METEOR

Modelling Exposure Through Earth Observation Routines

INTRODUCTION TO MULTI-HAZARDS

https://meteor-project.o

METEOR project

Modeling Exposure Through Earth Observation Routines

- Three-year project
- Funded by UK Space Agency
- Aims to develop innovative application of Earth Observation (EO) technologies to improve understanding of exposure
- Specific focus on pilot countries Nepal and Tanzania
- Consortium of eight organizations

funded by:

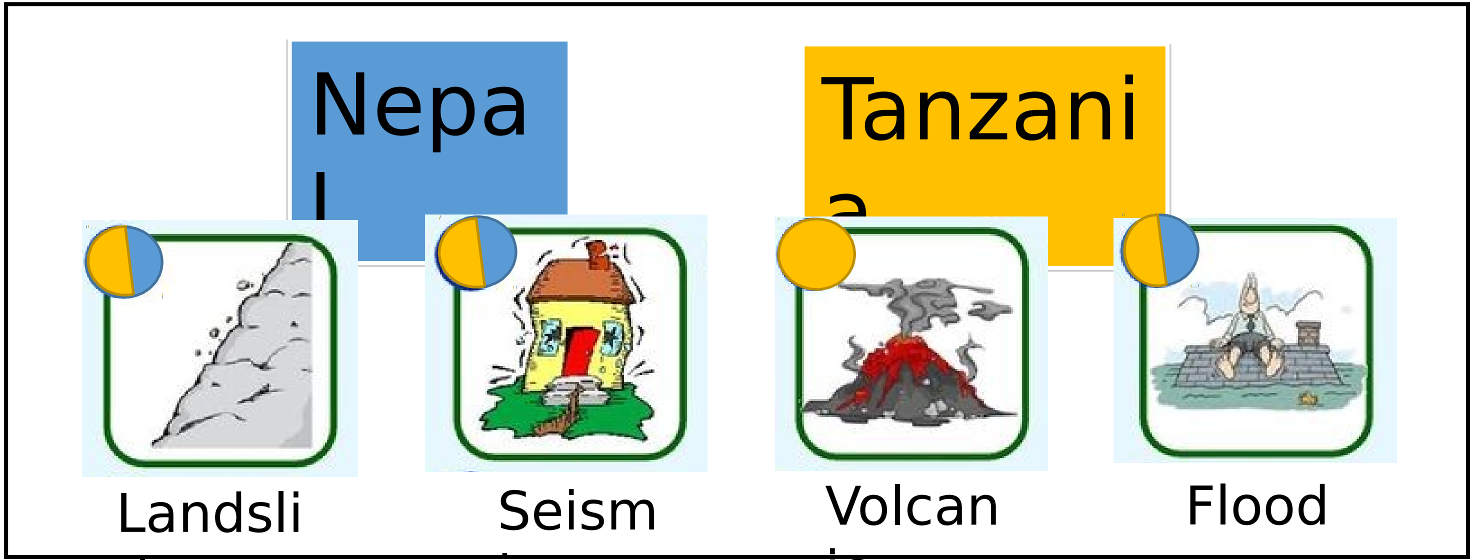
project consortium:

https://meteor-project.org

Introduction to multi-hazards and complexity in modelling

1. What are multi-hazards?
2. The importance of understanding multi-hazards
3. Type and scale of multi-hazards
4. Methods for modelling multi-hazards
5. Visualizing multi-hazards

What are multi-hazards?



***"Multi-hazard** means (1) the selection of multiple major hazards that the country faces, and (2) the specific contexts where hazardous events may occur simultaneously, cascadingly or cumulatively over time, and taking into account the potential interrelated effects" – UNDRR (2019)*

British Geological Survey

METEOR

The importance of multi-hazards

“*Undertaking of complete multi-hazard research into risk and vulnerability of human settlements and settlement infrastructure, including water and sewerage, communication and transportation networks, as one type of risk reduction may increase vulnerability to another (e.g., an earthquake-resistant house made of wood will be more vulnerable to wind storms*” (UNEP, 1992)

“Disaster risk reduction practices need to be multi-hazard and multisectoral, inclusive and accessible in order to be efficient and effective”

Introduction to multi-hazards

Single hazards exhibit various characteristics such as: time of onset, duration and extent

Multi-hazard assessments are complicated by:

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
4. Any of the existing measures of hazard quantification need to be adapted to allow for comparison of multiple hazards

Types of multi-hazards

After Tilloy et al (2019):

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.
5) Mutual exclusion – Two hazards that show a negative dependence.

Spatial and Temporal scales

Type	Interaction	Implications for
Only Spatial	Hazards of different sources occurring in the same location at different times.	Building codes / design of mitigation measures. It is possible that an effort to stabilize an element at risk for one hazard may destabilize it in reference to another.
Neither spatial nor temporal	Different hazards occurring in different locations at different times.	No importance to physical vulnerability but may have implications for the awareness and education of the population and their behaviour.
Spatially and temporally	Hazards that occur at the same location at the same time. These may trigger each other (e.g. and earthquake causing widespread landslides) or they may simply be simultaneous.	Understanding the implications of cascading or simultaneous hazards on buildings, response, pre-positioning etc. An area defined as low hazard for a single hazard may be more exposed in the event of multiple hazards occurring at the same time, or exacerbated by each other.
Only temporally	Hazards that occur at the same time but in different locations.	Emergency planners (national / government), as they may be called upon to manage two events from separate administrative units simultaneously.

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Modelling multi - hazards

Essential to standardise single hazard data to a common measure. This is achieved by:

1. Classification of hazards
2. Development of indices

Depending on how these standardisation calculations are approached, a model can be thought to be qualitative, semi-quantitative or quantitative.

Natural Hazard	INTENSITY SCALES			
	Low	Medium	High	Parameters
Flood	<0.25	0.2 - 1.25	>1.25	Flood depth (m)
Forest Fire	< 350	350-1750	>1750-3500	Predicted Fire-line Intensity(*) (kW/m)
Forest Fire	< 1.2	1.2-2.5	>2.5-3.5	Approximate Flame Length (m)
Volcanoes	<5	5-10	>10	Intensity= Volcanic Explosive Index $\log_{10}$(mass eruption rate, kg/s) + 3
Landslide (fast and slow movements)	<5%	5 - 15%	>15 %	percentage of landslide surface (m^2, Km^2, ...) Vs stable surface;
Seismic	< 10 %g	10 - 30 %g	>30 %g	Peak ground horizontal Acceleration (%g)

An example of hazard classification from the European ARMONIA project (Menoni, 2006)

Modelling multi - hazards

Classification of hazards:

Intensity and frequency thresholds are defined in order to classify the respective hazards into a predefined number of hazard classes (e.g. High, Medium and Low). This allows for an equivalency between hazards.

Qualitative

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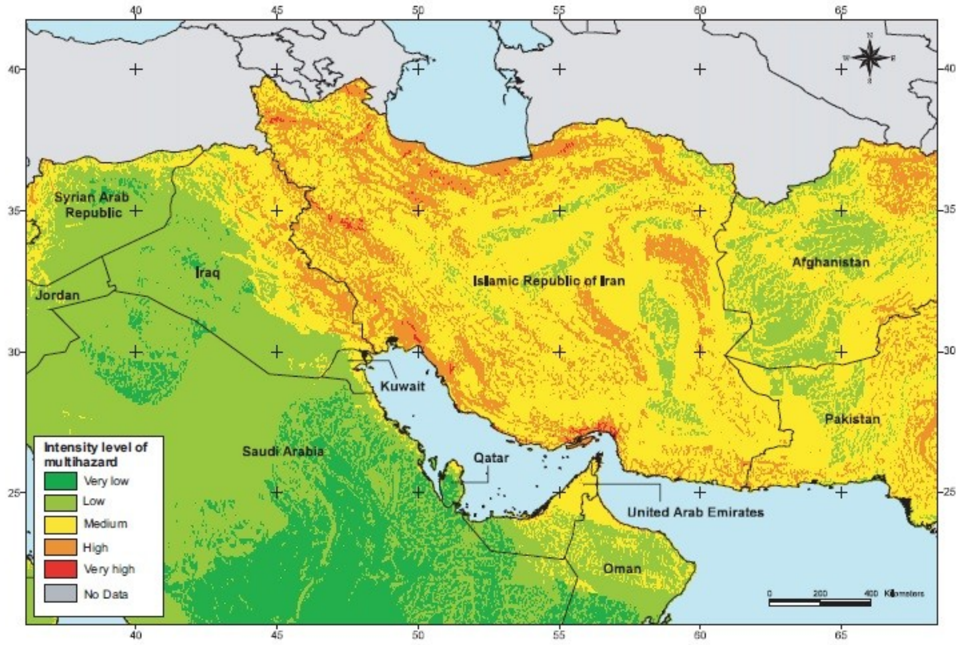
Modelling multi - hazards

Development of indices:

- Allows for the comparison of differing parameters
- Develop indices that are uniquely weighted to reflect the impact of a hazard.

Semi-quantitative



A 'multi-hazard index distribution map' from El Morjani et al., 2007

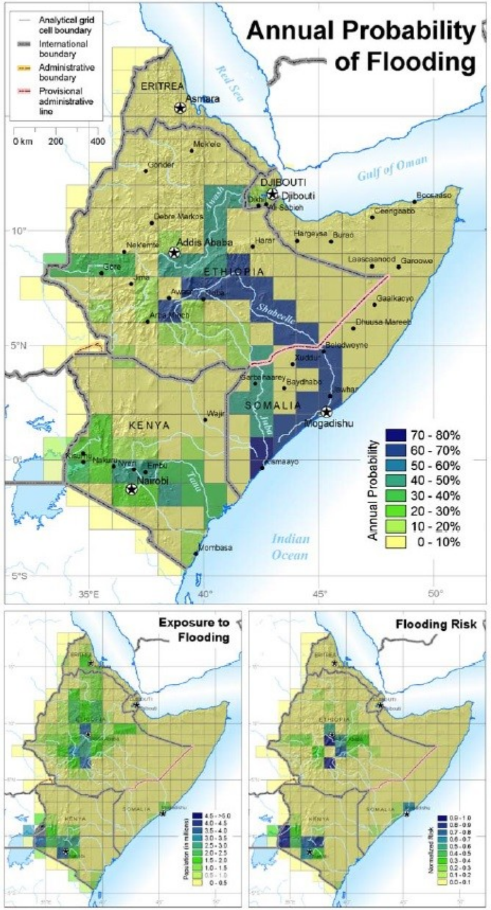
Key modelling variations

- Type of hazard: Only address natural (geological and meteorological hazards). Other models include anthropogenic hazards.
- Scale: May be - local/city/catchment, regional, and global. The higher the resolution, the more information required.
- 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.
- Type: Quantitative, Semi-Quantitative or Qualitative models
- Model Inputs: Concerning only hazard data or else also incorporating vulnerability and socio-economic indicators.
- End users: Who is getting the data and what will they do with it.

Visualising multi-hazards

Single hazard visualizations:

- Refers to a set of maps that display the single hazards one by one.
- Allows user to observed detailed patterns
- Does not unite data

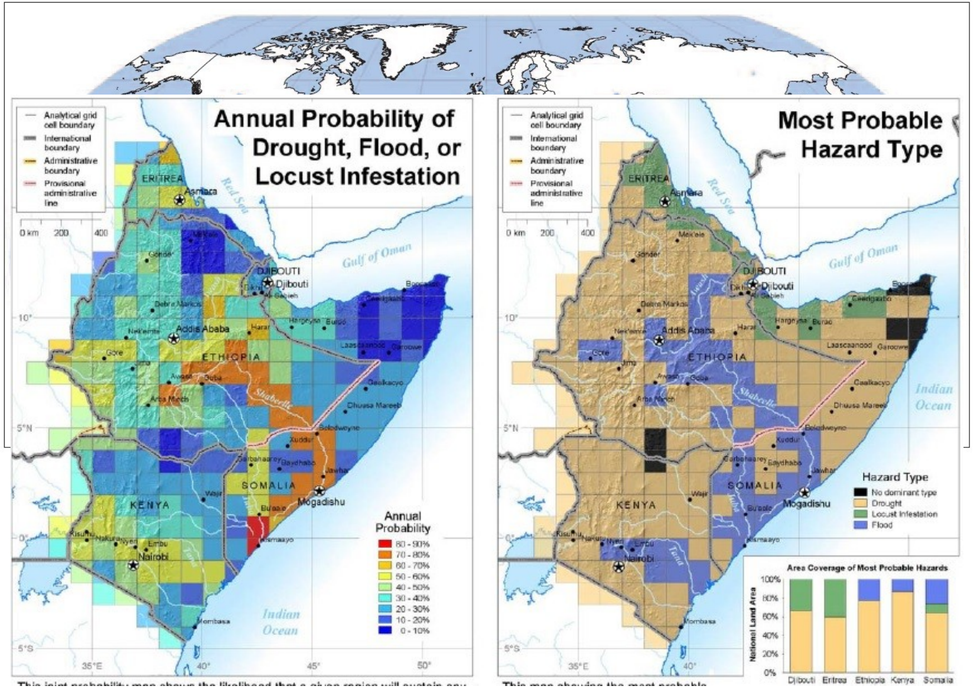


‘Flooding probability and risk analysis’ from Bartel and Muller, 2007. Hazard, Exposure and Risk are visualised separately in this study

Visualising multi-hazards

Joint variable visualisations:

- Must involved some data transformation or aggregation.
- Reduce the multi-dimensionality to one pixel
- Display as the number of relevant processes per pixel.

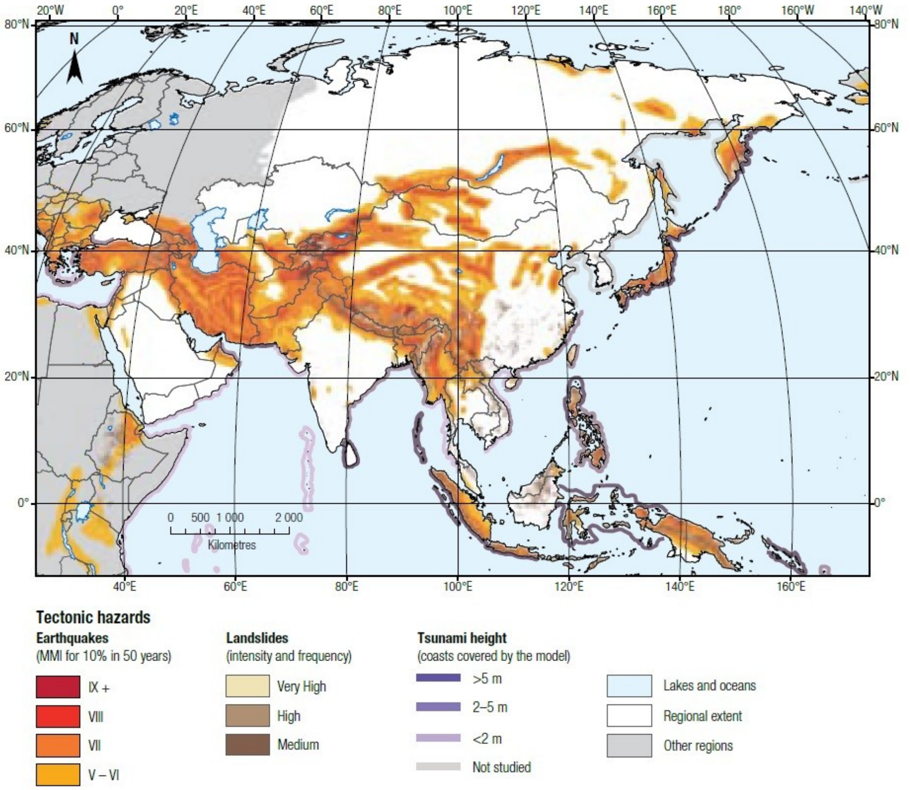


Hazard 'annual probability' and 'most probable' maps from Bartel and Muller, 2007.

Visualising multi-hazards

Maps visualising multi-hazards

- Provide simultaneous information on spatial co-incidences.
- Can make maps difficult to read



multi-hazard map of Asia. GAR, 2009.

Summary

- There are different types of hazard interrelations and scales of hazards.
- The comparison of hazards is difficult due to different process characteristics
- Classification and index schemes can help to overcome this problem
- 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.
- Visualising multi-hazards is non-trivial and may require different outputs for different end users / purposes.

Key References

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