Creating Impact with Data Analytics for Humanitarian Aid and Disaster Preparedness

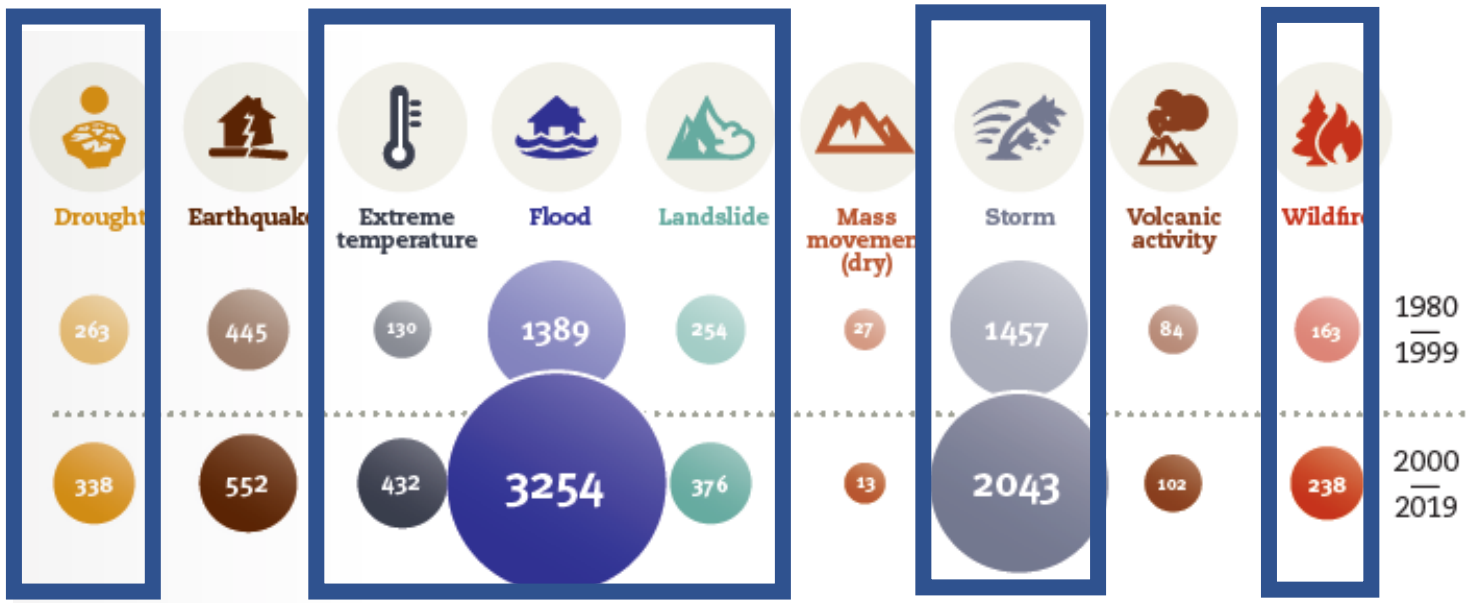
Conference Analytics for a Better World

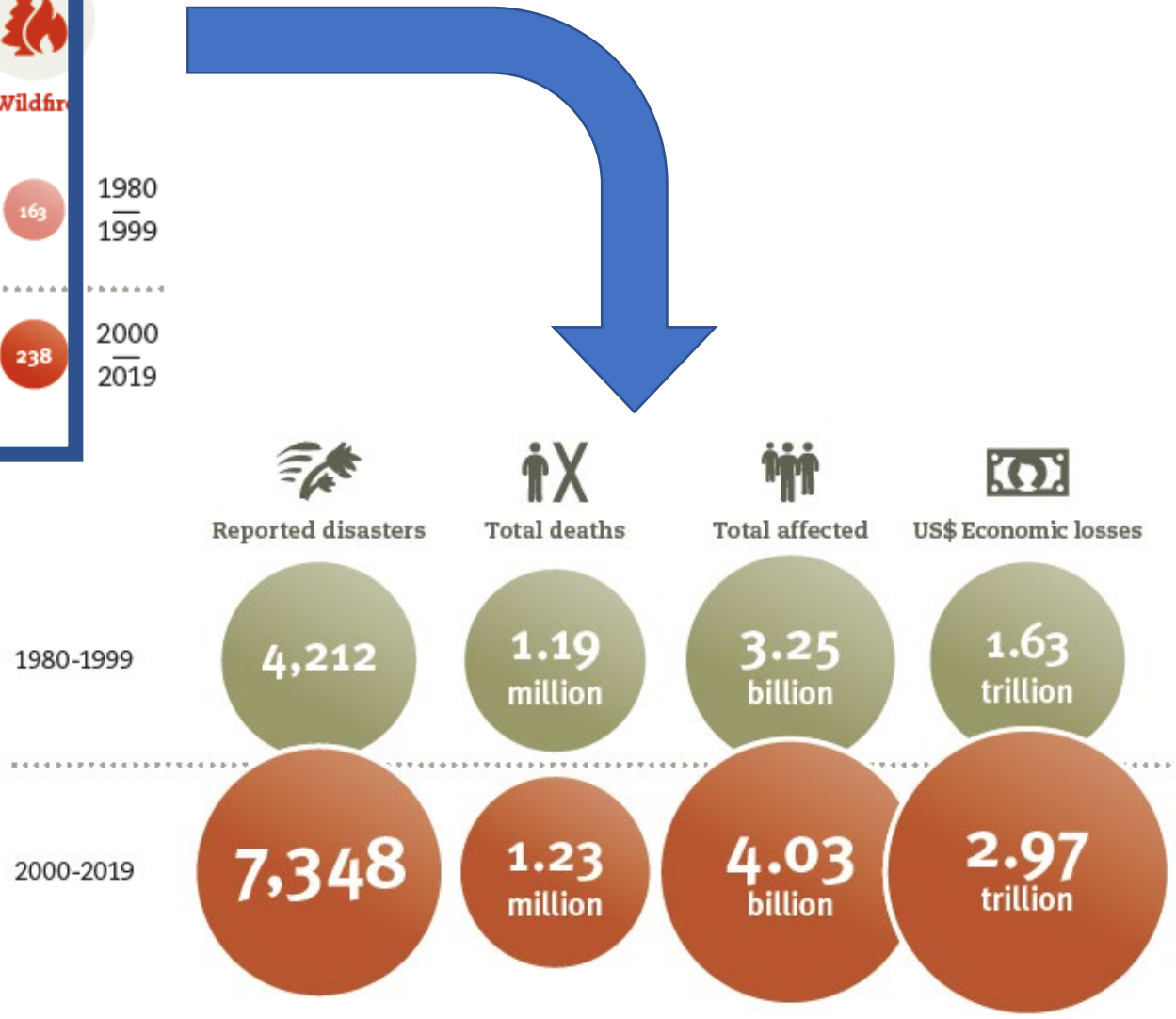
Marc van den Homberg

1/6/2022

An initiative of the Netherlands Red Cross

MORE CLIMATE-RELATED DISASTERS, INCREASED IMPACT

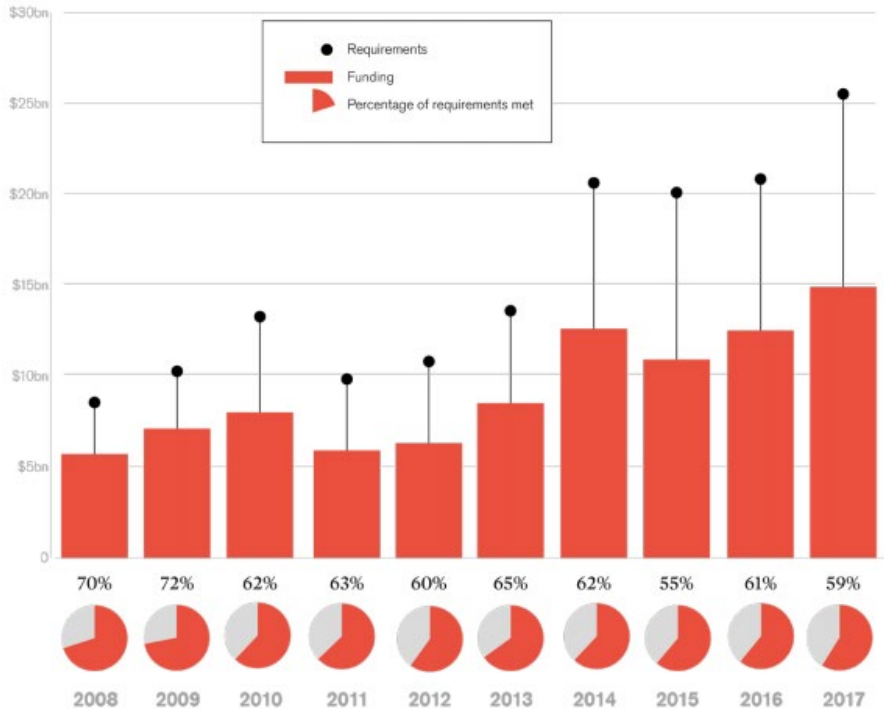


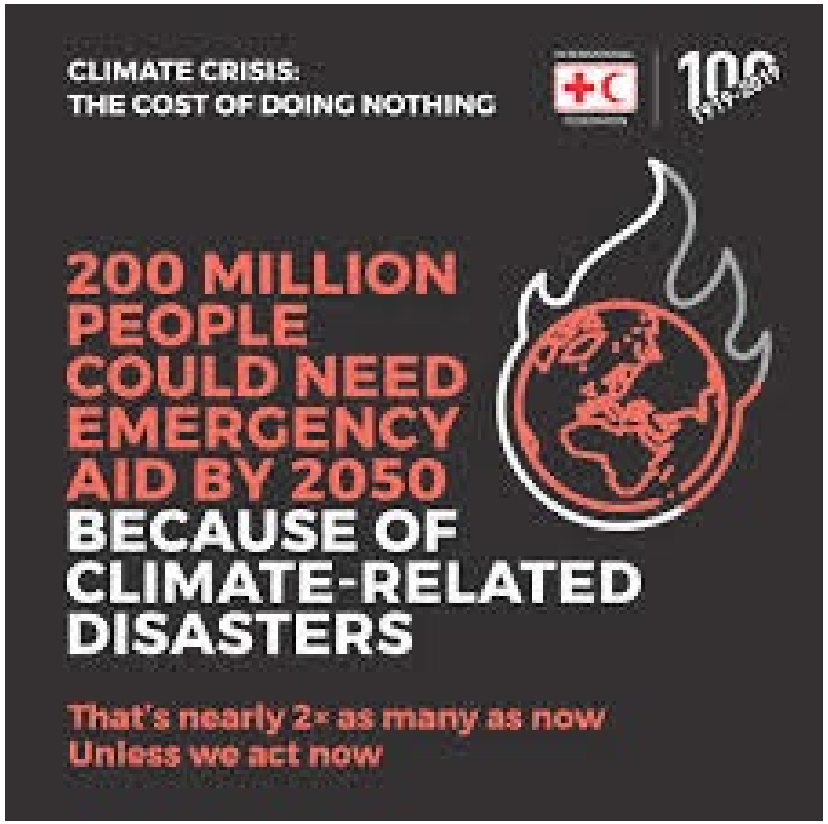


Human costs of disasters, an overview of the last 20 years, CRED (EM-DAT) and UNDRR

THE COST OF DOING NOTHING & FUNDING GAP

- Climate change a double threat to vulnerable communities
  - More extreme weather events
  - Climate change's macroeconomic impacts reduce resilience among world's poorest, leaving them less able to manage shocks





- Funding does not meet the requirements

The state of the humanitarian system. London: Overseas Development Institute (2018)

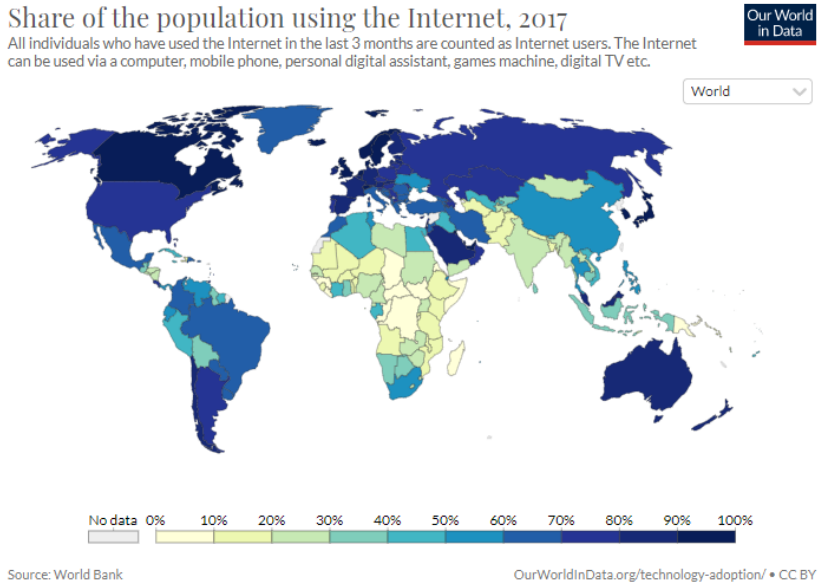
DIGITAL AND DATA REVOLUTION

- Increasing digitization: mobile phones, Internet of Things etc
- Rapid increase in Small & Big data





- Digital divide
  - Unequal internet access
  - Data illiteracy
  - Data capacity gap
  - Data poverty





Improving speed, quality and cost-effectiveness of **humanitarian aid** by creating products using **data** and **digital.**

510 million square kms
total surface of the **earth.**

Aiming to **help every national society** in need **anywhere.**

Founded in **March 2016** with a core team of 3 and never stopped growing. Currently, 510 has **108 team members** of **which 36 staff/consultants and 72 professional volunteers/MSc/PhD students.**

Our themes and topics

Anticipatory Action

- Impact Based Forecasting
- Understanding the Risk

Cash Aid

- Digital Cash Aid
- Direct Digital Aid

Digital Transformation

- Data Literacy
- Data team creation
- DT assessment

Emergency Support

- Damage assessment
- Rumor tracking

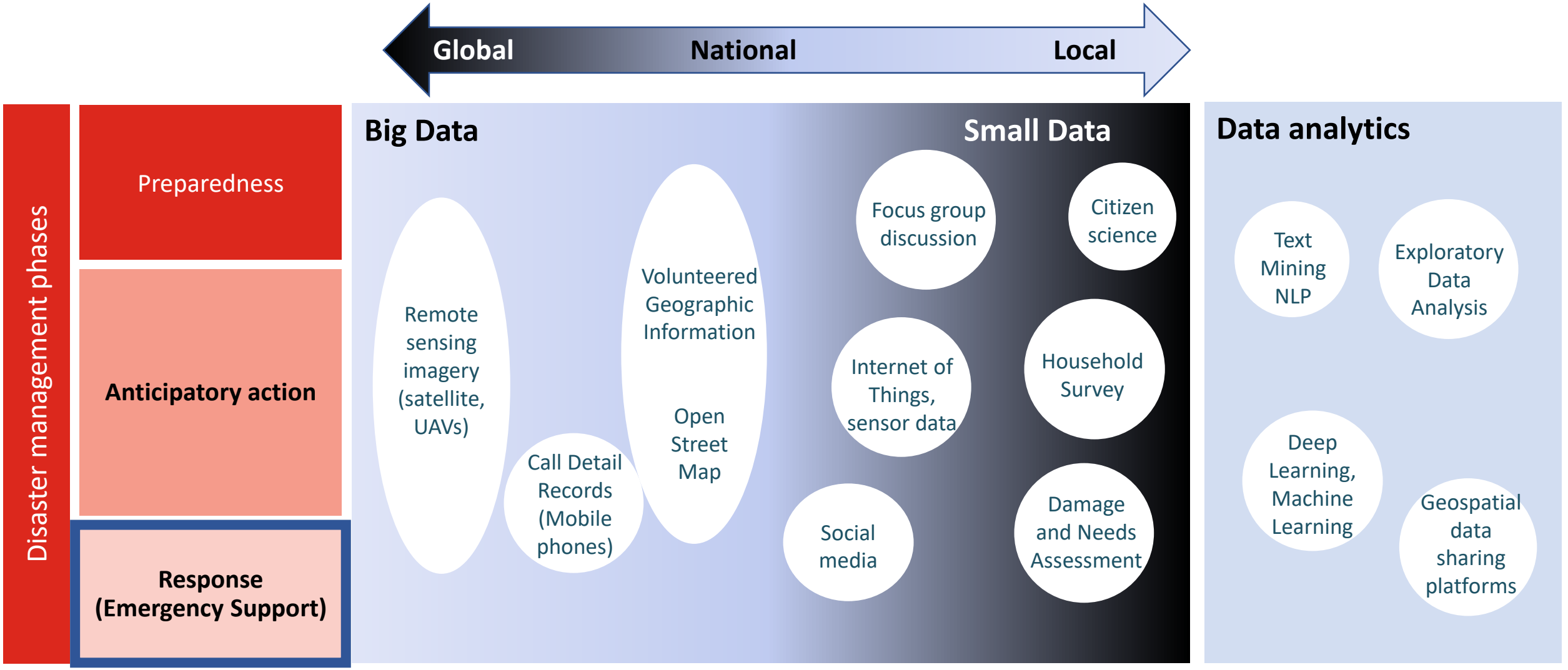
Water & Landscape

- Data for Water
- Landscape Restoration

Our way of working

- Community Engagement and Accountability
- Human Centered Design
- Data & Digital Responsibility
- Volunteers

LEVERAGE DATA ANALYTICS ACROSS DISASTER RISK MANAGEMENT PHASES



EMERGENCY DATA SUPPORT

Remote support



Deployed



REMOTE SUPPORT



DEPLOYED: WE COLLECT DATA FROM THE FIELD



DRONES IN ST MAARTEN: BEFORE AND AFTER

https://www.510.global/before-after-irma/



AUTOMATING DAMAGE ASSESSMENTS

- Emergency responders immediately need to know:
  - WHERE are the people in need
  - HOW BAD is the situation → the scale of the damage
- How can we do it?
  - By going to the field and surveying
    → often impossible, takes weeks/months for large areas
  - By manually checking satellite imagery
    → too slow if affected area is large



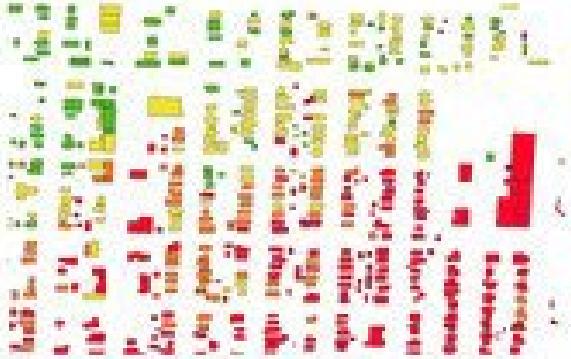
AUTOMATED DAMAGE ASSESSMENT TO FILL GAP IN DIRECT AFTERMATH OF DISASTER



(a) Before the Joplin tornado



(b) After the Joplin tornado



(c) Damage labels belonging to the Joplin tornado



(d) Before the Nepal flooding



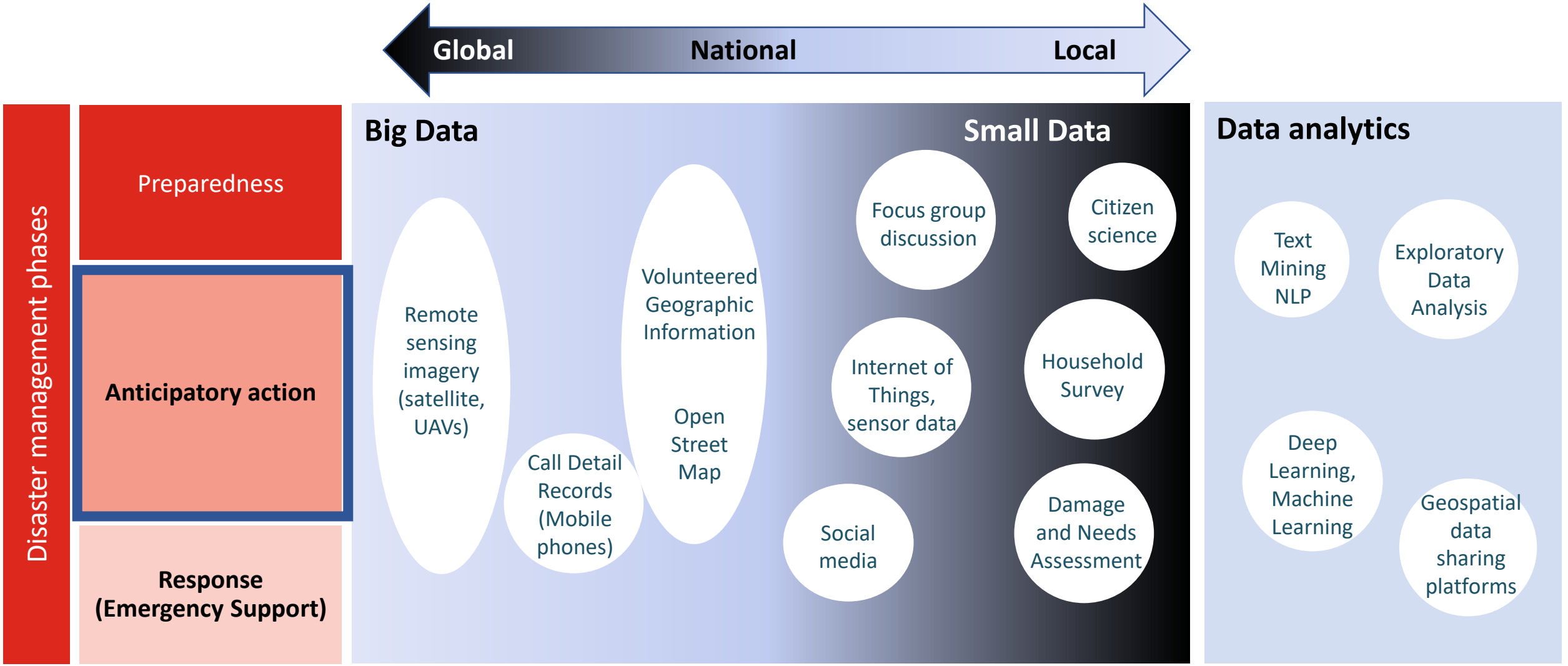
(e) After the Nepal flooding



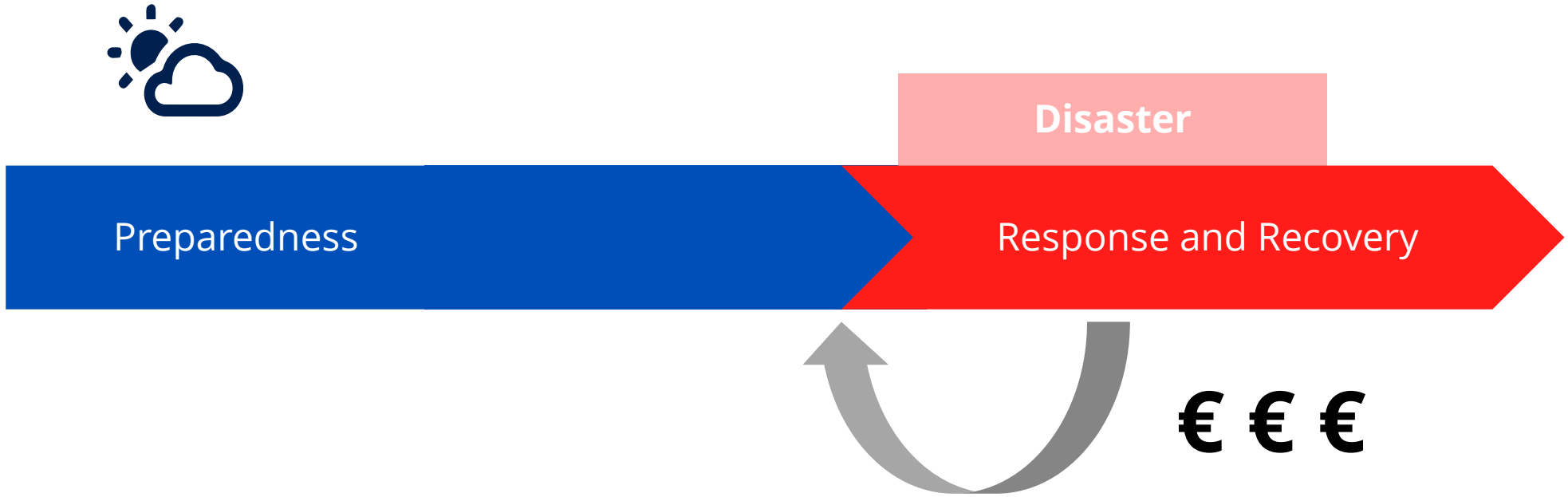
(f) Damage labels belonging to the Nepal flooding

Valentijn, T., Margutti, J., van den Homberg, M., & Laaksonen, J. (2020). Multi-hazard and spatial transferability of a cnn for automated building damage assessment. *Remote Sensing*, *12*(17), 2839.

LEVERAGE DATA ANALYTICS ACROSS DISASTER RISK MANAGEMENT PHASES



CURRENT SITUATION



ANTICIPATORY ACTION



Trigger level

Disaster

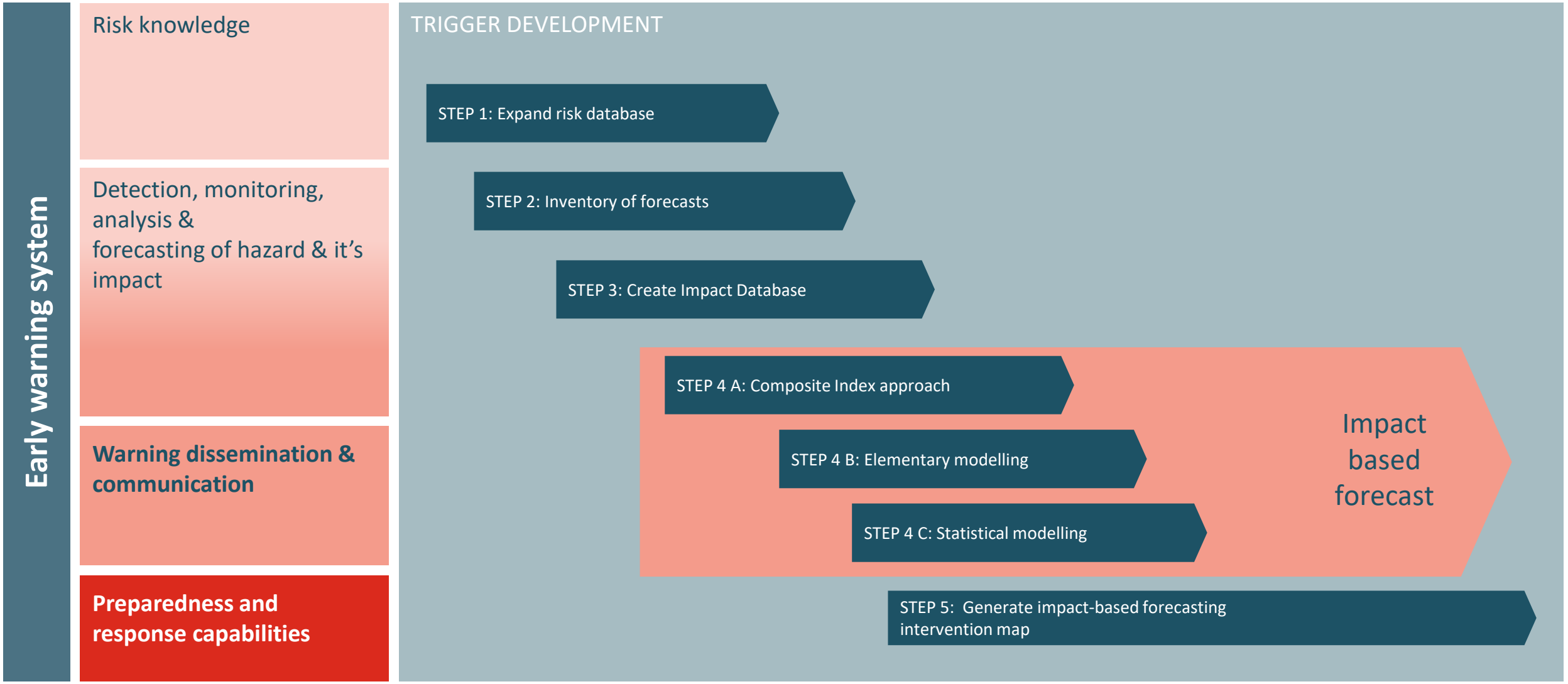
Preparedness | Early Actions | Response and Recovery

€ € €

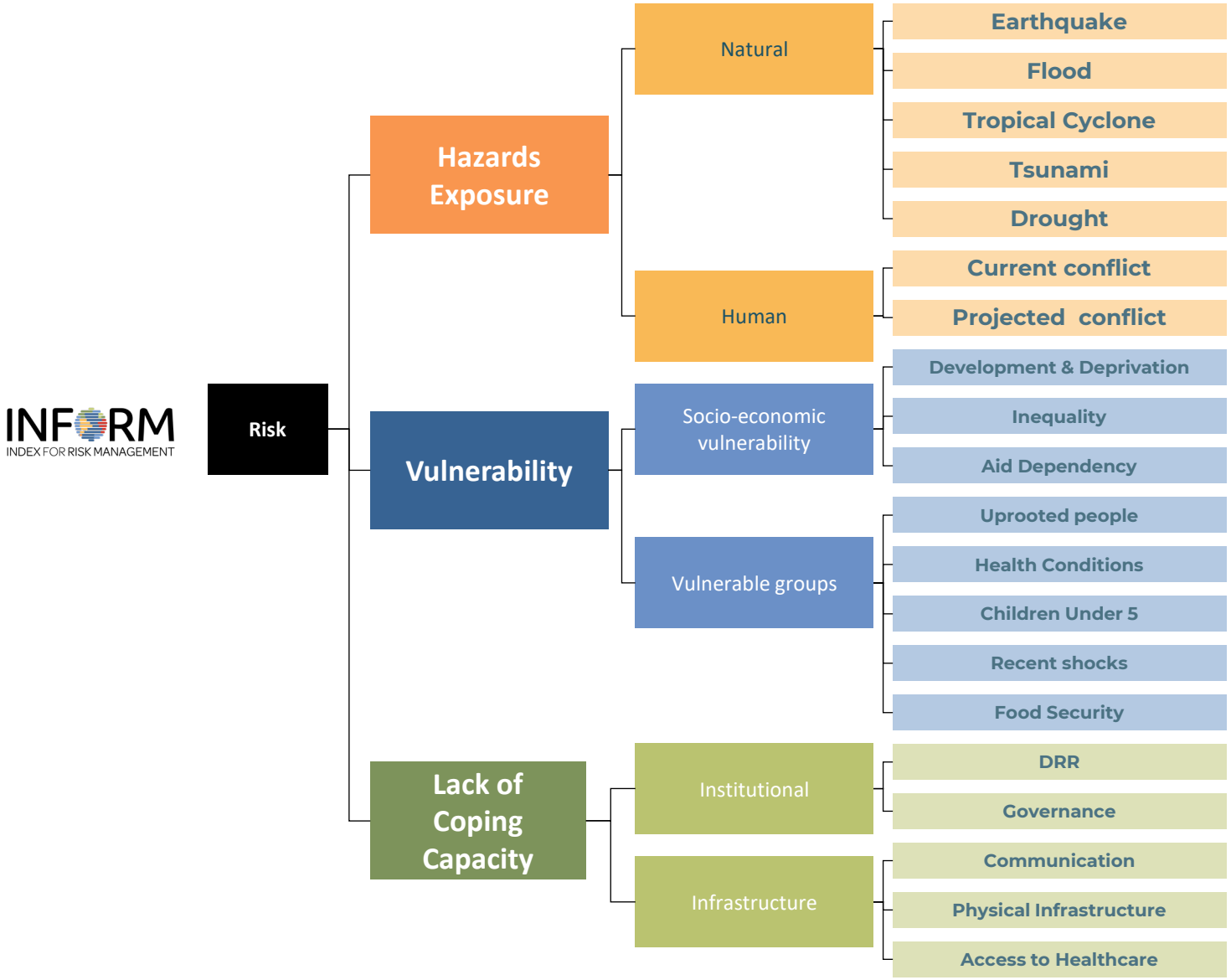
We need a trigger to release humanitarian funding & execute early actions e.g. 72 hours before the disaster strikes

Can we FORECAST which areas and people will be most impacted?

ANTICIPATORY ACTION: TRIGGER DEVELOPMENT



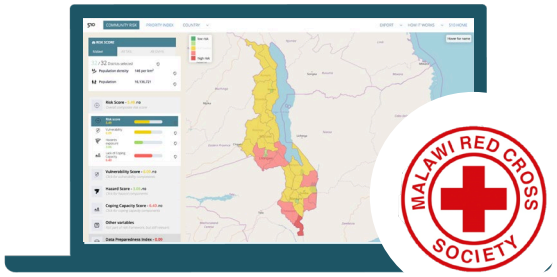
STEP 1: RISK ASSESSMENT: DATA FRAMEWORK

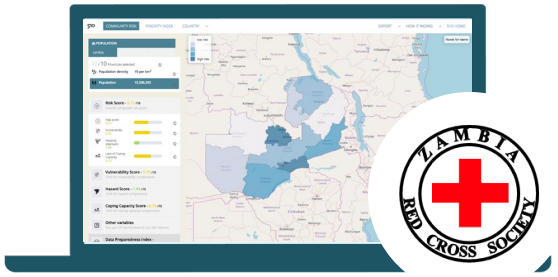


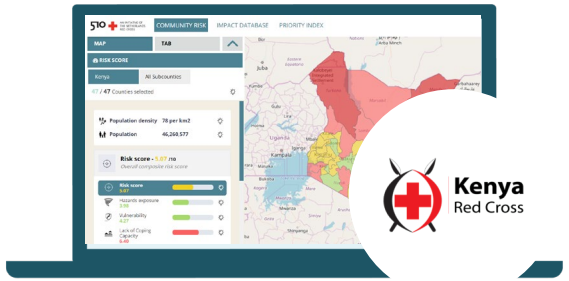
https://dashboard.510.global/#!/

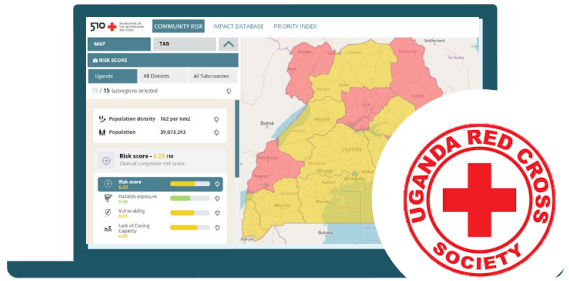
van den Homberg, M., Visser, J., & van der Veen, M. (2017). Unpacking Data Preparedness from a humanitarian decision making perspective: toward an assessment framework at subnational level. In Proc. Information Systems for Crisis Response and Management (ISCRAM) Conference, http://idl.iscram.org/files/marcvandenhomberg/2017/1995_MarcvandenHomberg_etal2017.pdf

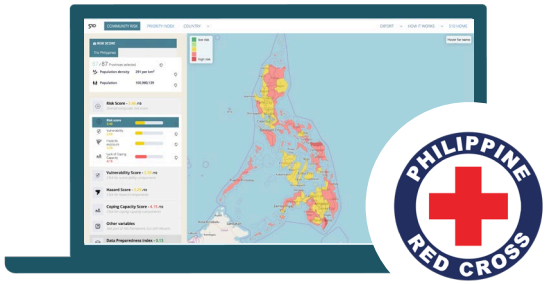
STEP 1: WHERE WE UNDERSTAND & IDENTIFY RISK

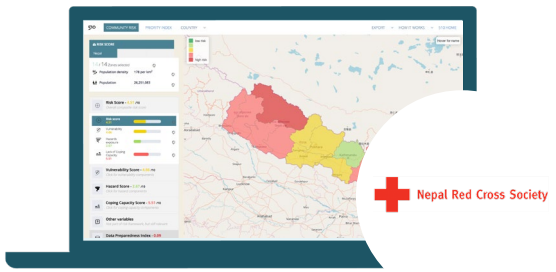


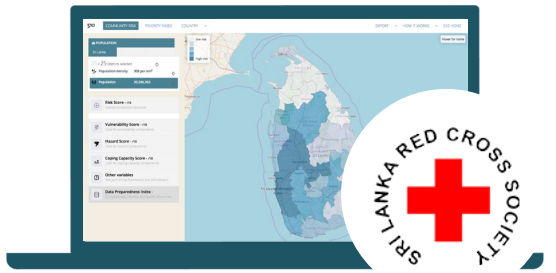


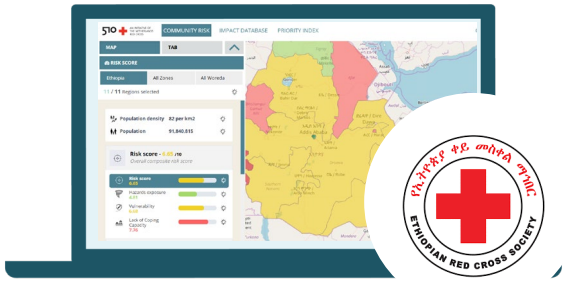




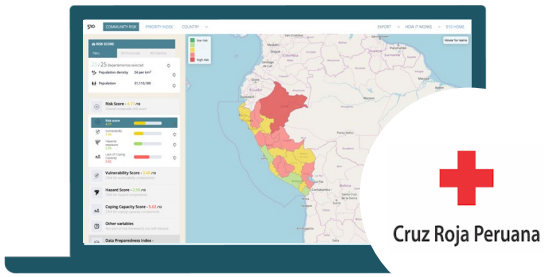


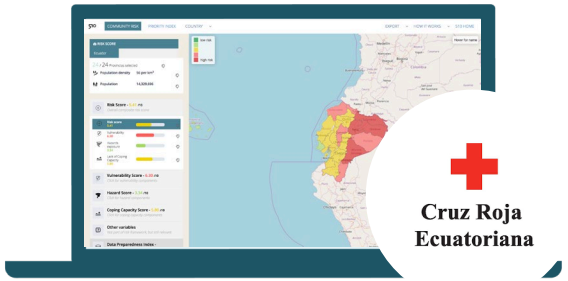


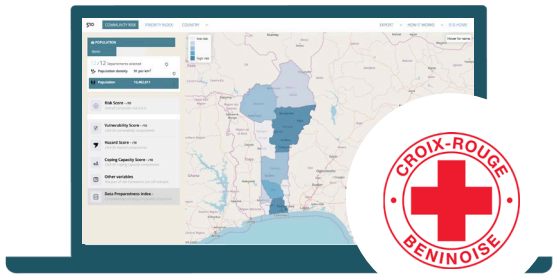


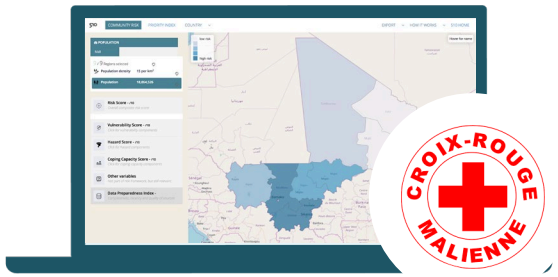


https://dashboard.510.global









STEP 1 RISK ASSESSMENT: DATA GRANULARITY

510 — An initiative of the Netherlands Red Cross

INFORM — INDEX FOR RISK MANAGEMENT



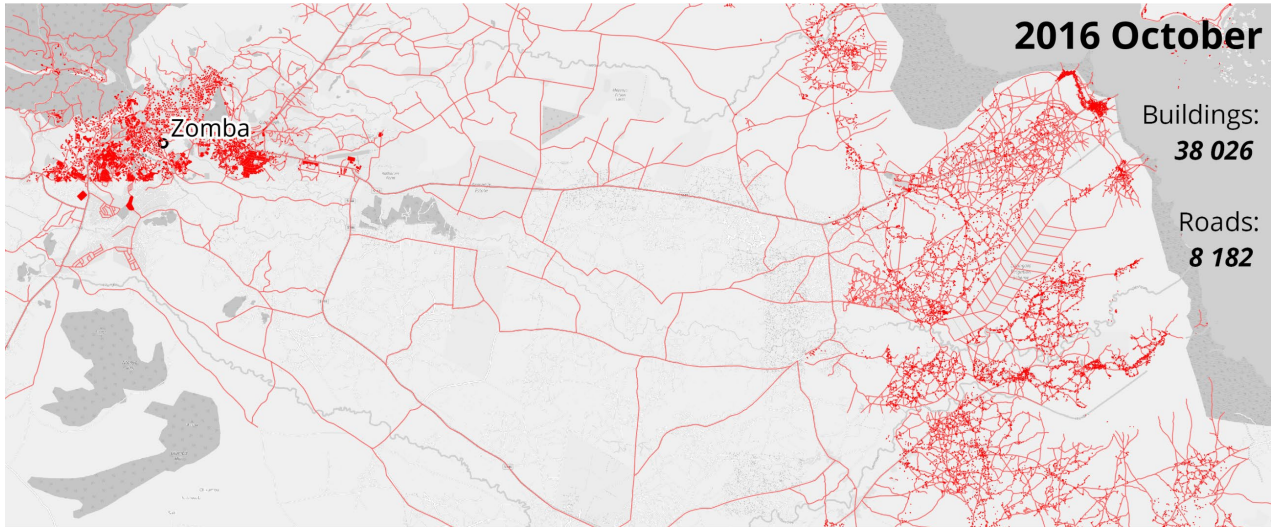
			32 DISTRICTS	367 TRADITIONAL AUTHORITIES	9133 GROUP VILLAGE HEADS	
Hazards Exposure	Natural	Earthquake	Yes	Yes	No	
		Flood	Yes	Yes	Yes	Flood risk
		Tropical Cyclone	-	-	-	
		Tsunami	-	-	-	
		Drought	Yes	Yes	Yes	Drought risk
	Human	Current conflict	No	No	No	
		Projected conflict	No	No	No	
Vulnerability	Socio-economic vulnerability	Development & Deprivation	Yes	Yes	Yes	Poverty incidence
		Inequality	No	No	No	
		Aid Dependency	No	No	No	
	Vulnerable groups	Uprooted people	No	No	No	
		Health Conditions	No	No	No	
		Children Under 5	Yes	No	No	
		Recent shocks	No	No	No	
		Food Security	Yes	No	No	
Lack of Coping Capacity	Institutional	DRR	No	No	No	
		Governance	No	No	No	
	Infrastructure	Communication	Yes	No	No	
		Physical Infrastructure	Yes	Yes	Yes	Travel times to facilities
		Access to Healthcare	Yes	Yes	No	

STEP 1: HOW DO WE EXPAND RISK DATABASE?

510 An initiative of the Netherlands Red Cross

Missing Maps

OPENSTREETMAP STARTING POINT

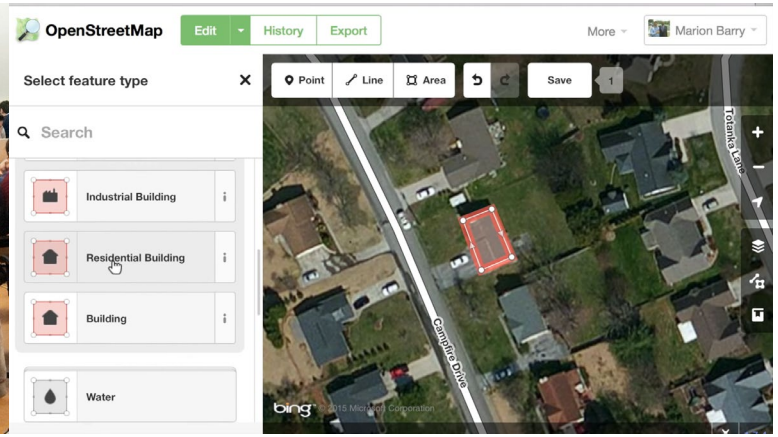


MAPATHONS

Manual tracing and labelling of buildings in aerial imagery.
Lots of commitment of many volunteers but:

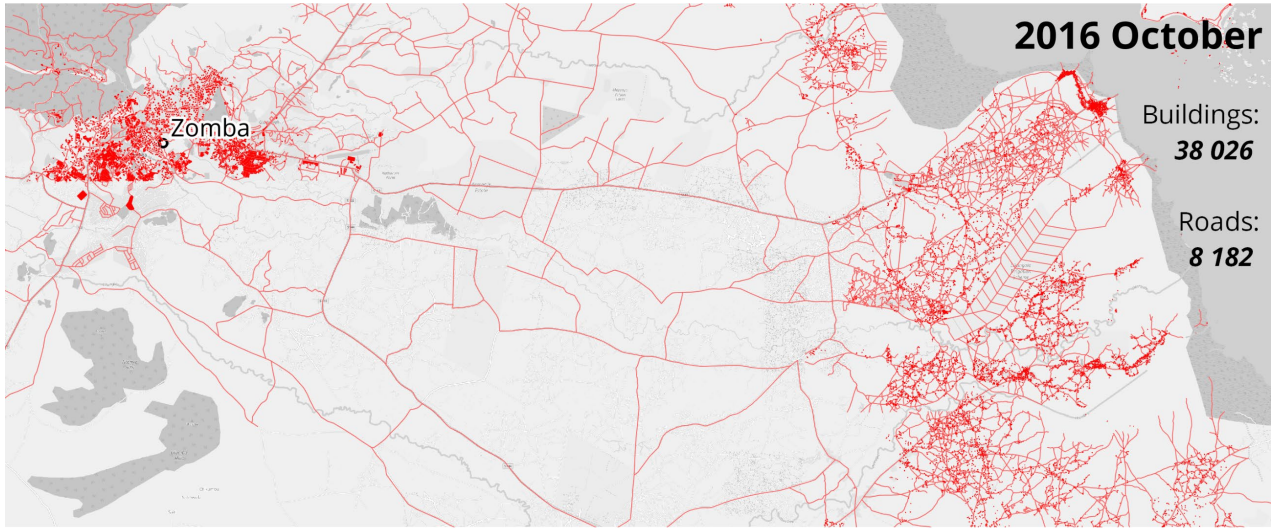
Labour-intensive
Time-consuming
Quality depends on skills volunteer





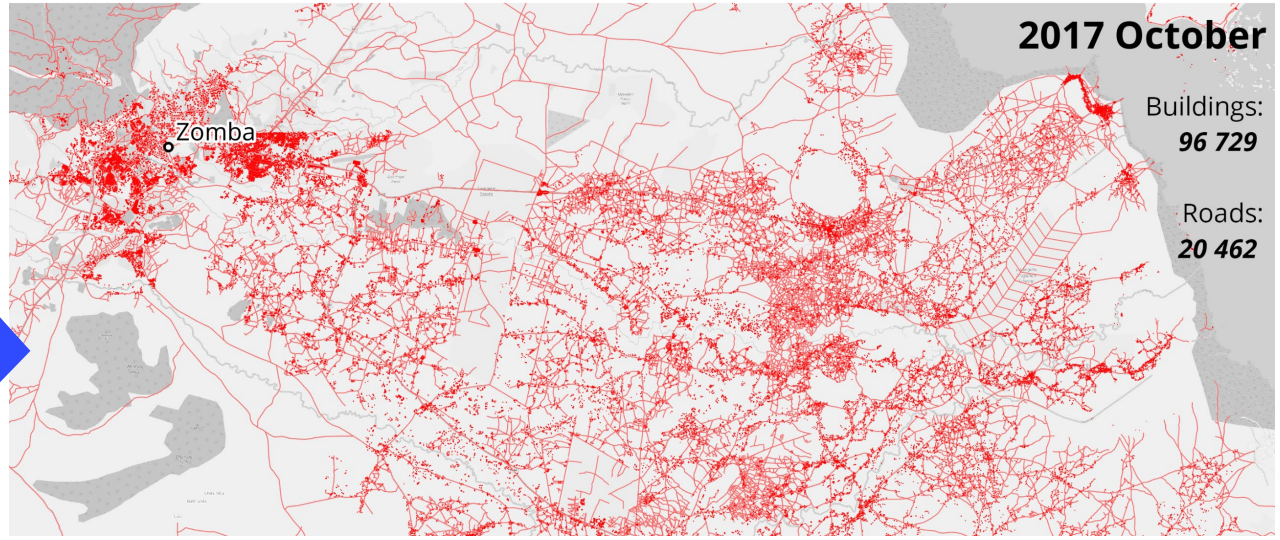
STEP 1: HOW DO WE EXPAND RISK DATABASE?

OPENSTREETMAP STARTING POINT



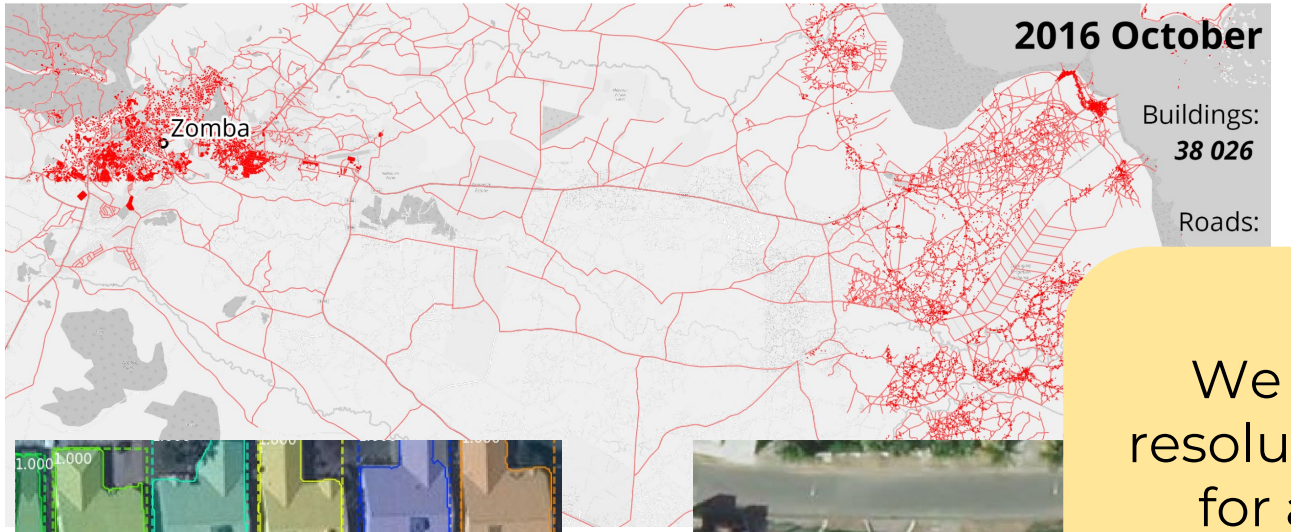
AFTER MAPATHON

Population, infrastructure, natural resources, assets are added



STEP 1: HOW DO WE EXPAND RISK DATABASE?

OPENSTREETMAP STARTING POINT

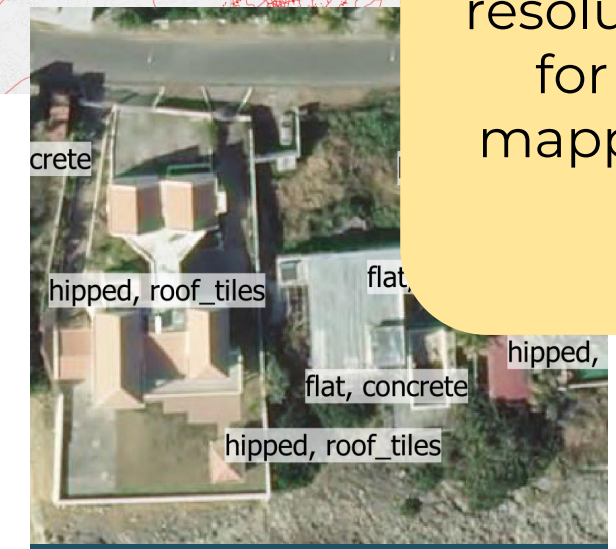


AUTOMATIC BUILDING DELINEATION + CLASSIFICATION

using convolutional neural networks
Classification of roof shape is successful; roof material not yet...
Availability of high-resolution aerial imagery key



Segmentation



Classification

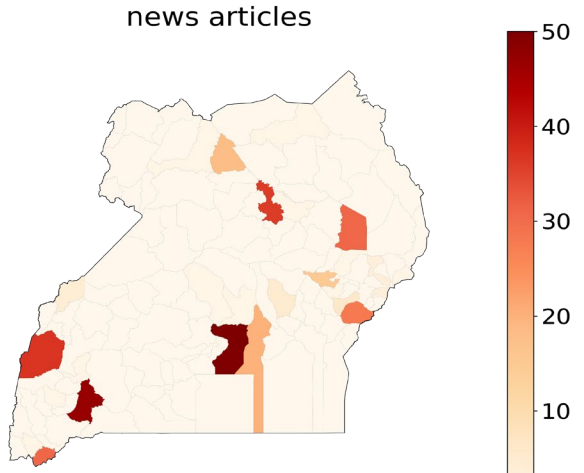
We need high resolution imagery for automatic mapping to work better!

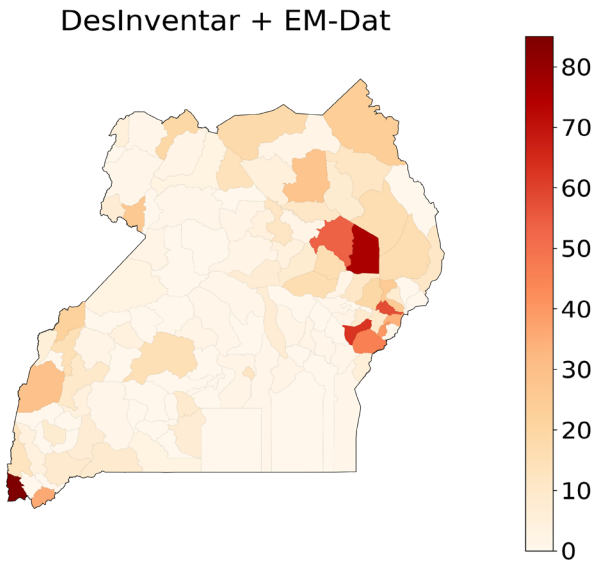
STEP 3: CURRENT IMPACT DATABASE

		SOURCES	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
IMPACT	DATA FROM LOCAL & NATIONAL LEVEL	DMMU												
	DATA FROM GLOBAL REPOSITORIES	EM DAT												
		DESINEVNTAR												
		HUMANITARIAN DATA EXCHANGE												

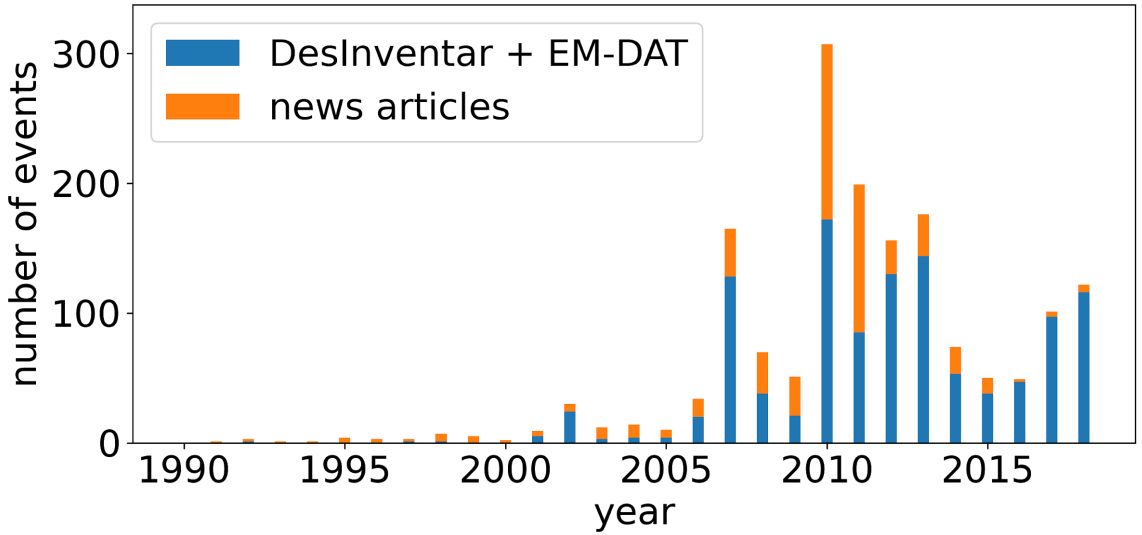
We are missing data with sufficient spatial and temporal resolution

STEP 3: 510s NEWS IMPACT MINER





Web scraping and Natural Language Processing
Example for Uganda





Enriching impact data by text mining digital media, GAR paper 2022, Marc van den Homberg, Jacopo Margutti et al.



STEP 3: FLOODS IN MALAWIAN NEWS MEDIA

Objectives

- Use text mining to detect flash and river flood events and extract impact data
- Identify the most trustworthy newspapers

Hannah Bailon
Kees Boersma



Claudia Orellana-Rodriguez



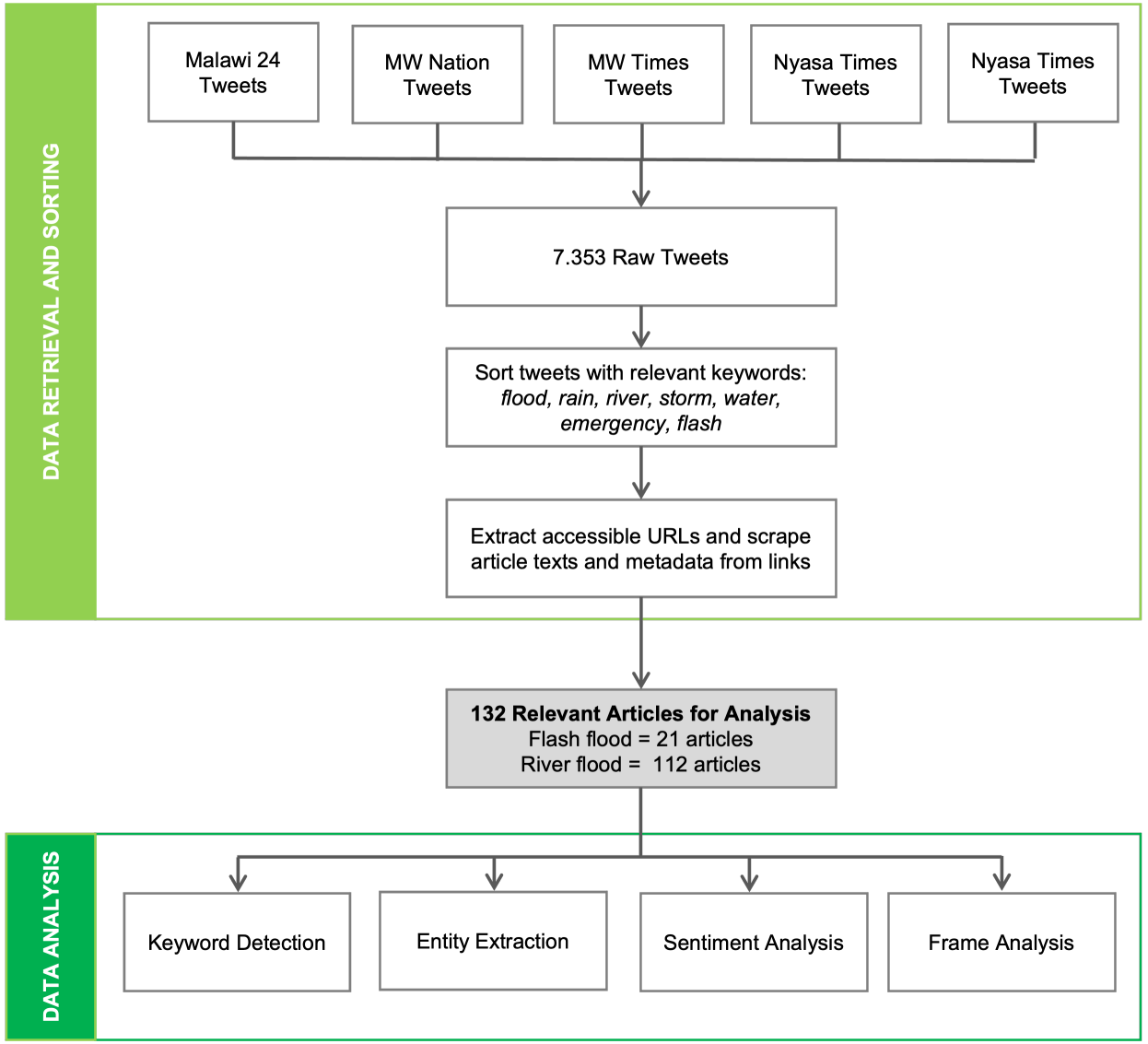
Marc van den Homberg
Jacopo Margutti

STEP 3: FLOODS IN MALAWIAN NEWS MEDIA: DATA SET

- Five national quality newspapers
  - Basic web search
  - Online database (ABYZ News Links)
  - Researcher consultation
- Access articles via Twitter/twarc
- Data cross-checked with disaster databases (EM-DAT and DoDMA)

- Case study: two flood types in 2019
- More articles covering flood with shorter period but higher impact

Flood Type	Start Date*	End Date*	# of Articles	Earliest Article	Latest Article
Flash Flood	01/01/2019	31/01/2019	20	11/01/2019	07/02/2019
River Flood	04/03/2019	10/03/2019	111	12/02/2019	29/04/2019



STEP 3: FLOODS IN MALAWIAN NEWS MEDIA: PRELIMINARY RESULTS

Keyword detection

- Most keywords used surrounding human aspect: people, victims, households

Entity extraction

- Geopolitical entities and locations are mainly emphasized in reports

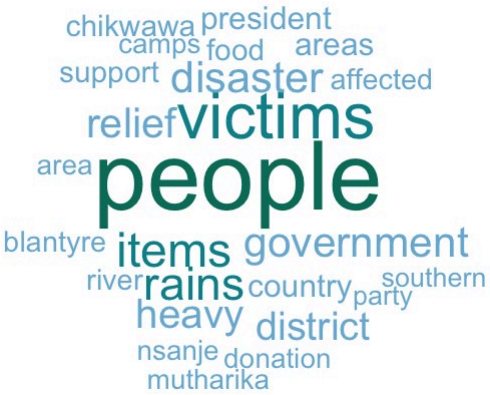
Sentiment analysis

- Neutral tone in reporting (65%) and more or less objective

Frame analysis

- Human impact and economic consequences are the main frames used to cover floods







STEP 3: HOW DO WE EXPAND IMPACT DATABASE?

		SOURCES	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
IMPACT	DATA FROM LOCAL & NATIONAL LEVEL	DMMU												
	DATA FROM GLOBAL REPOSITORIES	EM DAT												
		DESINEVNTAR												
		HUMANITARIAN DATA EXCHANGE												
	DATA FROM DIGITAL RESOURCES USING DATA & TEXT MINING	DIGTIAL NEWSPAPER REPOSITORIES												
		DISASTER RELIEF EMERGENCY FUNDS												
		SOCIAL MEDIA												

Text mining can be used to extract impact data from new sources (social media, online newspaper repositories) but fusing with other sources has to be done with care given potential biases and risk of duplications

STEP 4: COMPOSITE INDEX APPROACH



STEP 4: COMPOSITE INDEX APPROACH FOR CYCLONE

www.ifrc.org
Saving lives, changing minds.

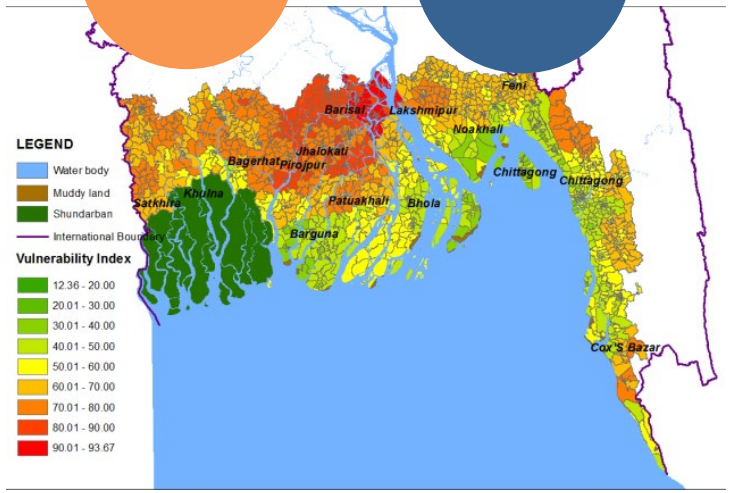
Bangladesh: Cyclone
Early Action Protocol summary

International Federation of Red Cross and Red Crescent Societies

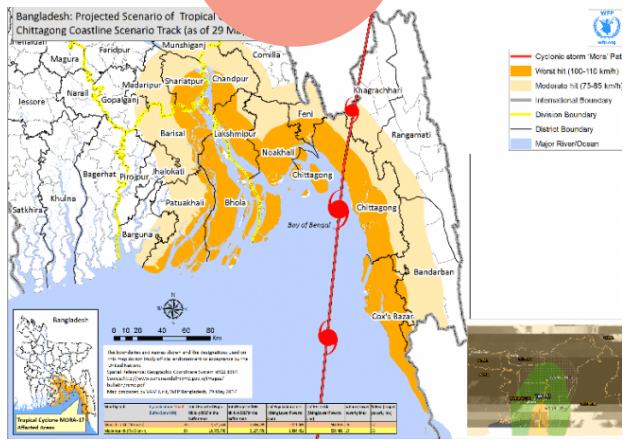
EAP APPROVED **December 2018**	**20,000 of people** to be assisted **Amount Swiss francs: 182,996**	EAP timeframe **5 Years** Early Action timeframe **1Month**

EXPOSURE

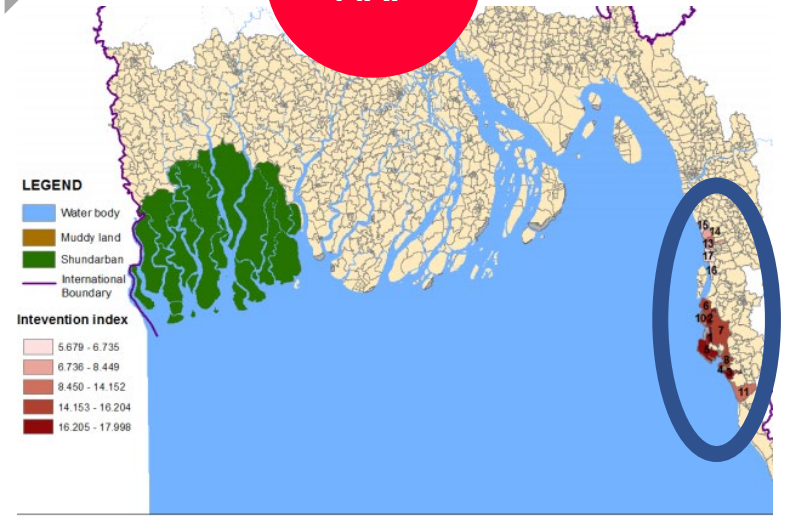
VULNERABILITY

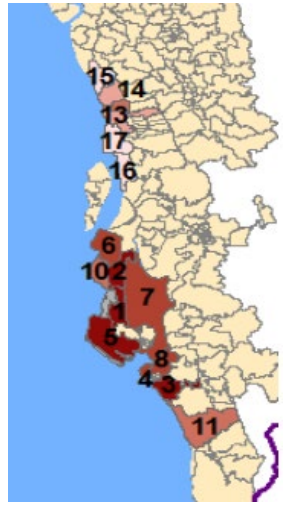


HAZARD FORECASTED



PRIORITY MAP





Inez Gortzak et al.

Characterising housing stock vulnerability to floods by combining UAV, Mapillary and survey data - A case study for the Karonga district in Malawi

OBJECTIVE

Identify most vulnerable households (socially & physically)







DATA & METHODOLOGY

Combine datasets to increase vulnerability attributes



UAV imagery → Remote sensing (OBIA) → Rooftop material

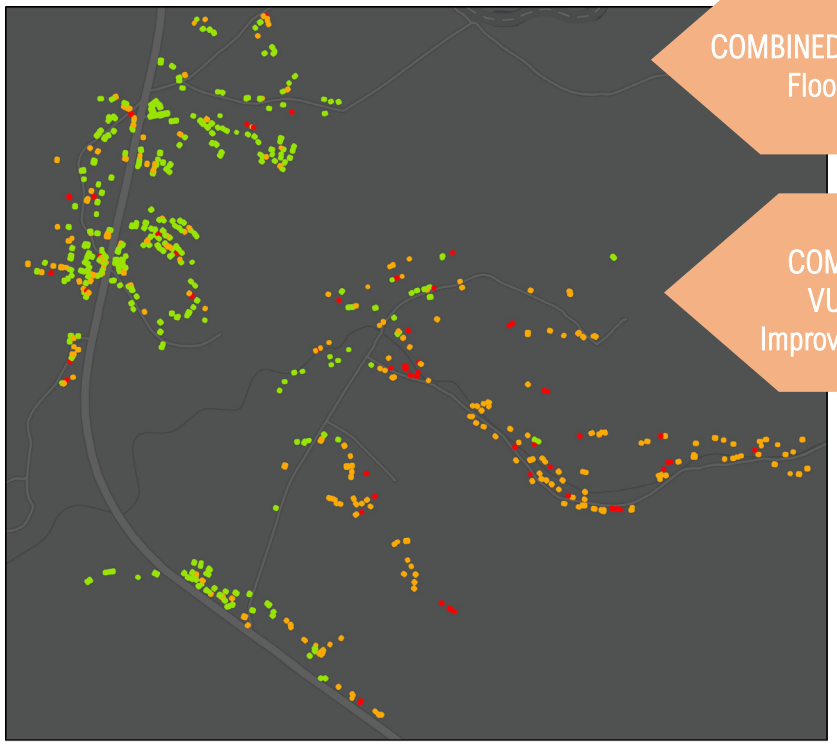


Mapillary imagery → Machine learning + camera data → Wall material



Survey data → Normalising indicator values → Social vulnerability index based on: health, wealth, education, age, household size

RESULTS PHYSICAL VULNERABILITY MAP



COMBINED WITH DAMAGE CURVES: Flood damage scenarios

COMBINED WITH SOCIAL VULNERABILITY MAP: Improved vulnerability targeting

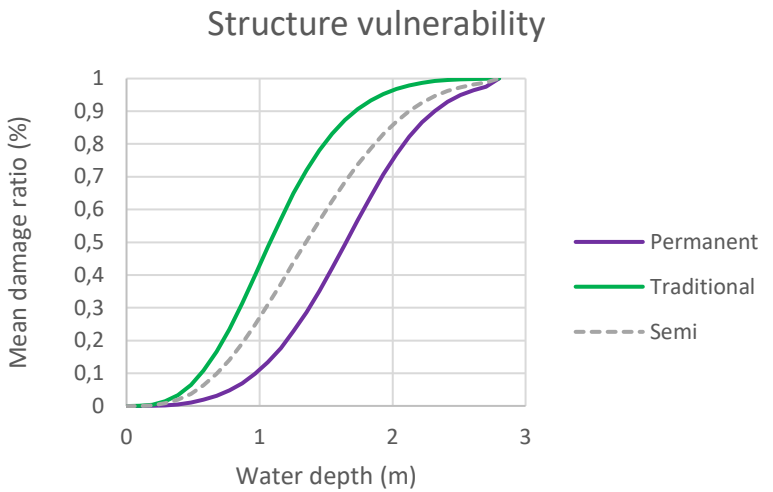
STEP 4: ELEMENTARY MODELLING FOR FLOODS



Wouters, L., et al.: Improving flood damage assessments in data scarce areas by retrieval of building characteristics through UAV image segmentation and machine learning – a case study of the 2019 floods in Southern Malawi, Nat. Hazards Earth Syst. Sci. https://doi.org/10.5194/nhess-2020-417, in review, 2021







1. Extract & classify structures (drone)

2. Estimate flood depth and extent from hydrological model (forecast) or SAR Sentinel 1 and Digital Elevation Model (response)

3. Determine –for each building- damage from damage curve based on flood depth. Sum over all buildings in area

STEP 4: STATISTICAL MODELLING

Predictors		**Predictand**
Exposure & vulnerability	Hazard	Impact

Physical vulnerability



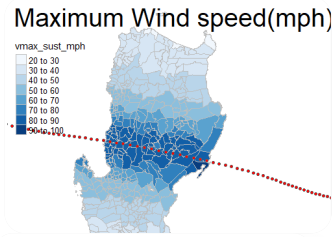
Social vulnerability:

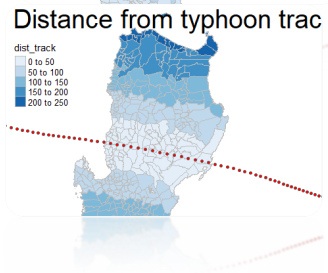
- Poverty
- Population <5 & > 60 years

Exposure:

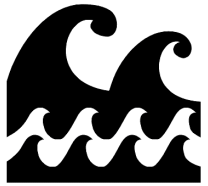
- Population density
- Ruggedness
- Coastal length
- Elevation

Typhoon





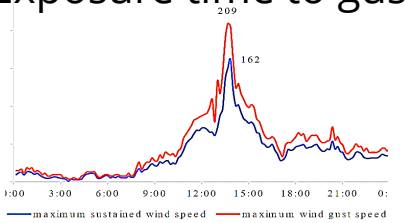
Storm surge



Landslide



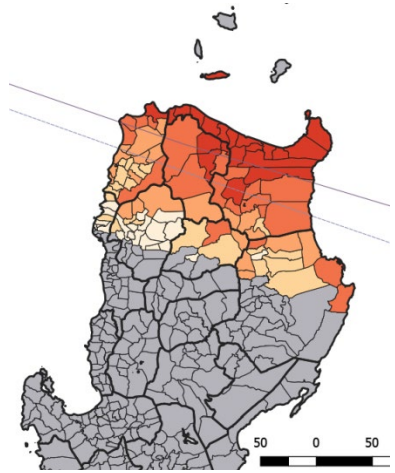
Exposure time to gust wind (>30mph)



Maximum rainfall (mm/day)

House damage







Aklilu Teklesadik et al.

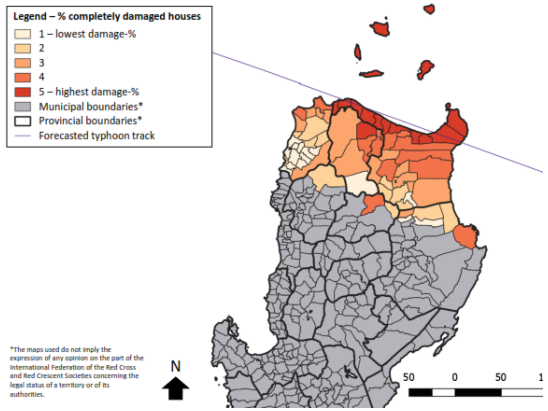
STEP 4: TYPHOON TRIGGER MODEL: RESULTS

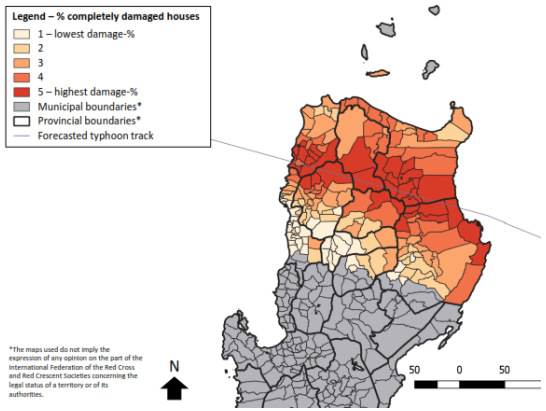
72 hours

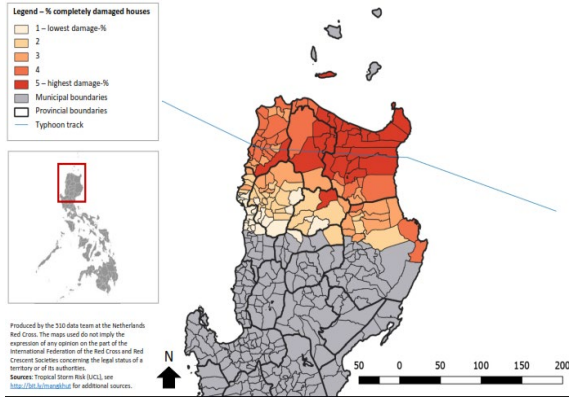
48 hours

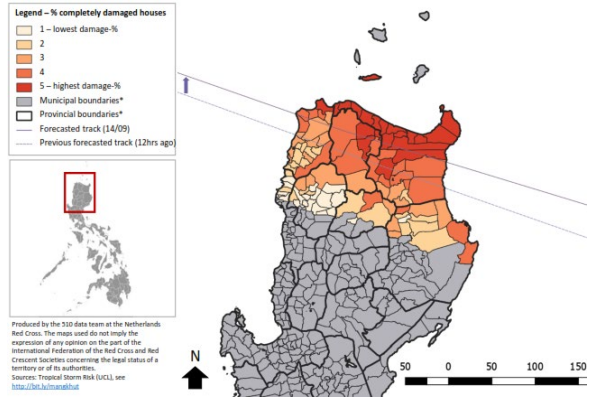
24 hours

6 hours after









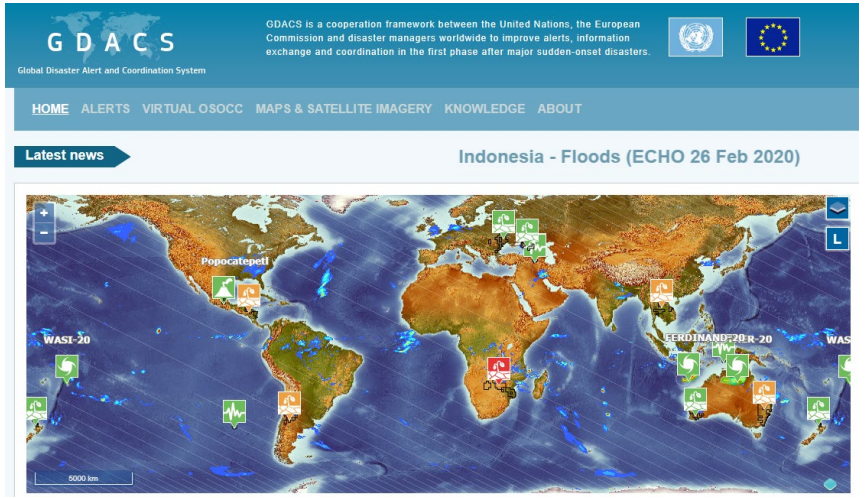
Hazard	Forecasts typhoon + historical typhoon events	Typhoon that made landfall
Exposure		
Topography		
Vulnerability		

Forecast skill and Machine Learning performance metrics

Machine Learning performance metrics

STEP 4: TYPHOON TRIGGER MODEL: OPERATIONAL WORKFLOW

1. Retrieve active typhoon name and location form GDACS
2. Check if any of this events are in Philippines Area of Responsibility
3. Download Rainfall + typhoon track data Via API (ECMWF, NOAA and UCL-TSR)
4. Preprocessing script model input- wind field for grid points
5. Run prediction model, make maps
6. Send email to relevant stakeholders



Philippine Red Cross uses the trigger since end of 2019 for activations:

- Tisoy 2019 (small scale)
- Ulysses 2020
- Goni (2020), but missed/not triggered due to rapid genesis

TO CONCLUDE

- Transitions at global level
  - More climate extremes, increased vulnerability, more disasters
  - Digital and data revolution
- Challenges when leveraging data analytics
  - Data scarcity
  - Digital divide
  - Explainability and usability
- Opportunities to partially close some of these gaps
  - Use Big/Small Data and Data Analytics across disaster risk management cycle, but hand in hand with:
    - Initiating and supporting local data capacity development
    - Putting the user first via human centered design
    - Building in accountability
    - Working transdisciplinary

Analytics for a Better World

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Let’s make together the world a better place



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