid, semi-quantitative model that allows the user to assess multi-hazards at a national scale, but with a resolution of c.90m.The team has finalised an assessment of the effect of data uncertainty on these model outputs by running an initial sensitivity analysis.

Training Materials: Multi-Hazard Risk Modelling



Introduction to Multi-hazards

Video URL: https://youtu.be/PNr2aLnU2GI?list=PL08aqbvcszvRmWJRjg5AMGAWFkhIuJdwq

Presentation Slides

1. Introduction to Multi-hazards

2a Modelling Multi-hazards in Tanzania

Video Transcripts

1. Introduction to Multi-hazards

2a Modelling Multi-hazards in Tanzania

4. Nepal Training (Pre-Workshop Session): 9 March 2021

The METEOR Tanzania Stakeholder Pre-Workshop Session took place on the 9th of March 2021. Due to COVID 19 travel restrictions, the session was held virtually as a combination of: in-person participation of METEOR partners based in Nepal; in-person participation of invited Nepal Stakeholders designated by NDRRMA; and remote participation from non-Nepal based METEOR partners.

4.1. Session Main Agenda

The METEOR Stakeholder Pre-Workshop Session for Nepal was designed primarily to introduce the future training topics to and to solicit feedback from stakeholders and fellow METEOR team members. The day included a morning and an afternoon session, both live-streamed and followed by a live discussion session to allow stakeholders to participate and ask questions. Training materials, listed after each technical training session summary, have also been provided to the participants through the METEOR website to allow for review and reference (https://meteor-project.org/training-materials/nepal/).

Agenda

AM:

- Welcome and introduction of delegates, led by NSET
- Introduction to the METEOR project, led by Kay Smith of BGS
- Exposure session, led by Charlie Huyck of ImageCat

PM:

- Seismic session, led by Nicole Paul of GEM
- Flood session, led by Christopher Sampson of Fathom
- Landslide session, led by Claire Dashwood and Roxana Ciurean of BGS
- Multi-hazard risk, led byAnnie Winson of BGS
- Overall discussion/feedback, led by NSET
- Feedback survey

Participants

METEOR Team Attendees: Sharad Wagle (NSET); Kay Smith (BGS); Annie Winson (BGS); Surya Shrestha (NSET); Michael Eguchi (ImageCat); Paul Amyx (ImageCat); Georgiana Esquivias (ImageCat); Nicole Paul (GEM); Dr. Christopher Sampson (Fathom); Roxana Ciurean (BGS); Claire Dashwood (BGS); Charles K. Huyck (ImageCat); Paul Amyx (ImageCat); Michael Eguchi (ImageCat); and Georgiana Esquivias (ImageCat)

Stakeholder Attendees: Anil Pokhrel (NDRRMA); Angela Tamrakar (Youth Innovation Lab); Suresh Chaudhary (NSET); Dammar Singh Pujara (NSET); Ram Shrestha (NSET); Reena Bajracharya (Youth Innovation Lab); Sarmila Paudyral (NSET); Beejay Kumar Maharjan (NDRRMA); Alina Khatiwada (Youth Innovation Lab); Anup Dhakal (NDRRMA); Buddhi Raj Shrestha (NSET); Reena Chaudhray (NDRRMA); Suchita Shrestha (Dept Mines & Geology); Janardan Gautam, Lekh Bhatta (NRA/NDRMMA); Arun Poudel (NDRMMA)

4.2. Technical Training Session Summaries

Exposure Session, led by Charles K. Huyck of ImageCat with Paul Amyx, Michael Eguchi, and Georgiana Esquivias, ImageCat

Charles K. Huyck emphasised that NSET co-developed the exposure work for Nepal, Sharad Wagle in particular. There were five main take-aways from this section of the training session: 1) the definition of exposure data; 2) its uses in the loss estimation process; 3) the basic process of developing exposure data; 4) the value of EO data in this process; and 5) how to check your exposure data and to ensure that it is fit for purpose. Aspects of exposure data to understand are levels, spatial resolution, building vulnerability attributes, replacement costs, vintage, challenges, and expectations. Exposure modelling is the art of distributing inventoried people into buildings. Exposure is an important part of a risk assessment. Exposure data for Nepal has five levels, depending on the data used for its development. Level 1, Global data, is typically global but can be continental or regional, includes minimal country-specific information, and aggregate of aggregates. Level 2, Country level data is typically global but can be continental or regional, includes minimal country-specific information, and aggregate of aggregates. Level 3 data has data improvement by the sub-national scale. Level 4 data includes aggregated building specific data, and Level 5 data is produced with data all produced at the site-level. Building vulnerability attributes include number of stories, first floor elevation, structural materials, lateral force resisting system, retrofits, nail density, and distance between buildings. The topic of replacement costs was introduced and how they can be tricky, data vintage and how it is sometimes ignored and can lead to issues, and challenges. Fourteen challenges often encountered in the development of exposure were listed, including data availability, bias, human error, and false precision. Lastly, tempering expectations when modelling exposure is very important.

The following section of the training, the basic process of exposure data, was also presented by Charles K. Huyck. Exposure data is developed by collecting census data, estimating building attributes, refining spatial distribution, estimating number the of buildings, and estimating the replacement value.

The next section of training presented by Charles explained the value of EO data and its significant role in developing exposure data. Sections on this topic included global population datasets, global urban/rural or urban intensity datasets, segmentation of development patterns, building footprint extraction, average building size, challenges, and emerging research. Lastly, challenges to using EO data in the development of exposure data include low lights, under tree canopies, cloud cover, mountainous regions, and indigenous materials. There are areas of emerging research using EO such as the development of new sensors, AI, and data from street view, and UAVs.

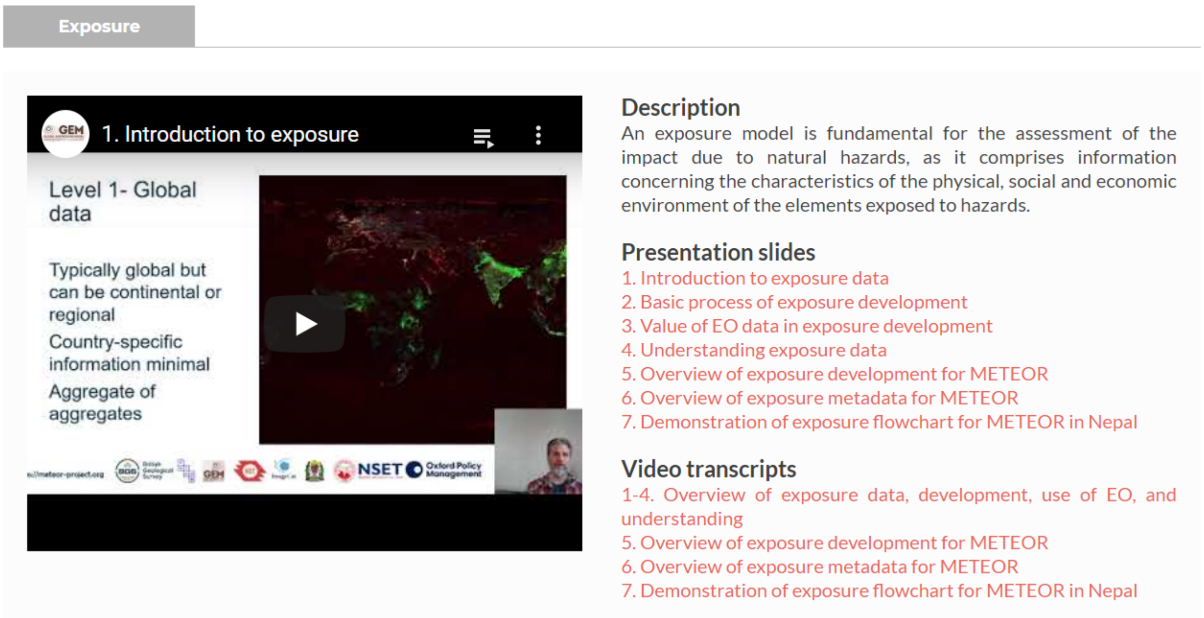
Understanding exposure data was the next topic of discussion. Charles introduced some of the contributions of the METEOR project to exposure development science, including a discussion of metadata and the various levels. The audience learnt what they should do when they receive exposure data on a project, and how to tell 'if it is any good'. Several of visuals of exposure were overlaid with hazard data so that users can understand intuitively why, for example, crude exposure is not adequate for localised hazard. One can check their exposure data and tell if it is fit for purpose by looking at the levels of exposure data, the resolution and scale of impact given the hazard, the key parameters, understanding the metadata, validation, and understanding the limitations. The five data levels, developed for the METEOR project, using Los Angeles exposure data were shown as examples. The law of large numbers can be problematic when considering exposure data. Persons per household, living area per household, rebuilding cost, and exchange rates are key, but often ignored data. Resolution and scale of impact given the hazard are important metrics. The metadata is a valuable source of information when using the exposure data. Aspects to look at are source, vintage, key contacts, resolution- final and base data, and methods. Important aspects of the development of exposure data to keep in mind are to illuminate the process, acknowledge the uncertainty, validate, look at the data and understand where it came from, understand the limitations, look at building costs and understand why they are important, looking at price disruption and at the questions trying to be answered. Exposure data created by ImageCat after the 2015 M8.1 earthquake in Nepal was used as an example. To conclude, questions one might use the exposure data to answer can include the following- Is it cost effective to retrofit certain types of buildings regionally? Where should we focus retrofitting efforts? Are building codes cost effective, and where? What might happen after a hundred-year flood or a large earthquake, or volcano There has just been a large earthquake, what are the likely impacts? Where is likely to have been most affected? How should we deploy resources? Questions that are not applicable to exposure data include-Is it cost effective to retrofit this building? Which buildings fell down? Which homes are flooded? Exactly how many buildings fell down?

The next discussion in the training was titled Heuristic Evaluations of Construction Patterns for Generating a Level 1 Exposure Database and led by Michael Eguchi. This section introduced key concepts to the audience relating to building vulnerability and development of country-specific mapping schemes. Identifying typical construction materials/systems can be done through reading scholarly reports, such as World Housing Encyclopedia (WHE), looking through reports about the specific country, building codes, and finding online imagery, such as streetview or geotagged photos. Bangladesh was used as an example.

Paul Amyx then led a talk on the purpose, content, and format of exposure metadata. Specific information that can be gleaned from the metadata are spatial resolution, source of the data, replacement cost, data vintage. Documentation and the metadata were discussed before a walkthrough of two examples of flowcharts- exposure data Level 1 and 5. Both ArcGIS and ESRI are systems in which the metadata can be created. Paul went through some examples of useful information that can be found in the metadata, including mapping scheme and development pattern definitions, detailed country-specific source data information and references, detailed country-specific processing steps, replacement cost information, data field descriptions, limitations, and contact information.

In the final section of the exposure training, Georgiana Esquivias described step-by-step the Level 3 flowcharts used for gathering data to develop the Level 3 building exposure for Nepal. Level 3 data is termed Data Improvement at the Sub-National level. Thirty-seven datasets were used to create the Level 3 data for Nepal. The flowcharts created for this level include building height, structural distribution, number of buildings, dasymetric mapping, replacement cost, and building area. Georgiana emphasised three concluding points. There is a great deal of information that goes into creating a building exposure database. These flowcharts assist in organising metadata collection and processing step review. Lastly, with these flow charts future researchers can update or refine the exposure database as a whole or finely tune an individual section with improved data.

Training Materials: Exposure



Introduction to Exposure

Video URL: https://youtu.be/AFuHJzfRbuk?list=PL08aqbvcszvSB-fRKzWgg9yZteLSxprTB

Presentation Slides

1. Introduction to exposure data
2. Basic process of exposure development
3. Value of EO data in exposure development
4. Understanding exposure data
5. Overview of exposure development for METEOR
6. Overview of exposure metadata for METEOR
7. Demonstration of exposure flowchart for METEOR in Nepal

Video Transcripts

1-4. Overview of exposure data, development, use of EO, and understanding

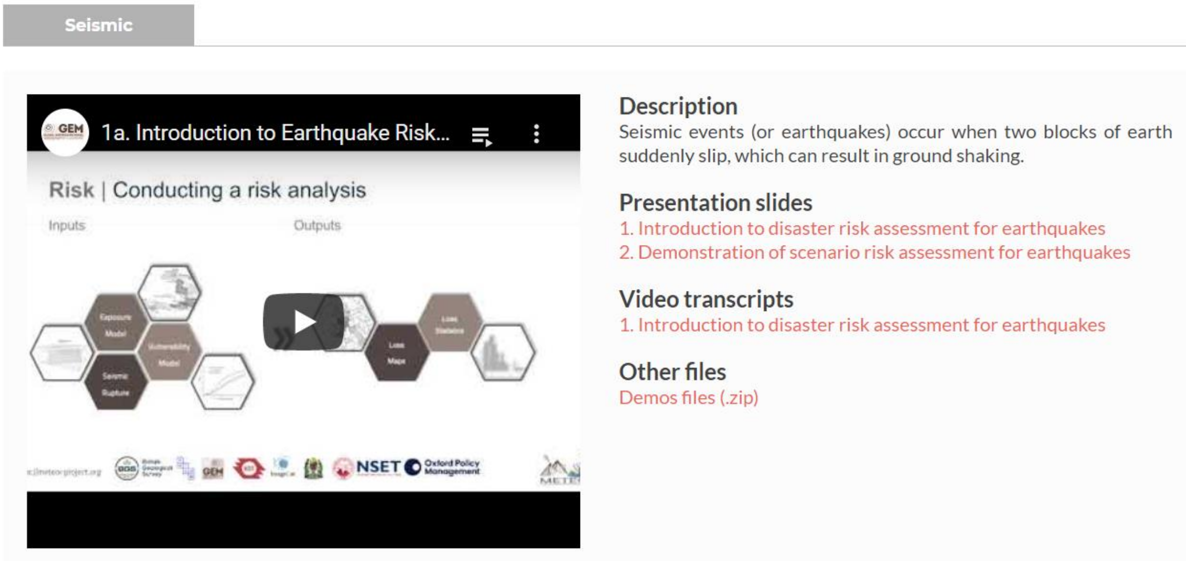
5. Overview of exposure development for METEOR
6. Overview of exposure metadata for METEOR
7. Demonstration of exposure flowchart for METEOR in Nepal

Seismic Modelling & Scenario Walkthrough, led by Nicole Paul, Global Earthquake Model (GEM)

Nicole Paul of GEM presented the Seismic training session, beginning with a discussion on disaster risk assessment for earthquakes. Risk has three components, hazard, exposure, and vulnerability. Within seismic hazard modelling there are seismic source characterisation and ground motion characterisation. Some seismic hazard terminology includes faults and ruptures, fault mechanisms, and rupture parameters. A seismic rupture can be defined through the geometry, magnitude, and mechanism of a fault source. Other topics examined were ground motion prediction equations, ground motion distance metrics, ground motion variability, side effects, and scenario hazard modelling. Nicole then examined exposure and exposure modelling, stating that “the exposure refers to the built environment and its contents and occupants, which are exposed to a seismic hazard source. Necessary parameters include the geographic location and replacement value for all loss types to be considered (e.g., financial loss due to building damage, casualties)”. When looking at the geographical attributes of assets, it is important to identify the geographical location of the exposed elements with respect to the source(s) of seismicity, since the ground motion intensity is a function of the distance to the source. One should also look at the value and structural attributes of assets. Vulnerability was the next topic of discussion, beginning with fragility and vulnerability models. Seismic fragility is defined through the damage states, which “establish the level of damage that an exposed asset will experience under certain engineering demand parameters (EDPs) are met”. Fragility, consequences, and vulnerability can be modelled. Last was the topic of risk, including conducting a risk analysis, creating a scenario loss map and a scenario loss ratio map.

Nicole then led the participants through an earthquake disaster risk assessment demonstration. This assessment was done through OpenQuake, a free, public and open-source code. Explanation of the installation process of OpenQuake and how to find the manual, engine calculators, and scenario models was given. Also provided were some links to useful information about the program and instruction on running the program, including some command line basics. The scenario 1 demonstration included the following instructional slides: input and output files, job configuration file, rupture model file, site model file, ground motion models, running the analysis, outputs from calculations, and hazard maps. Scenario damage was demonstrated with the following slides: input and output files, job configuration file, exposure model file, visualization of exposure data, taxonomy model file, fragility model file, running the analysis, outputs from calculation, and scenario damage maps. The next demonstration was the creation of scenario risk, including input and output file, job configuration file, vulnerability model file, running the analysis, outputs from calculation, scenario loss maps, and scenario loss ratio maps.

Training Materials: Seismic Hazard and Earthquake Scenario



Introduction to Earthquake Risk

Video URL: https://youtu.be/6N9sR_dqoKc?list=PL08aqbvcszvQ_1giOFNSxo6T7nwoqjGSg

Presentation Slides

1. Introduction to disaster risk assessment for earthquakes
2. Demonstration of scenario risk assessment for earthquakes

Video Transcripts

1. Introduction to disaster risk assessment for earthquakes

Other Files

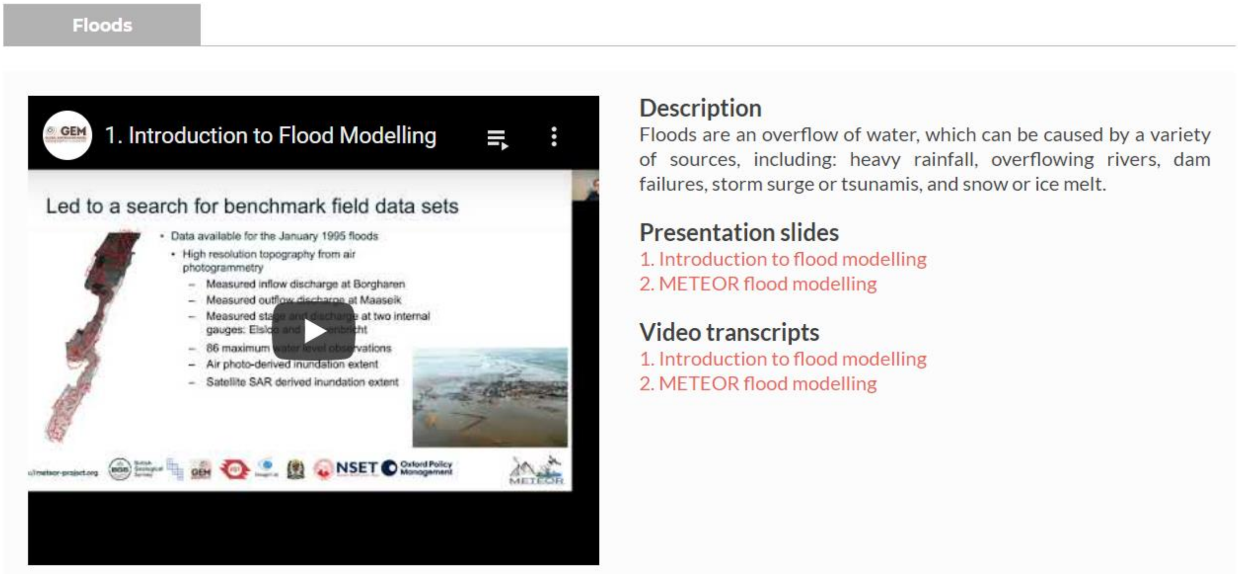
1. Demos files (.zip)

Flood Modeling Training Session, led by Christopher Sampson, Fathom

Christopher Sampson from Fathom led the Flood Modelling training session. A flood model is "a computer-based simulation of flood inundation and more specifically, a simulation of large, low-amplitude, shallow water waves". Discussion of the flood modelling and some background to how it was developed and used over the last 20 years was next. The advent of topography data was a breakthrough and at this point benchmark field data sets were sought after. There are differences between using models compared to benchmark data and once multiple models began to be used, modellers came to understand that simple models did as well as complex ones, given data errors, increasing model resolution was a better way to improve skill, terrain data accuracy and resolution are more important than physics, and floodplain inundation is, to first order, a simple gravity-friction balance. This all led to the belief that a new modelling approach was needed, leading the discussion to modern flood models. There are two conservation laws in flood modelling, conservation of mass and of momentum. The New LISFLOOD-FP formulation, which includes continuity and momentum equations. A description of how flood models work and what data is needed in order to develop a model was given, using the River Severn in the UK as an example. Here the question is posed, are dynamic models necessary? Can't we just use GIS? The example of Machine Learning inundation models from Woznicki et al (2018) is used as an example. Using these models have pros and cons which are basically that they can only interpolate, not extrapolate. There are two types of flood spreading algorithms, non-mass conserving, and mass conserving. Some of the replacements for dynamic models include pure ML approaches and Rapid Flood Spreading Algorithms, but both have limitations. The session was concluded with the following statements: Many large scale river flows can be represented by simplified shallow water physics; Given finite computing resources, model skill is improved more by increasing resolution than improving the physics; Highly resolved models now possible; ~ 1 - 2 m over whole major cities (where data permits); ~30 - 100 m over whole continents (using globally available data); and lastly, fusing models, ground and space data is yielding new insights into surface water dynamics.

In the second section of the Flood modelling training, Christopher Sampson walked the participants through the national scale data developed by the METEOR team for Nepal. The introduction included discussion of the data, methods used to create the data and potential applications. The first type of key data in this project is Terrain data, which is critical and has components. Hydrography is another data key to flood modelling, as is MERIT Hydro, the "most accurate global hydrography dataset". The discussion of methods of flood modelling began with the topic of Automated Model Framework. Instructional slides included the methods of modelling terrain, discharge, rainfall, river networks, boundary conditions, hydrodynamic models, and post-processer. Data applications for differing stakeholders were broken down into the type of information, planning, and potential actions resulting from the information.

Training Materials: Flood Modelling



Introduction to Flood

Video URL: https://youtu.be/LyRcfxIVsb8?list=PL08aqbvcszvRCG4blOhhOXSpT4VZM9HuY

Presentation Slides

1. Introduction to flood modelling

2. METEOR flood modelling

Video Transcripts

1. Introduction to flood modelling

2. METEOR flood modelling

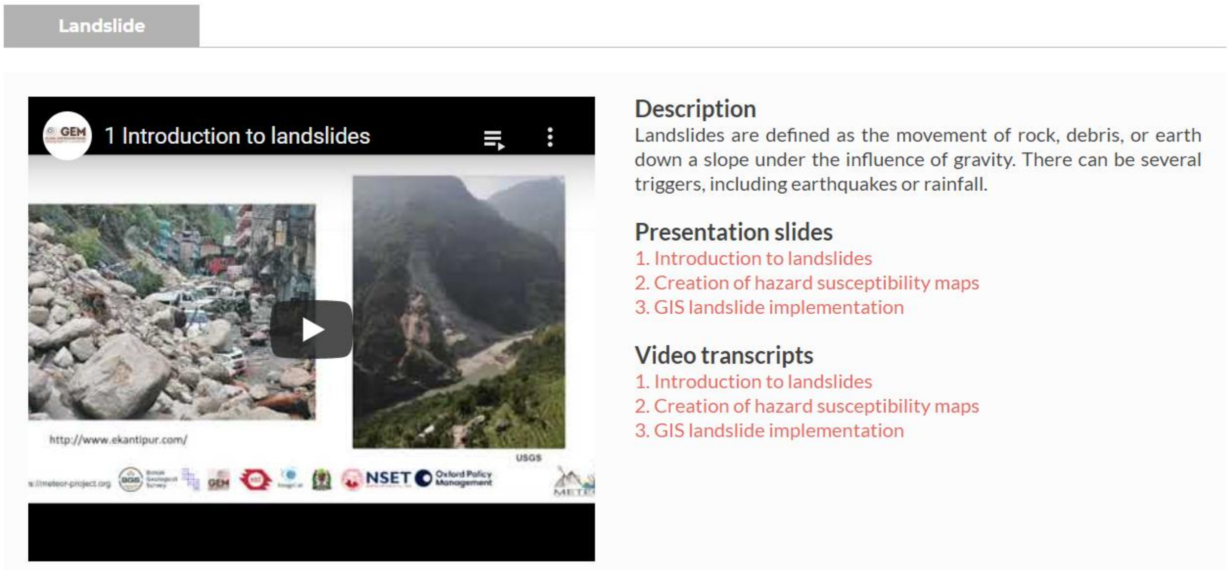
Landslide Modelling, led by Roxana Ciurean and Claire Dashwood, BGS

Roxana Ciurean and Claire Dashwood of BGS led the training session on Landslide Modelling. Landslides are a type of mass wasting characterised by downslope movement of soil and rock under the direct influence of gravity. They are classified by type of movement, rate of movement (speed or velocity), age/activity of movement, and they are commonly used classifications include Hungr (2013), Varnes (1954, 1978), Sharpe (1938) and Cruden and Varnes 1996). There are a number of potential causes of landslides, including certain ground conditions, geomorphological processes, physical processes, and anthropogenic processes. Landslides can be triggered by rainfall, both prolonged and intense short burst rain. They can also be triggered by earthquakes and take the form of rock falls or soil/rockslides from steep slopes or earth spreads or earth slumps on gentler slopes. Landslide inventories can be either archive inventories, which are produced through archives, reports, maps and newspapers, or geomorphological inventories, which are historical, event, seasonal or multi-temporal. These are different from landslide susceptibility maps, which can be defined as “a quantitative or qualitative assessment of the spatial distribution of landslides which exist or potentially may occur in an area (Fell et al. 2008)”. The methods for creating these maps are both quantitative and qualitative.

The creation of landslide susceptibility and hazard maps in Nepal was the next discussion. This began with explanations of the flowcharts of Landslide Susceptibility in Nepal-Predisposing/Preparatory data, Frequency Ratio Analysis, Fuzzy Logic, Expert Elicitation, Aggregation, Landslide Hazard Maps. There were eight types of predisposing/preparatory data used in the development of landslide maps for Nepal. Frequency ratio and fuzzy logic are important aspects of the modelling to understand, as are the expert judgment elicitation, and the Cooke Classical Method, and the process of weighting.

The presenters then introduced the implementation of the model in GIS, illustrated for rainfall-induced landslides. This section introduced the participants to the modelling tool, ModelBuilder from ArcGIS, and demonstrated the input data workflow. Two examples were shown: example A: fuzzy membership function for continuous-scaled variables, and example B: fuzzy membership function for categorical variables. Lastly, model and resulting susceptibility and hazard maps were discussed.

Training Materials: Landslide Modelling



Introduction to Landslides

Video URL: https://youtu.be/EOSqVWMPvFw?list=PL08aqbvcszvRKGRnmKsL1u73eHno-m0SM

Presentation Slides

1. Introduction to landslides
2. Creation of hazard susceptibility maps
3. GIS landslide implementation

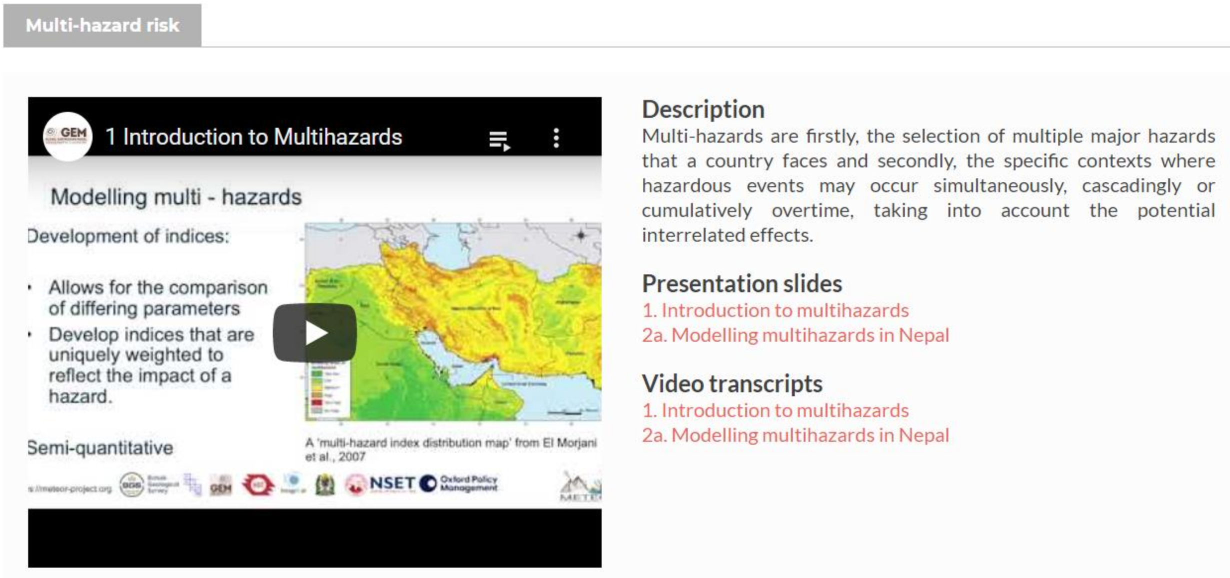
Video Transcripts

1. Introduction to landslides
2. Creation of hazard susceptibility maps
3. GIS landslide implementation

Multi-Hazard Risk Modelling, led by Annie Winson, BGS

Annie Winson led the Multi-hazard Modelling training session. The session began with an introduction to multi-hazards and complexity in modelling. Multi-hazard assessments have complications to consider. There are five types of multi-hazards: 1) Independent - hazards that occur independent of each other but that have a spatial and / or temporal coincidence; 2) Triggering – implies a primary and secondary hazard; 3) Change conditions – one hazard alters the probability of another hazard by changing the underlying conditions; 4) Compound hazard – different hazards that are the result of the same primary event; and 5) Mutual exclusion – two hazards that show a negative dependence. The next topic was spatial and temporal scales, how they interact and the resulting implications. Modelling multi-hazards requires a classification of hazards and the development of indices. Key modelling variations include: 1) type of hazard; 2) scale- may be local/city/catchment, regional, and global; 3) the higher the resolution, the more information required; 4) focus- different resources maybe required depending on the focus, e.g. Civil engineers for building surveys and social scientist to advise on socio economic indicators; 5) type: Quantitative, Semi-Quantitative or Qualitative models; 6) model inputs: concerning only hazard data or else also incorporating vulnerability and socio-economic indicator; and 7) end users. Visualising multi-hazards is different than for single hazards. It involves joint variable visualisations. Maps that visualise multi-hazards provide simultaneous information on spatial coincidences but can also make the maps difficult to read. To summarise: 1) There are different types of hazard interrelations and scales of hazards; 2)The comparison of hazards is difficult due to different process characteristics; 3) Classification and index schemes can help to overcome this problem; 4) There are many existing multi-hazard models that have been designed to address differing variables – it is therefore important to assess these parameters before apply or designing a model; and 5) Visualising multi-hazards is non-trivial and may require different outputs for different end users/purposes.

Training Materials: Multi-Hazard Risk Modelling



Introduction to Multi-hazards

Video URL: https://youtu.be/PNr2aLnU2GI?list=PL08aqbvcszvSL5pbqiec-CrL9M1nYJdh8

Presentation Slides

1. Introduction to multi-hazards
2. Modelling multi-hazards in Nepal

Video Transcripts

1. Introduction to multi-hazards
2. Modelling multi-hazards in Nepal

4.3. Technical Training Supporting Material

Additional supporting material and tools are also provided through the training. These are freely downloadable and linked through the METEOR website:

1. ArcGIS Training
2. QGIS on the road
3. OQ Introduction & Installation

Annex A: Lists of Stakeholders that Participated in Training

Stakeholder Training Attendance

February 25th – 26th 2021, Dodoma Tanzania

Table 3: Day 1 AM Online Non-METEOR Attendees

Name	Position	Institution
Devyani Gajjar		Open University
Mdathiru Abubakar		World Food Programme
Venla Aaltonen		Resilience Academy
Enock Molla		
Sisahau Ahmada		
Siajabu Msafirji		
Abbas Kitogo		

Table 4: Day 1 AM Attendees on location in Tanzania

Name	Position	Institution
Charles Msangi		DMD-PMO
Col Jimmy M. Said	Director DMD	DMD-PMO
John Kiriwai	Statistician & DRM coordinator	DMD-PMO
Abigael B.Marwa	Social Welfare Officer	DMD-PMO
Alex Ndimbo	ICTO	DMD-PMO
Ally Mwantima	Economist	DMD-PMO
Mahulu N.Butondo	DRR	DMD-PMO
Eugenia John		DMD-PMO
Ewald Bonifasi	Economist	DMD-PMO
Consolata Mbanga		DMD-PMO
Valentina Sanga		DMD-PMO
Wilfrida E. Ngowi	SWO-DRR	DMD-PMO
Numpe N. Mwambeja	HRO-DMD	DMD-PMO

Nyamagory O.Kitwara	IO-PMO	DMD-PMO
Yona Benjamini	ICT-DMD	DMD-PMO
Japher Mtengwa		DMD-PMO
Edna Chibwana		DMD-PMO
Nuru Said Gagu		DMD-PMO
Saidi Chotimbao		DMD-PMO
Edga Sanga		DMD-PMO
Godfrey A. Sanga	Administrative Officer	DMD-PMO
Emanuel Kombe	Project Manager	OMDTZ/HOT
Innocent Maholi	Executive Director	OMDTZ/HOT
Hawa Adinani	Communications Lead	OMDTZ/HOT
Alex Masanja		Geological Survey of Tanzania
Aminiel Mshana		DarMAERT
Africos Mattogoro	Principal Game Officer-DM	Ministry of Natural Resources and Tourism
Jeremiah Regera		Ministries of Livestock and Fisheries
Henry Mchome		Ministry of Water
Godrey Mwangole		Ministry of Lands
Bernard Abraham		Dodoma Regional Office
Elias Lipko	Meteorologist	Tanzania Meteorological Agency)
Charo Mangare		Fire and Rescue Force
Haika V.Mgonja	Economist	Ministry of Finance
Jonston Wenston	Tanzania Red Cross-Disaster Preparedness	Tanzania Red Cross
Shukuru Njati	Env. Officer	TARURA
Ecklesia Sironga		Ministry of Works and Transport
Emmanuel Experious		Ministry of Agriculture
Risper Koyi		VPo
Java Myulla		E-Government Agency
Marry Ponela		Ministry of Mining

Table 5 Day 1 PM Online NON-METEOR Attendees

Name	Position	Institution
Devyani Gajjar		Open University
Mdathiru Abubakar		World Food Programme
Venla Aaltonen		Resilience Academy
Nicholaus Mwageni		Ardhi University
Erick Tamba		SUA
Imma Mwanja		OMDTZ
Sisahau Ahmada		
Doreeen Shedrack		
Abbas Kitogo		

Table 6: Day 1 PM Attendees on location in Tanzania

Name	Position	Institution
Charles Msangi		DMD-PMO
Col Jimmy M. Said	Director DMD	DMD-PMO
John Kiriwai	Statistician & DRM coordinator	DMD-PMO
Abigael B.Marwa	Social Welfare Officer	DMD-PMO
Alex Ndimbo	ICTO	DMD-PMO
Ally Mwantima	Economist	DMD-PMO
Mahulu N.Butondo	DRR	DMD-PMO
Eugenia John		DMD-PMO
Ewald Bonifasi	Economist	DMD-PMO
Consolata Mbanga		DMD-PMO
Valentina Sanga		DMD-PMO
Wilfrida E. Ngowi	SWO-DRR	DMD-PMO
Numpe N. Mwambeja	HRO-DMD	DMD-PMO
Nyamagory O.Kitwara	IO-PMO	DMD-PMO
Yona Benjamini	ICT-DMD	DMD-PMO
Japher Mtengwa		DMD-PMO

Edna Chibwana		DMD-PMO
Nuru Said Gagu		DMD-PMO
Saidi Chotimbao		DMD-PMO
Edga Sanga		DMD-PMO
Godfrey A. Sanga	Administrative Officer	DMD-PMO
Emanuel Kombe	Project Manager	OMDTZ/HOT
Innocent Maholi	Executive Director	OMDTZ/HOT
Hawa Adinani	Communications Lead	OMDTZ/HOT
Alex Masanja		Geological Survey of Tanzania
Aminiel Mshana		DarMAERT
Africos Mattogoro	Principal Game Officer-DM	Ministry of Natural Resources and Tourism
Jeremiah Regera		Ministries of Livestock and Fisheries
Henry Mchome		Ministry of Water
Godrey Mwangole		Ministry of Lands
Bernard Abraham		Dodoma Regional Office
Elias Lipko	Meteorologist	Tanzania Meteorological Agency)
Charo Mangare		Fire and Rescue Force
Haika V.Mgonja	Economist	Ministry of Finance
Jonston Wenston	Tanzania Red Cross-Disaster Preparedness	Tanzania Red Cross
Shukuru Njati	Env. Officer	TARURA
Ecklesia Sironga		Ministry of Works and Transport
Emmanuel Experious		Ministry of Agriculture
Risper Koyi		VPo
Java Myulla		E-Government Agency
Marry Ponela		Ministry of Mining

Table 7: Day 2 AM Online NON-METEOR Attendees

Name	**Position**	**Institution**
Devyani Gajjar		Open University
Mdathiru Abubakar		World Food Programme

Enock Molla		
Sisahau Ahmada		
Erick Tamba		SUA
Fadhili Mtengela		
Domina		
Msilikale		

Table 8: Day 2 AM Attendees on location in Tanzania

Name	Position	Institution
Charles Msangi		DMD-PMO
Col Jimmy M. Said	Director DMD	DMD-PMO
John Kiriwai	Statistician & DRM coordinator	DMD-PMO
Ally Mwantima	Economist	DMD-PMO
Alex Ndimbo	ICTO	DMD-PMO
Mahulu N.Butondo	DRR	DMD-PMO
Esta Samson;		
Eugenia John		DMD-PMO
Ewald Bonifasi	Economist	DMD-PMO
Consolata Mbanga		DMD-PMO
Valentina Sanga		DMD-PMO
Wilfrida E. Ngowi	SWO-DRR	DMD-PMO
Numpe N. Mwambeja	HRO-DMD	DMD-PMO
Nyamagory O.Kitwara	IO-PMO	DMD-PMO
Yona Benjamini	ICT-DMD	DMD-PMO
Japher Mtengwa		DMD-PMO
Edna Chibwana		DMD-PMO
Nuru Said Gagu		DMD-PMO
Saidi Chotimbao		DMD-PMO
Edga Sanga		DMD-PMO
Godfrey A. Sanga	Administrative Officer	DMD-PMO

Emanuel Kombe	Project Manager	OMDTZ/HOT
Innocent Maholi	Executive Director	OMDTZ/HOT
Hawa Adinani	Communications Lead	OMDTZ/HOT
Alex Masanja		Geological Survey of Tanzania
Aminiel Mshana		DarMAERT
Africos Mattogoro	Principal Game Officer-DM	Ministry of Natural Resources and Tourism
Jeremiah Regera		Ministries of Livestock and Fisheries
Henry Mchome		Ministry of Water
Godrey Mwangole		Ministry of Lands
Bernard Abraham		Dodoma Regional Office
Elias Lipko	Meteorologist	Tanzania Meteorological Agency)
Charo Mangare		Fire and Rescue Force
Haika V.Mgonja	Economist	Ministry of Finance
Jonston Wenston	Tanzania Red Cross-Disaster Preparedness	Tanzania Red Cross
Shukuru Njati	Env. Officer	TARURA
Ecklesia Sironga		Ministry of Works and Transport
Emmanuel Experious		Ministry of Agriculture
Risper Koyi		VPo
Java Myulla		E-Government Agency
Marry Ponela		Ministry of Mining

Table 9: Day 2 PM Online NON-METEOR Attendees

Name	Position	Institution
Devyani Gajjar		Open University
Sisahau Ahmada		

Table 10: Day 2 PM Attendees on location in Tanzania

Name	Position	Institution
Charles Msangi		DMD-PMO

Col Jimmy M. Said	Director DMD	DMD-PMO
John Kiriwai	Statistician & DRM coordinator	DMD-PMO
Abigael B.Marwa	Social Welfare Officer	DMD-PMO
Alex Ndimbo	ICTO	DMD-PMO
Ally Mwantima	Economist	DMD-PMO
Mahulu N.Butondo	DRR	DMD-PMO
Eugenia John		DMD-PMO
Ewald Bonifasi	Economist	DMD-PMO
Consolata Mbanga		DMD-PMO
Valentina Sanga		DMD-PMO
Wilfrida E. Ngowi	SWO-DRR	DMD-PMO
Numpe N. Mwambeja	HRO-DMD	DMD-PMO
Nyamagory O.Kitwara	IO-PMO	DMD-PMO
Yona Benjamini	ICT-DMD	DMD-PMO
Japher Mtengwa		DMD-PMO
Edna Chibwana		DMD-PMO
Nuru Said Gagu		DMD-PMO
Saidi Chotimbao		DMD-PMO
Edga Sanga		DMD-PMO
Godfrey A. Sanga	Administrative Officer	DMD-PMO
Emanuel Kombe	Project Manager	OMDTZ/HOT
Innocent Maholi	Executive Director	OMDTZ/HOT
Hawa Adinani	Communications Lead	OMDTZ/HOT
Alex Masanja		Geological Survey of Tanzania
Aminiel Mshana		DarMAERT
Africos Mattogoro	Principal Game Officer-DM	Ministry of Natural Resources and Tourism
Jeremiah Regera		Ministries of Livestock and Fisheries
Henry Mchome		Ministry of Water
Godrey Mwangole		Ministry of Lands
Bernard Abraham		Dodoma Regional Office

Elias Lipko	Meteorologist	Tanzania Meteorological Agency)
Charo Mangare		Fire and Rescue Force
Haika V.Mgonja	Economist	Ministry of Finance
Jonston Wenston	Tanzania Red Cross-Disaster Preparedness	Tanzania Red Cross
Shukuru Njati	Env. Officer	TARURA
Ecklesia Sironga		Ministry of Works and Transport
Emmanuel Experious		Ministry of Agriculture
Risper Koyi		VPo
Java Myulla		E-Government Agency
Marry Ponela		Ministry of Mining

Stakeholder Pre-Workshop Session Attendance

9 March 2021, Nepal

Name	Position	Institution
Anil Pokhrel	Chief Executive	NDRRMA
Angela Tamrakar	Disaster Risk Reduction Researcher	Youth Innovation Lab
Suresh Chaudhary	GIS Expert	NSET
Dammar Singh Pujara	GIS expert	NSET
Ram Shrestha	Geomatics Engineer	NSET
Alina Khatiwada	Environmentalist, Researcher	Youth Innovation Lab
Reena Bajracharya	BIPAD	Youth Innovation Lab
Sarmila Paudyral	Geologist	NSET
Beejay Kumar Maharjan	Section Officer	NDRRMA
Anup Dhakal	Disaster Risk Reduction and Information Management Officer	NDRRMA
Buddhi Raj Shrestha	GIS Officer	NSET
Reena Chaudhray		NDRRMA
Suchita Shrestha		Dept Mines & Geology
Janardan Gautam	Engineer	Nepal Electricity Authority
Lekh Bhatta	Engineering Geologist	NRA/NDRMMA
Arun Poudel		NDRMMA