Damage Assessment Disrupted:
Innovations of the GRADE methodology

November 15th 2024

GFDRR
Global Facility for Disaster Reduction and Recovery

Administered by
THE WORLD BANK
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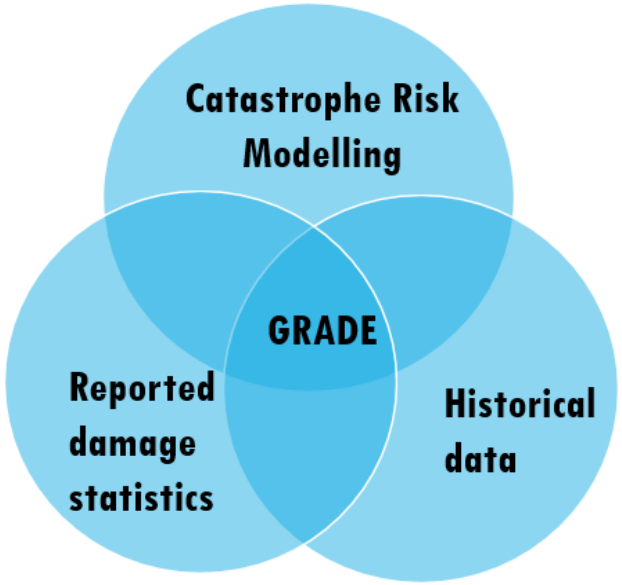
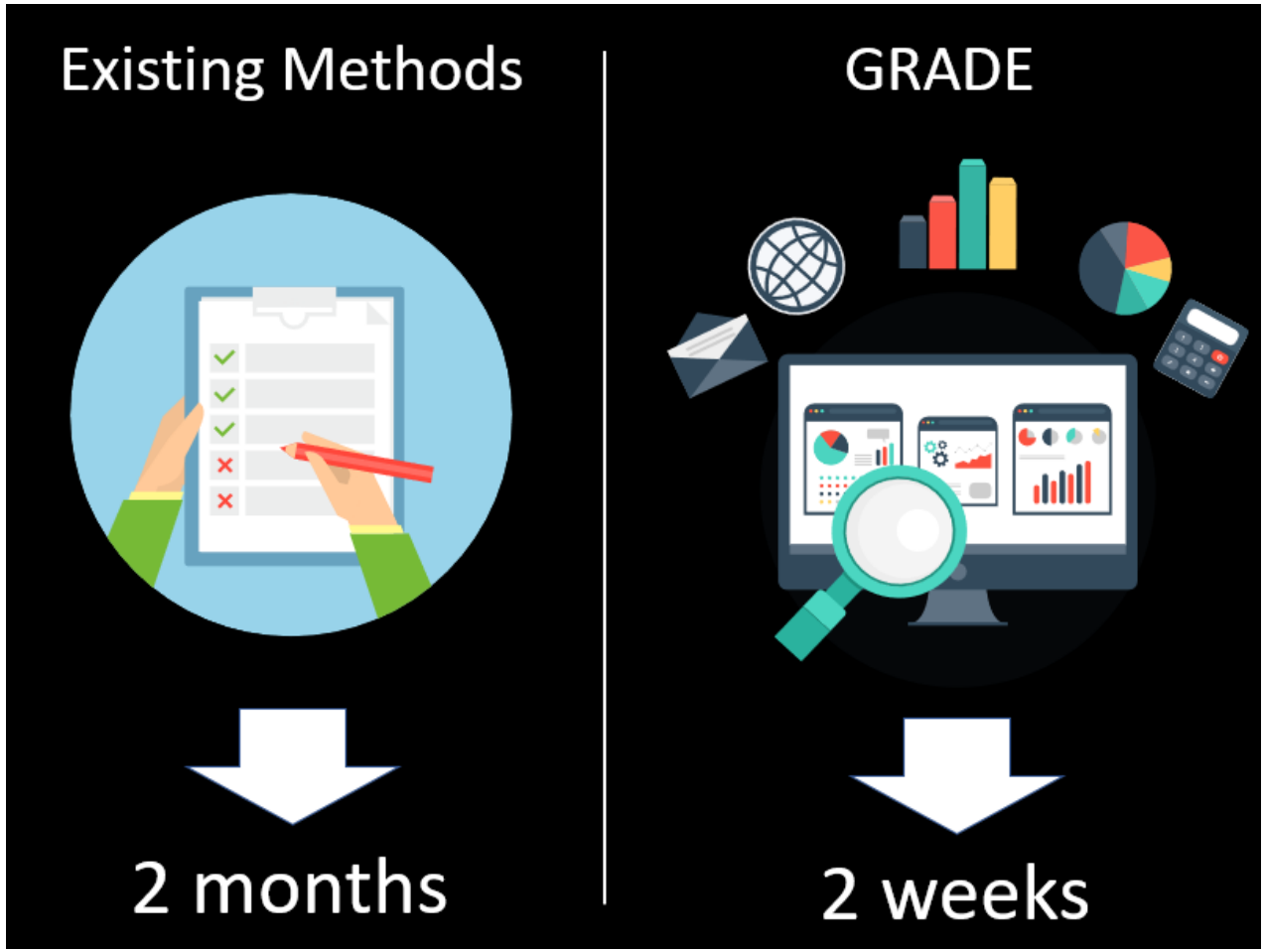
D-RAS

Many urgent questions arise following a disaster:

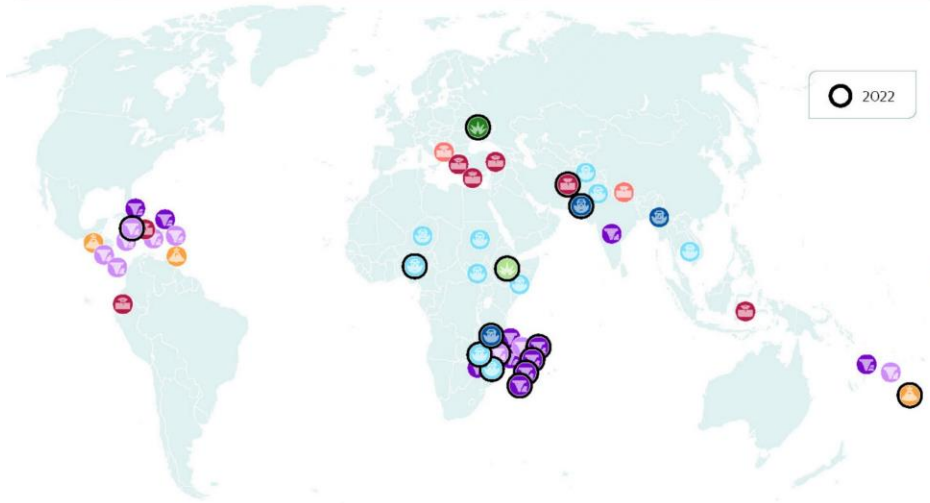
- **How** do we assess damages?
- **Where** are the damages distributed?
- **What** is the socio-economic impact?



Global RApid Post-Disaster Damage Estimation (GRADE)



	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Volcanoes				Guatemala			St. Vincent & Grenadines	Tonga		
Earthquakes	Nepal	Ecuador		Indonesia	Albania	Greece Turkey Croatia	Haiti	Afghanistan	Turkey Syria Morocco Afghanistan	
Cyclones		Haiti (Matthew)	Dominica (Maria) Caribbean (Irma) Madagascar (Enawo)	Madagascar (Ava)	The Bahamas (Dorian) Comoros (Kenneth) Mozambique (Idai) India (Fani) Malawi (Idai) Mozambique (Kenneth) Zimbabwe (Idai)	Fiji (Yasa) Ctr. America (Iota) Ctr. America (Eta) Vanuatu (Harold)	Mozambique (Eloise)	Madagascar (TS Ana, TS Batsirai, TS Dumako, TC Emnati) Mozambique (Gombe) Dominican Republic (Fiona) Yemen	Vanuatu (TC Judy/TC Kevin) Yemen (TC Tej)	Madagascar (TC Gamane) *Mexico (HU Otis)*
Floods					Myanmar (RF)	Sudan (FF/RF) Ethiopia (FF/RF) Niger (FF/RF) Pakistan (FF/RF) Afghanistan (FF/RF)	South Sudan (FF/RF) Cambodia (FF/RF)	Zimbabwe (TS Ana) Malawi (TS Ana) Pakistan Mozambique (TS Ana) Nigeria South Sudan	Kosovo Mozambique (TC Freddy) Malawi (TC Freddy) Myanmar (TC Mocha)	Congo, Dem. Rep. Burundi Kazakhstan Brazil *Libya*
Conflict								Ethiopia (Tigray) Conflict Ukraine Conflict	Ukraine (Dam Collapse)	

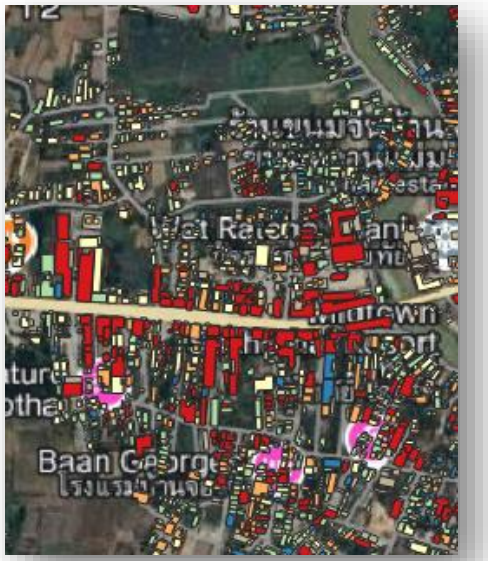


Determining the exposure

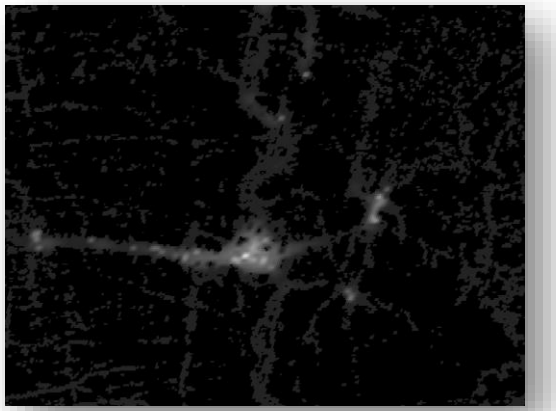
Using a combination of the following exposure datasets:

Google AI Open Buildings

Microsoft AI



GloBFP – Che et al.



Copernicus Emergency Management Service

GHSL - Global Human Settlement Layer

OpenStreetMap

What does a GRADE event report look like?

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FEBRUARY 20, 2023

Source: https://turkiye.un.org/en/219067-un-supports-rescue-and-relief-efforts-turkiye

Global Rapid Post-Disaster Damage Estimation (GRADE) Report

February 6, 2023 Kahramanmaraş Earthquakes

Türkiye Report

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- **At least 15 hospitals have suffered partial or severe damage, with damage assessments still ongoing[16].** Hospitals or hospital wings with risk of collapse have been evacuated by emergency services, with patients referred to facilities across the country and field hospitals established to provide continuity of care.
- **The minimum expected direct damages for the most affected provinces are shown below for the key sectors: residential (housing), non-residential buildings [17], and infrastructure[18].** Estimates cover buildings and contents; however, the analysis does not include costs associated with humanitarian and emergency response, or the losses associated with economic flows (e.g. business interruption). Moreover, damage assessments are ongoing in the affected areas

Table 1: Estimate of the direct damages by sector and province in absolute values (in US$ millions). This includes the 11 Provinces which were named as "Disaster Areas" by the Government of Türkiye, plus all other Provinces which experienced damage.

Province	Residential	Non-Residential	Infrastructure	Total		
				Median	Lower	Upper
HATAY	6,601	3,516	2,331	12,448	11,236	13,643
KAHRAMANMARAS	3,182	1,609	1,040	5,831	5,037	6,720
GAZIANTEP	2,285	1,516	1,066	4,867	3,907	5,996
MALATYA	1,493	660	450	2,604	2,105	3,197
ADIYAMAN	1,190	525	295	2,011	1,714	2,372
ADANA	915	475	394	1,783	1,308	2,352
DIYARBAKIR	883	518	315	1,716	1,283	2,296
OSMANIYE	654	453	251	1,358	1,084	1,716
SANLIURFA	447	273	137	856	632	1,144
ELAZIG	127	61	52	240	160	474
KILIS	88	37	26	152	116	199
MERSIN	58	15	32	105	36	159
MARDIN	27	7	9	42	8	73
KAYSERI	22	10	7	40	13	104
SIVAS	23	9	5	37	22	50
NIGDE	23	4	9	37	-	66
BINGOL	15	2	5	23	1	40
OTHER	1	0	0	2	1	147
TOTAL	18,036	9,691	6,424	34,151	28,665	40,751

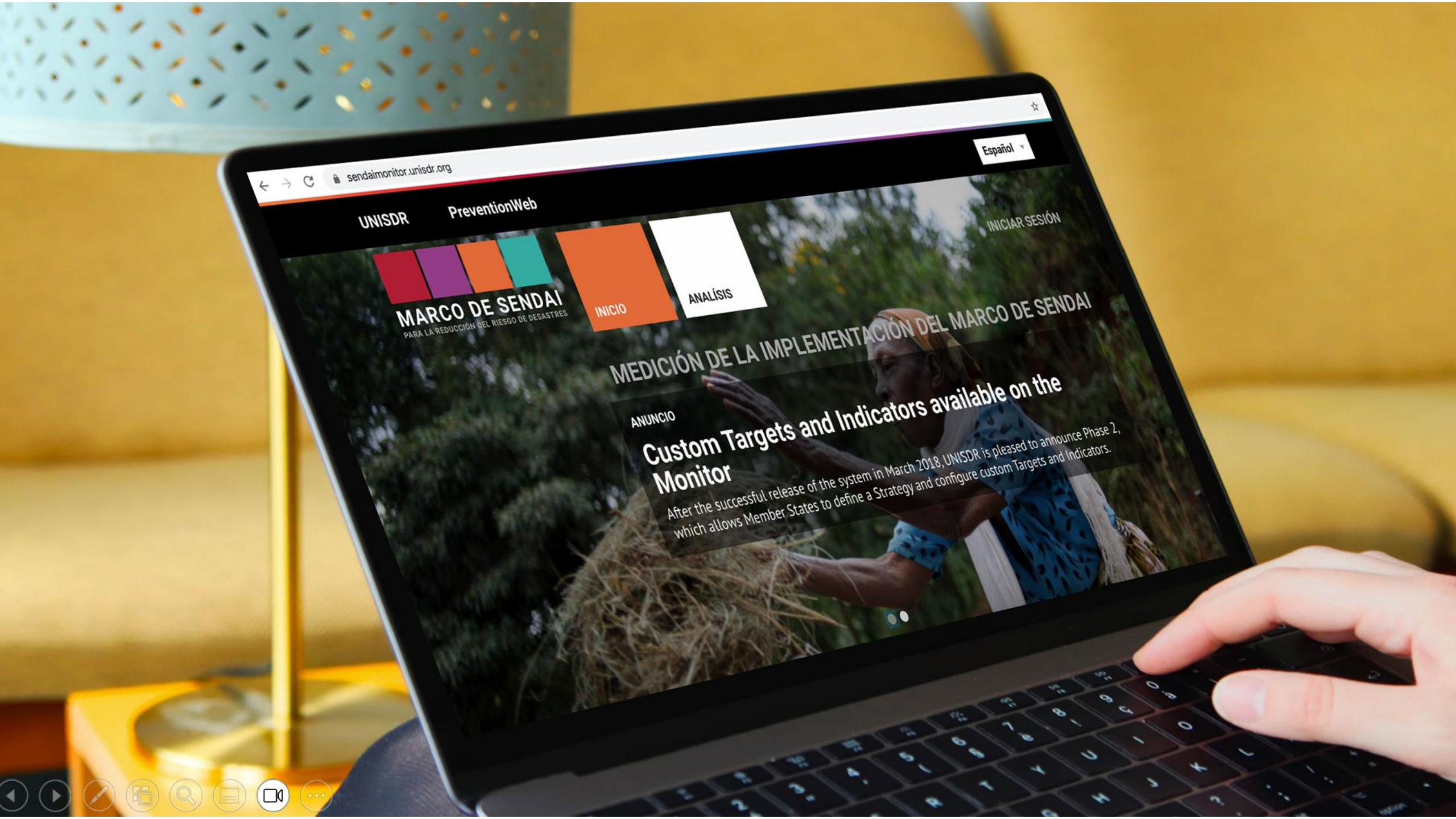
[16] WHO Flash Appeal

[17] Non-residential buildings include buildings that are private or public, commercial (offices, hotels, trade/retail, etc.), educational, hospitals and clinics/health centers, public administration, and industrial/warehouses.

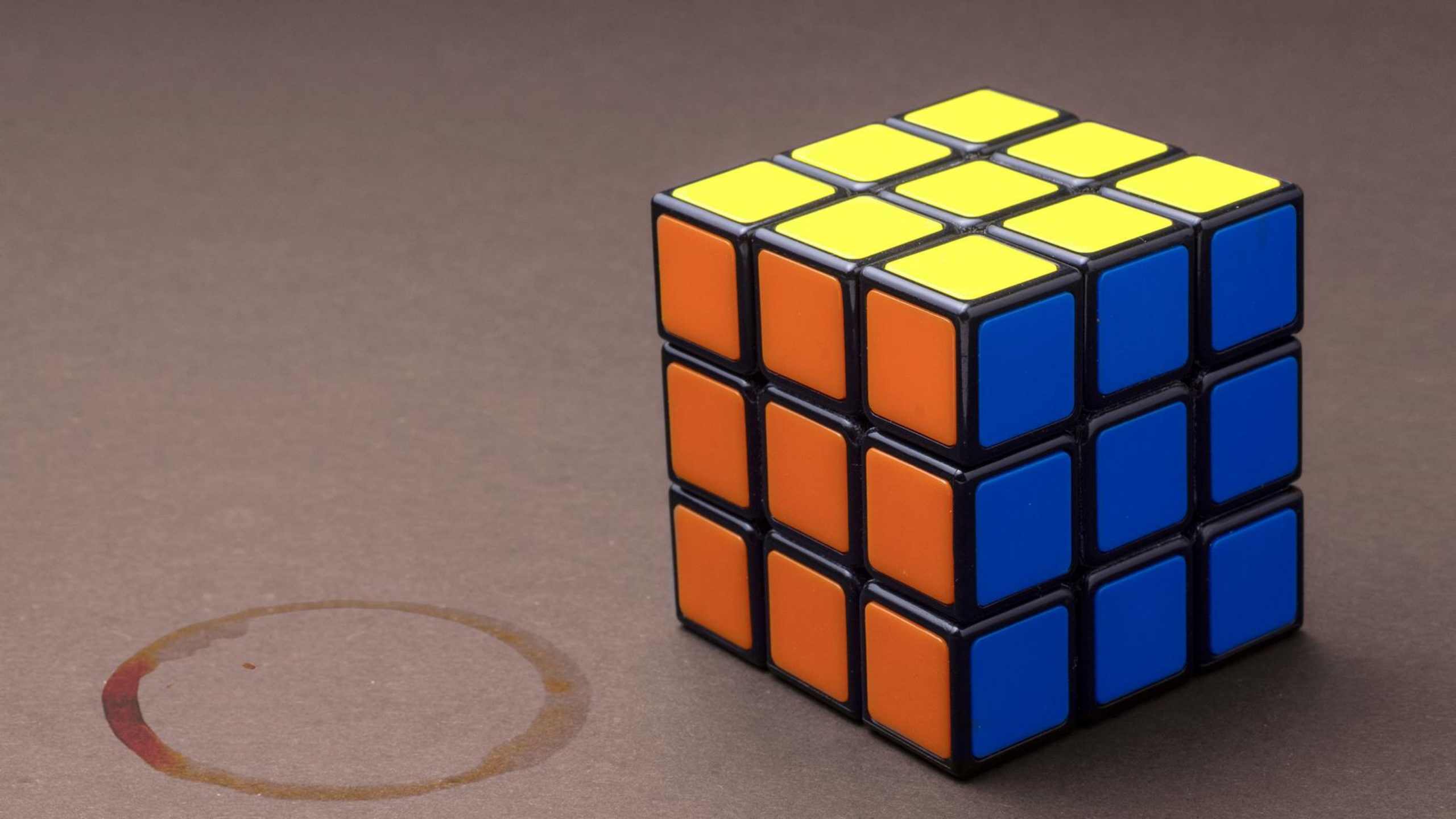
[18] Infrastructure covers roads, bridges, ports, airports, railways, embankments, culverts as well as underground infrastructure.

GRADE Humanitarian

- **The Problem:** How to understand, evaluate and interpret existing damage assessments in EU countries?
- **The Solution:** DSS Platform
- **Impact:**
  - Climate Change & Future Trends in Risk
- **Conclusions:** Analytics & Benchmarking for Better Decision Making


sendaimonitor.unisdr.org
Español
UNISDR
PreventionWeb
INICIAR SESIÓN
MARCO DE SENDAI
PARA LA REDUCCIÓN DEL RIESGO DE DESASTRES
INICIO
ANALÍSIS
MEDICIÓN DE LA IMPLEMENTACIÓN DEL MARCO DE SENDAI
ANUNCIO
Custom Targets and Indicators available on the Monitor
After the successful release of the system in March 2018, UNISDR is pleased to announce Phase 2, which allows Member States to define a Strategy and configure custom Targets and Indicators.


AMERICANO
CAPPUCCINO
LATTE
T-BROWN MOCHA
CHAI
BREW

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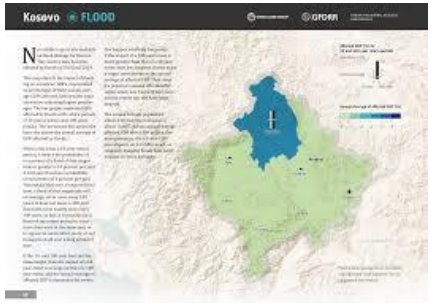
LAC Risk-Viewer | Costa Rica
Costa Rica | Earthquake
Exec Summary
What Risk Profiles are Available for Costa Rica?
COLOR
BLACK

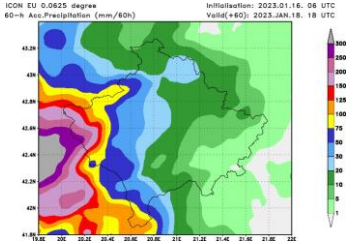
Impacts & Benefits of GRADE

- Conducted over 70 GRADE assessments since 2015.
- Allow the World Bank and partners to determine appropriate levels of financial and TA and develop WB Operations.
- Supports **disaster response, recovery plans, financing, and donor coordination**.

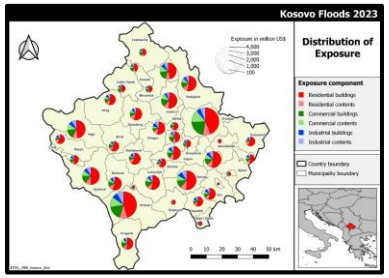
Expert knowledge



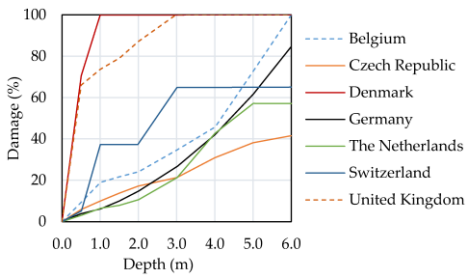
Historical damage data



Event scientific data



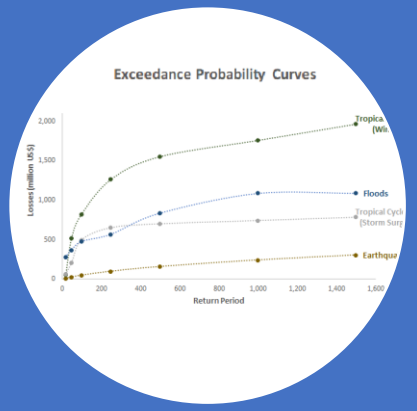
Census
Socioeconomic data



Vulnerability/Built Data

Integrating climate and disaster risk info.

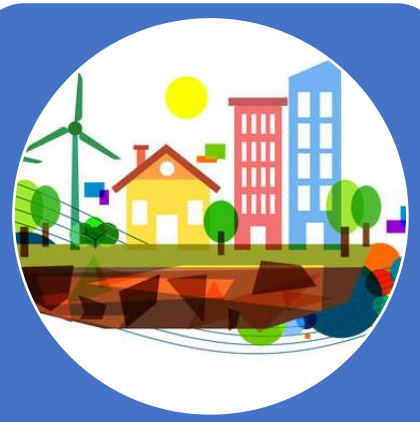
Provide an analytical framework for assessing climate and disaster impacts on macroeconomic, poverty, and welfare indicators.



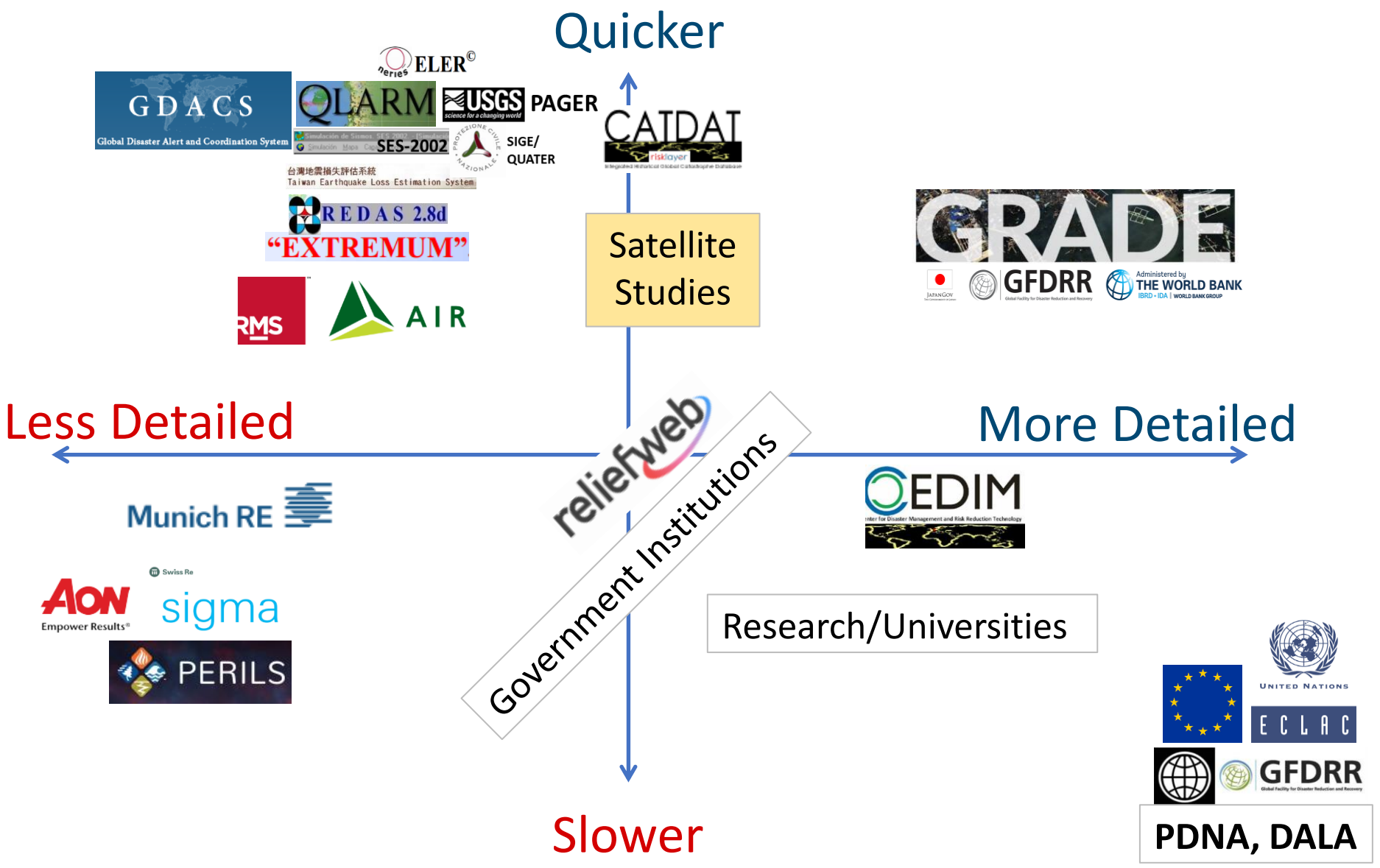
Rapid Disaster damage Assessment

Macroeconomic Impact of Disasters

Impact of Disasters on Poverty and Inclusion



Changing Risk Picture


Quicker
GDACS
Global Disaster Alert and Coordination System
ELER©
QLARM
USGS
science for a changing world
PAGER
SES-2002
SIGE/
QUATER
台灣地震損失評估系統
Taiwan Earthquake Loss Estimation System
REDAS 2.8d
"EXTREMUM"
RMS
AIR
CATDAT
riskayer
Satellite
Studies
GRADE
GFDRR
Administered by
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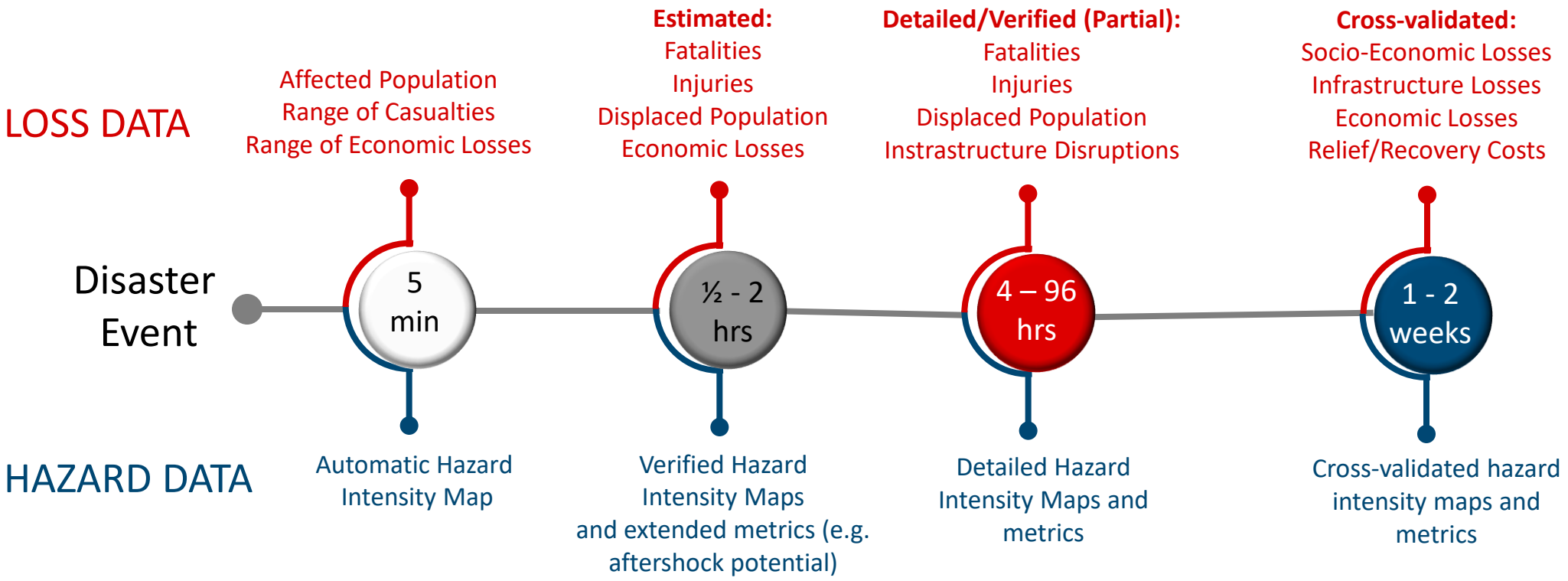
IBRD • IDA | WORLD BANK GROUP
Less Detailed
More Detailed
reliefweb
Government Institutions
Munich RE
EDIM
Swiss Re
AON
Empower Results
sigma
PERILS
Research/Universities
UNITED NATIONS
ECLAC
GFDRR
PDNA, DALA
Slower

Timeline for production of hazard and loss data

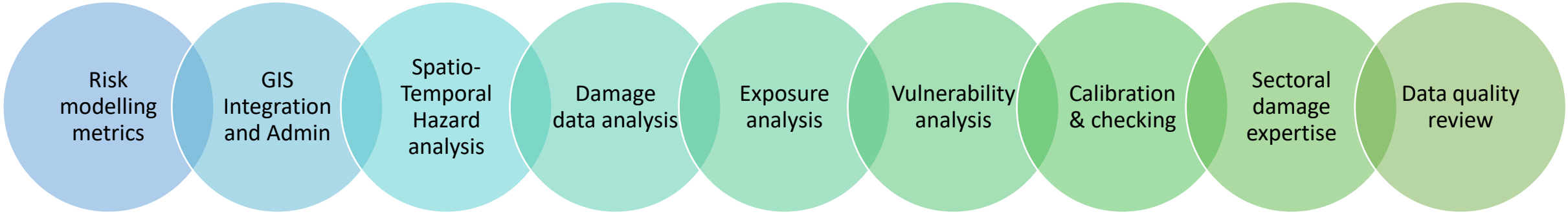


- 1st level analysis (automatic detection, trigger models, outputs as most likely ranges)
- 2nd level analysis (manual verification, updated models, outputs as absolute values)
- 3rd level analysis (detailed analysis, model cross checking)
- 4th level analysis (detailed analysis with extended parameters and verification across multiple sources)

Official Checked Information

Benchmarking online response data and portals

- Main Portals
  - GDACS (key links, basic impacts and modelling, maps, media links)
  - RSOE EDIS
  - Remote Sensing (UNOSAT, COPERNICUS, SERTIT etc.) – Disasters Charter
  - ReliefWeb, IFRC Alertweb, GLOFAS, IDMC etc.
  - PDC Meteoalarm, ARISTOTLE etc.
  - Facebook, Google Crisis Response, NGOs
  - Ministry, Govt, National Portal sources
  - Engineering and Ground Reports, Universities
  - Twitter/Instagram/FB
  - Online news articles & web scraping with manual engineering model.



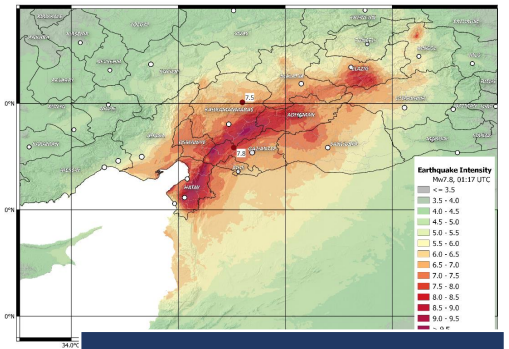
Some GRADEs related to Europe

Date	Country - Event	Type	Report/ Note	PDNA/DALA	Hazard types	Innovations and additional tasks
2019.11	Albania - Durrës, earthquake	EQ	Full GRADE	PDNA	Ground shaking	understanding exposures & vulnerability of socialist era building stock; received recognition from EU
2020.03	Croatia - Zagreb earthquake	EQ	GRADE Note	no	Ground shaking	Not a full GRADE
2020.11	Turkey - Samos Island earthquake	EQ	Full GRADE	National Assessment	Ground shaking & Tsunami	tsunami run-up model & mapping of major RC building collapses (and casualties related to these)
2020.11	Greece - Samos Island earthquake	EQ	Full GRADE	National Assessment	Ground shaking & Tsunami	tsunami run-up model
2022.04	Ukraine - Conflict & Crisis	Conflict	Full GRADE	RDNA	Conflict	
2022.04	Ukraine - Conflict (& Dam break)	FL	GRADE Note		Floods	
2023.01	Kosovo - Floods	FL	GRADE Note	no	Floods	
2023.02	Turkey - Kahramanmaras earthquakes - Turkey	EQ	Full GRADE	no	Ground shaking	Composite ShakeMap for mainshock and 2 aftershocks

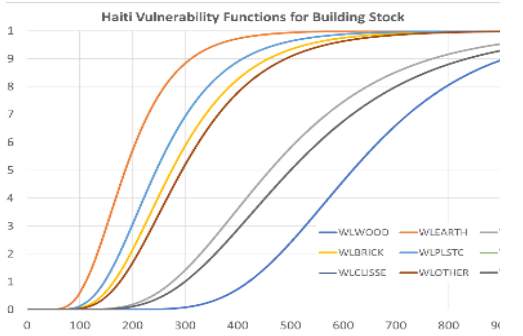
What data is needed to calibrate these?

- Comparison of past risk studies
- Collection of damage data statistics
- Comparison with past events
- Comparison with asset values

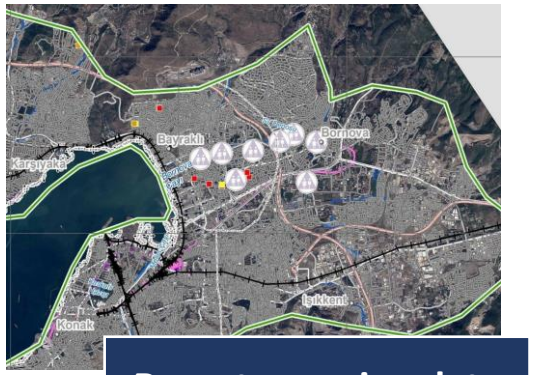
+ spatio-temporal scale + much calibration



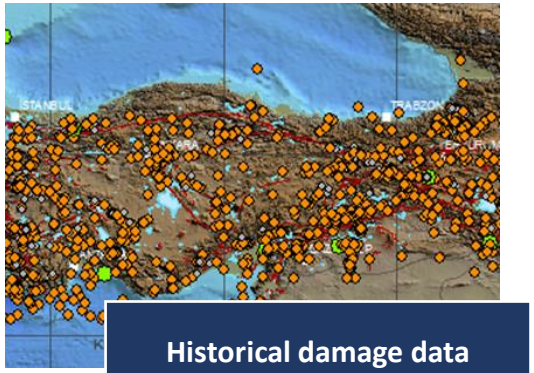
Scientific event data



Vulnerability data

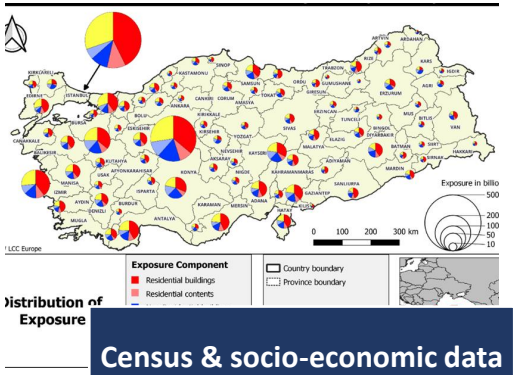


Remote sensing data



Historical damage data

Built asset data

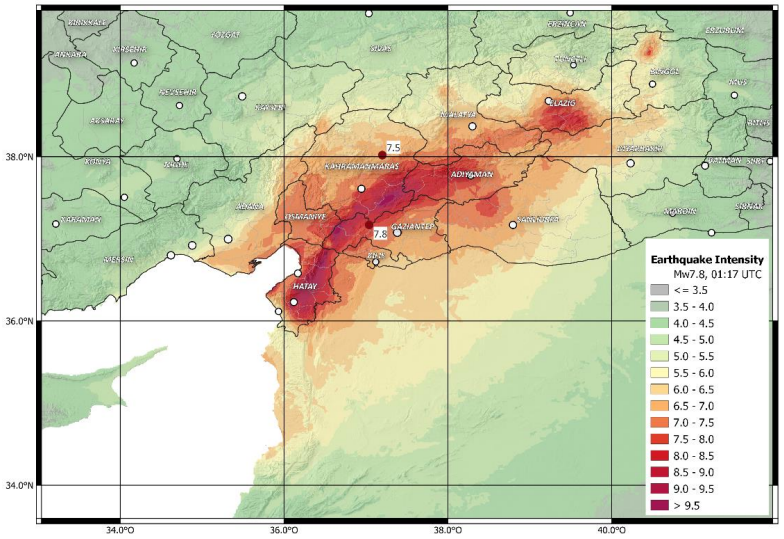


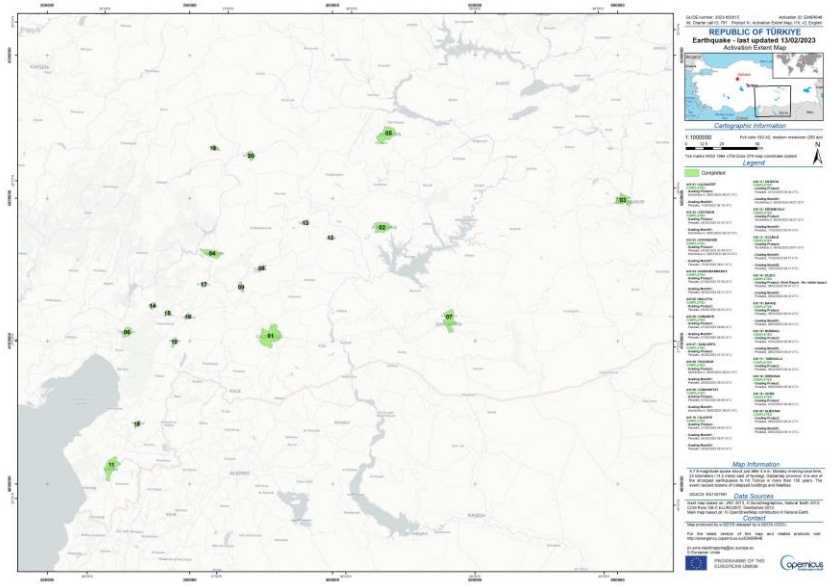
Census & socio-economic data

Reported damage data (official sources, media & social media)

Criteria for comparison: Scale

- Each portal / rapid assessment source looks at the disaster scale very differently.
- What is the detail needed on the hazard side – are secondary effects covered?
- In what way is the pre-disaster state taken into account?
- Are the damages static or dynamic in terms of the reporting?





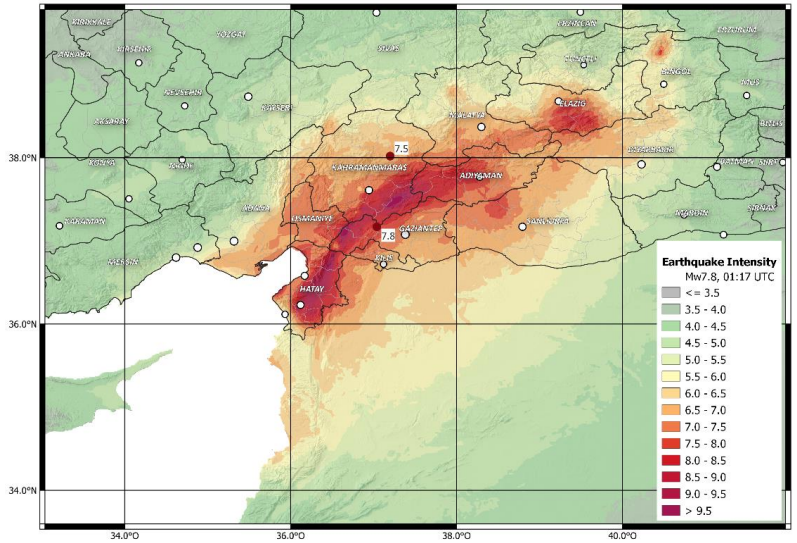
What data?

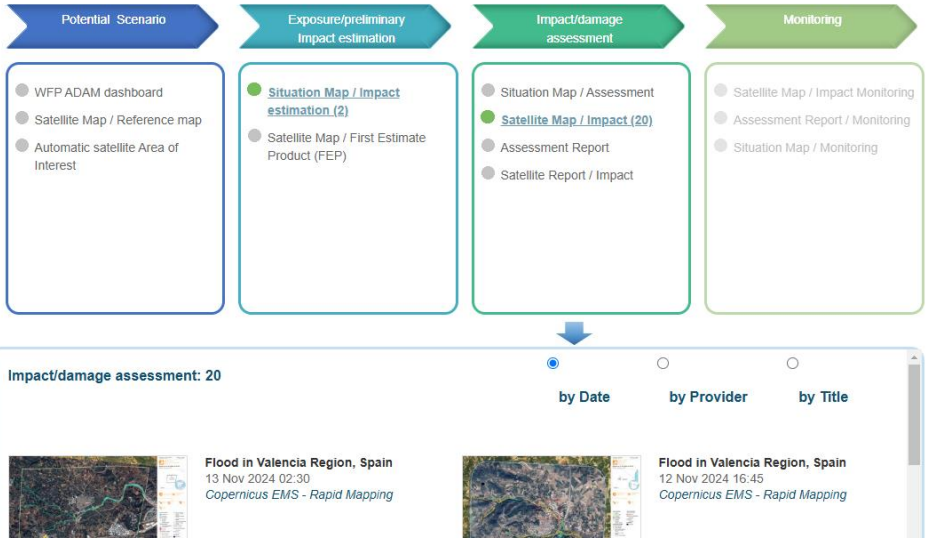
- Extent affected
- All hazards covered?
- Does the portal cover all damaged and undamaged locations?
- Temporal resolution
- Spatial resolution

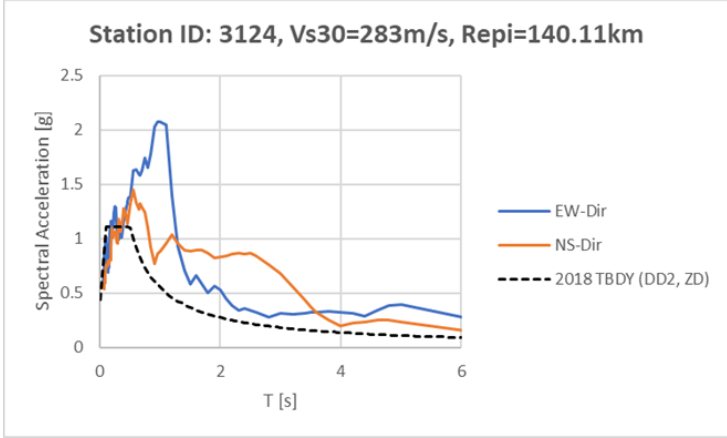
vs. 7328 engineers assessing 3 million buildings in 8 days.

Criteria for comparison: Event Scientific Data/Hazard Type

- Very dependent on hazard and location.
- Each portal looks at scale very differently.
- What is the detail needed?







What data?

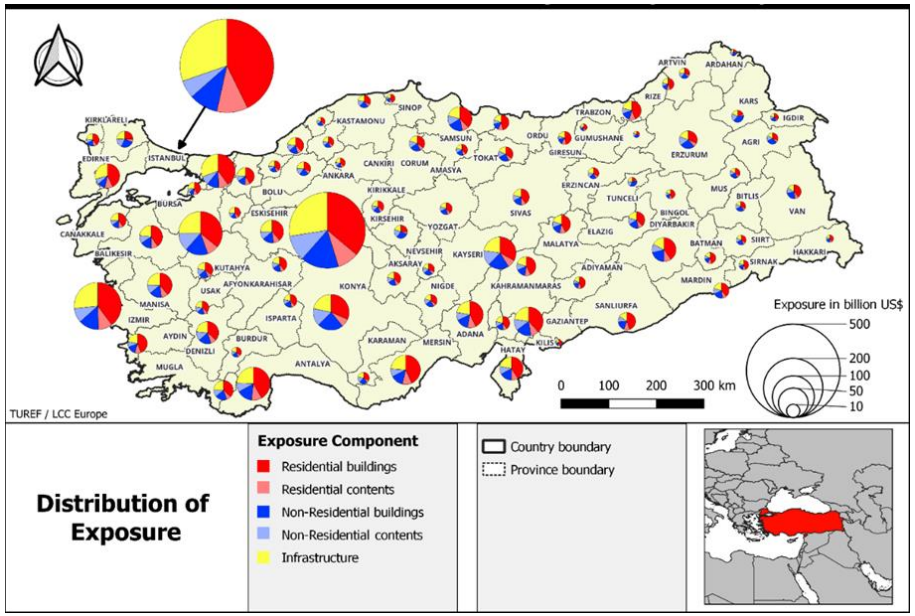
- Station Data (Weather, Seismic, Water etc.)
- Other sensor data
- Models and methods
- Knowledge as to what parameters are important
- Secondary Hazard Data
- GIS, Spatio-temporal.

Benchmarking Exposure, Socioeconomic and Building Data

What data?

- Household Data
- Historic Census data
- Survey Data
- Population Data
- Critical & Sectoral Data (Schools, Health)
- OSM, open data
- Competent GIS teams

Which portals use pre-existing data?
i.e. GDACS with Population; PDC and PAGER with basic exposed capital?

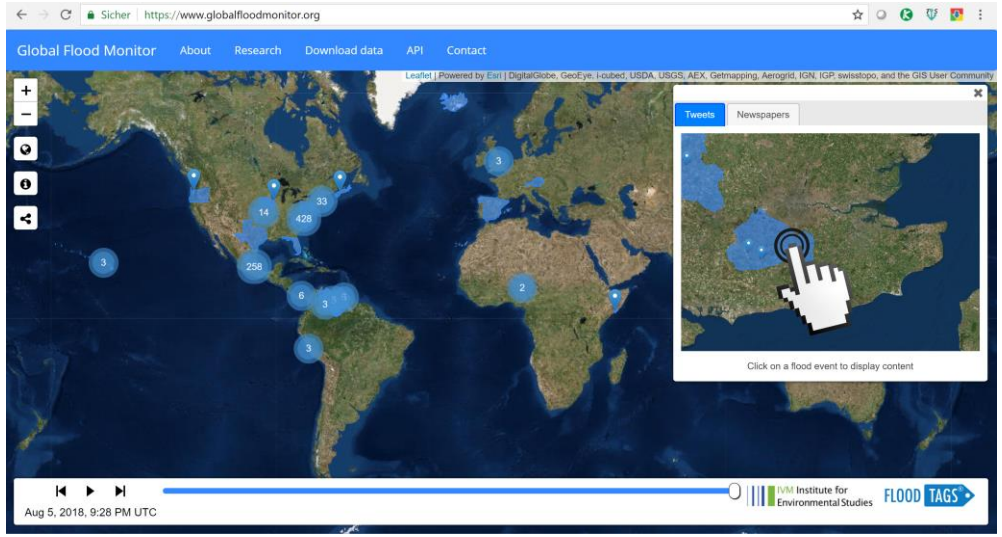


What data?

- Building statistics data
- Socioeconomic data
- Welfare data
- Local data
- Existing Studies
- GDP and economic data

Criteria for comparison: Social Media and AI products

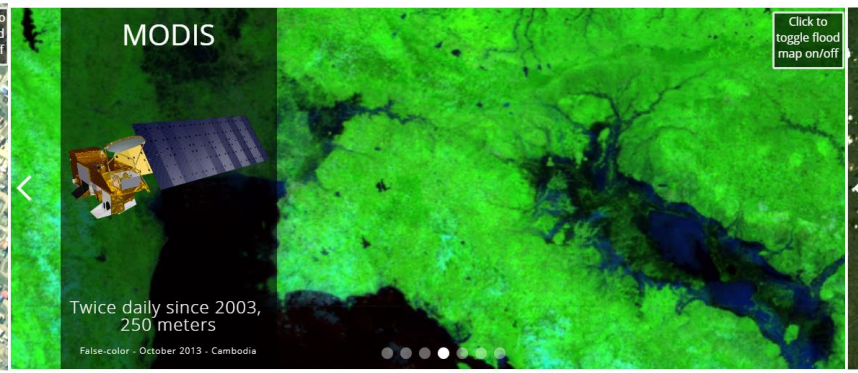
- Many portals exist with aggregation of news feed data (not much set criteria).
- GDACS, and a number of others bring data directly in.
- Number of AI and automated products: scale and applicability.

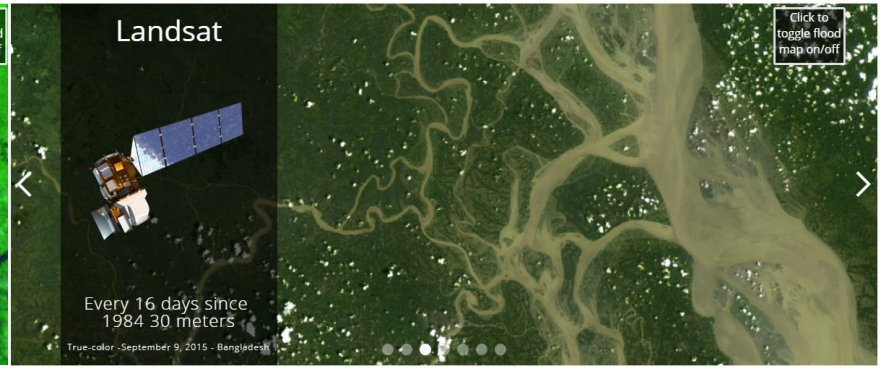


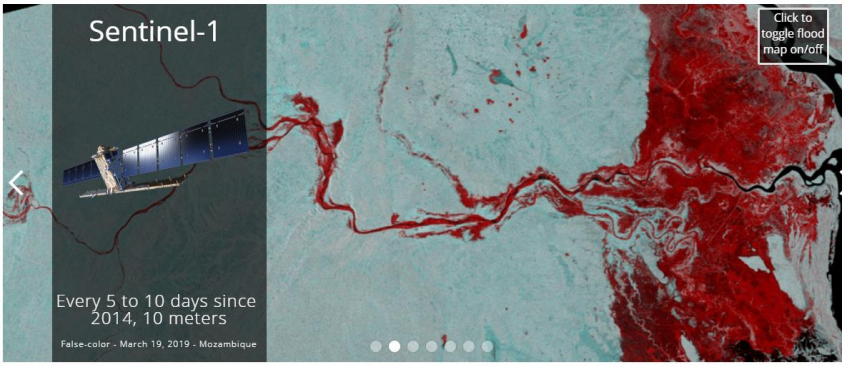
What data?

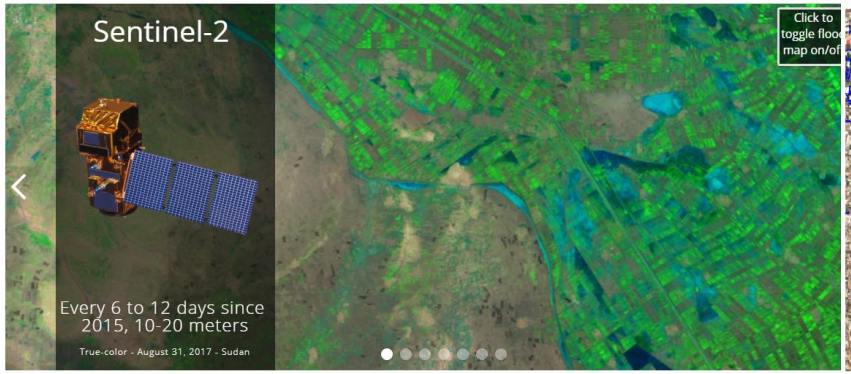
- Relevant Social Media Feeds (+ Videos)
- Geolocation data
- Temporal data
- **Misinformation checks**
- Official Govt. Feeds List
- Official Hazard, Exposure, Vulnerability and Post-Disaster Feeds

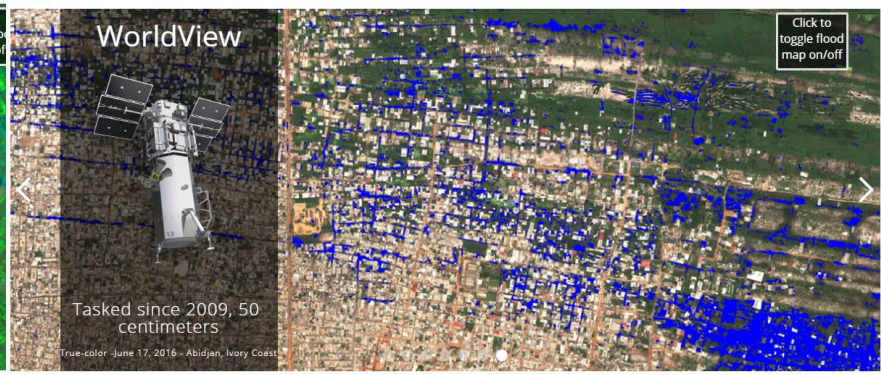
Remote Sensing

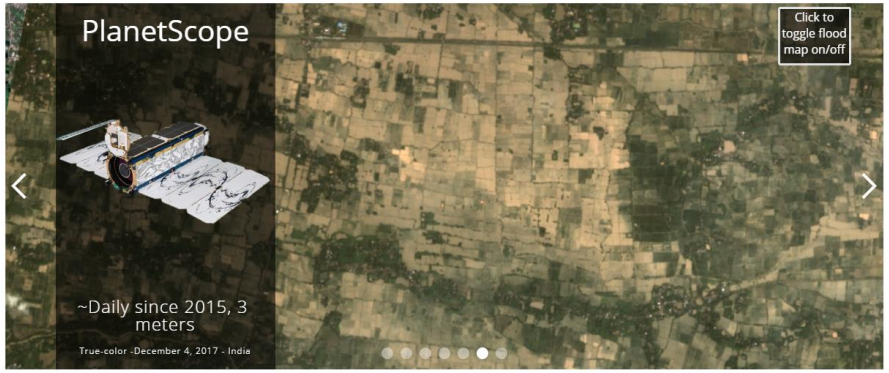






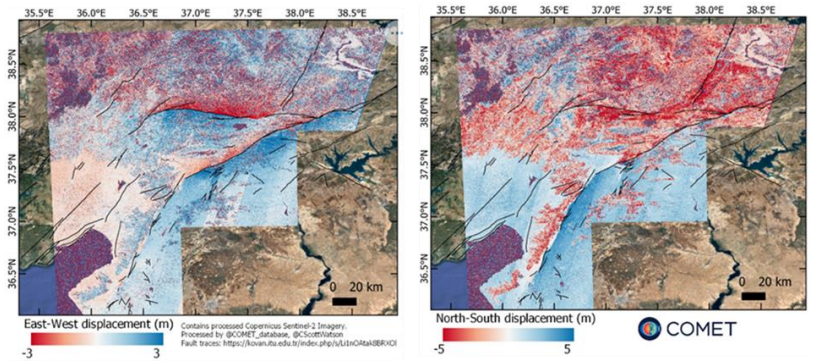


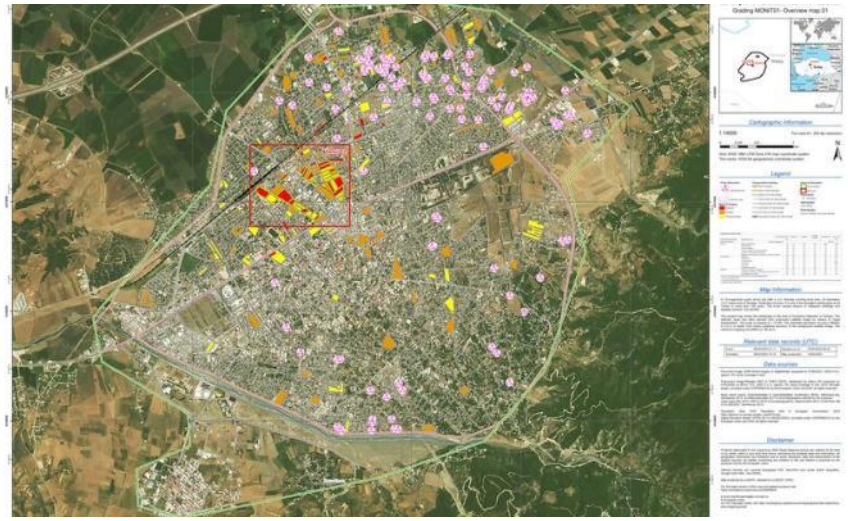




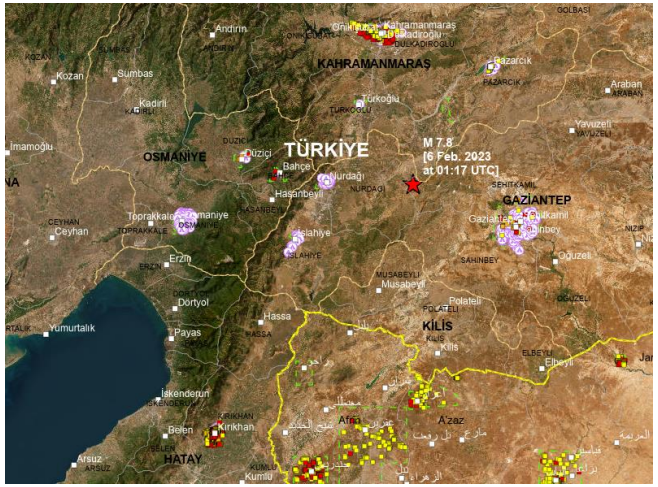
Criteria for comparison: Remote Sensing

Portals such as Unosat, GDACS, Copernicus etc.





Damage Proxy - NASA via ALOS-2, PALSAR-2, Landsat 9, OLI-2



What data?

- Checks of Satellite Products
- Other sensor data
- Drone data
- **Fly-over data**
- Pre-event and Post-event data
- Change analysis products

Criteria for comparison: Vulnerability and Damage Data

	Total Buildings					Total Independent Sections				
	Heavily Damaged	Moderately Damaged	Slightly Damaged	Undamaged	Total	Heavily Damaged	Moderately Damaged	Slightly Damaged	Undamaged	Total
ADANA	97	462	2,568	9,396	13,141	1,715	10,667	53,986	113,890	**183,448**
ADIYAMAN	13,730	4,338	19,410	18,598	63,452	44,817	17,489	63,737	40,037	**190,693**
DİYARBAKIR	1,110	1,044	10,977	27,334	45,149	8,284	12,106	109,784	226,953	**373,947**
ELAZIĞ	1,036	174	2,176	1,266	4,810	5,193	1,027	21,911	15,401	**44,536**
GAZİANTEP	15,088	5,662	42,945	135,809	228,272	36,620	22,829	252,089	461,926	**842,811**
HATAY	30,112	7,281	36,112	77,107	158,112	123,349	33,351	117,588	169,711	**465,813**
MALATYA	16,870	1,694	17,745	17,333	64,883	62,547	12,098	88,763	54,180	**257,762**
KAHRAMANMARAŞ	22,113	2,208	33,664	45,395	117,801	84,059	12,975	139,406	98,242	**374,218**
ŞANLIURFA	663	829	22,913	30,964	63,428	3,535	5,932	165,453	123,916	**327,130**
KİLİS	1,261	307	4,746	7,918	15,387	1,921	1,629	24,044	25,301	**55,290**
OSMANİYE	3,794	465	11,830	36,666	56,371	12,505	3,472	54,959	80,097	**158,241**
TOTAL	**105,794**	**24,464**	**205,086**	**407,786**	**830,783**	**384,545**	**133,575**	**1,091,720**	**1,409,654**	**3,273,605**

Damage Data Collection and Evaluation System - SIRED

"**SIRED** is a digital tool and a method of measuring the **physical and fiscal impact** of natural events in any country."

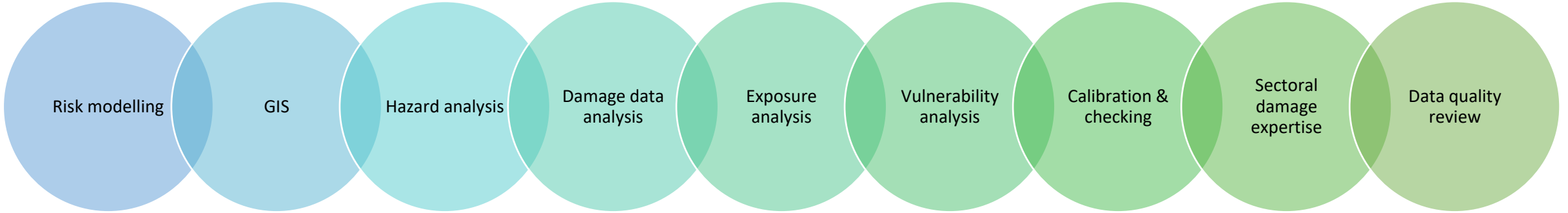
- COLLECTS
- STANDARIZES
- ANALYZES
- ASSESSES

What data?

- Damage Surveys
- Past studies on relevant buildings + infrastructure
- Damageability studies
- Post-disaster ground based studies
- Photo + Video Damage Assessment evidence.

Criteria for comparison: Verification

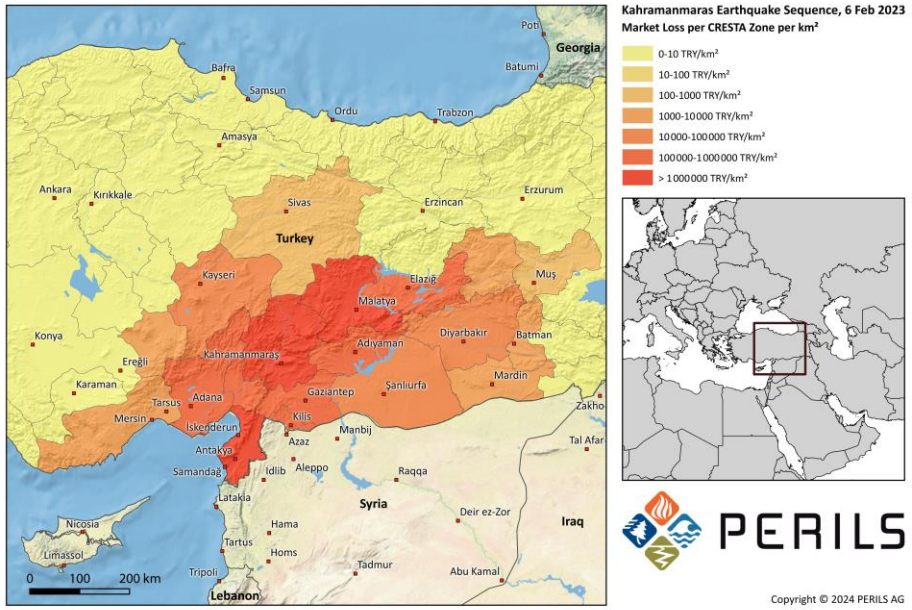
Fake news	Knowledge of what data are from past events vs. current event.
Independent Auditing information	Combining official source data with initial damage reports to adapt loss functions Auditing of the overestimation or underestimation bias in media sources
Exposure Estimates for upper limits	Affected Population, Economic Sectors, Critical Infrastructure, Repair ratios, Displaced Population

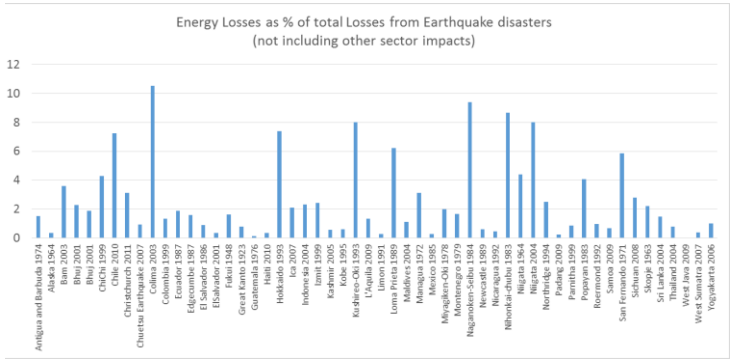


Criteria for comparison: Economic Considerations

Important: Damage Cost Data for components

- EU Horizon Projects
- Databases such as SERA-EU, PIK, etc.
- Definitions are important from each tool (similarly for damage states) – i.e. Insurance vs. Public cost etc.





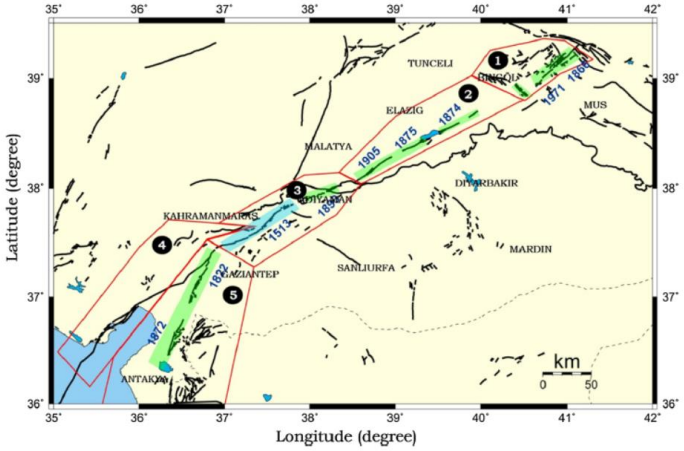
What data?

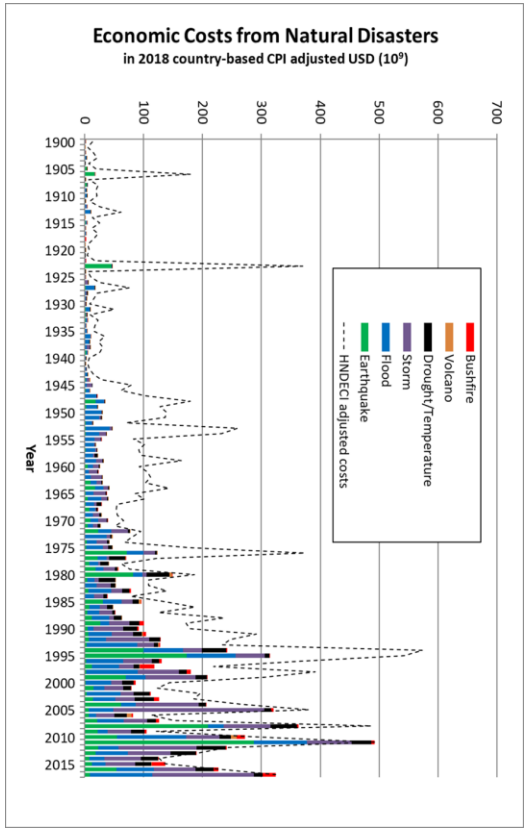
- Through previous disasters (PDNAs, DALAs)
- Economic surveys
- Risk Assessments
- **Capital Stock Models**
- Official Govt. Lists
- Tender Data
- Valuations

Criteria for comparison: Historic Data Benchmarking

Historical Damage Data

- Historical damage data, Local databases such as AFAD-RED, TABB, Desinventars etc. etc.
- European scale databases (HANZE, EEA, etc.)
- Global Internal Displacement Databases
- Global Damage and Loss Databases (CATDAT, EM-DAT, MunichRe, SwissRe, etc.)





What data?

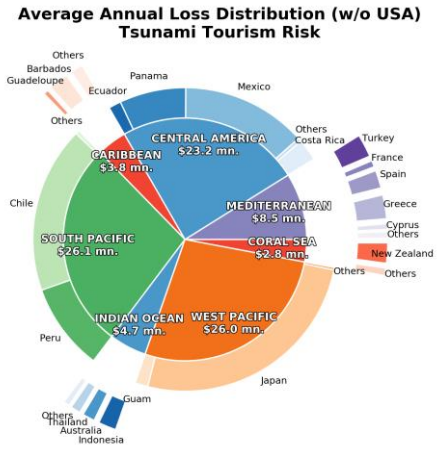
- Past event losses
- Hazard Footprints
- Where did the past events occur?
- What were the conditions back then?
- Was the built stock the same as now?
- Is this data complete?

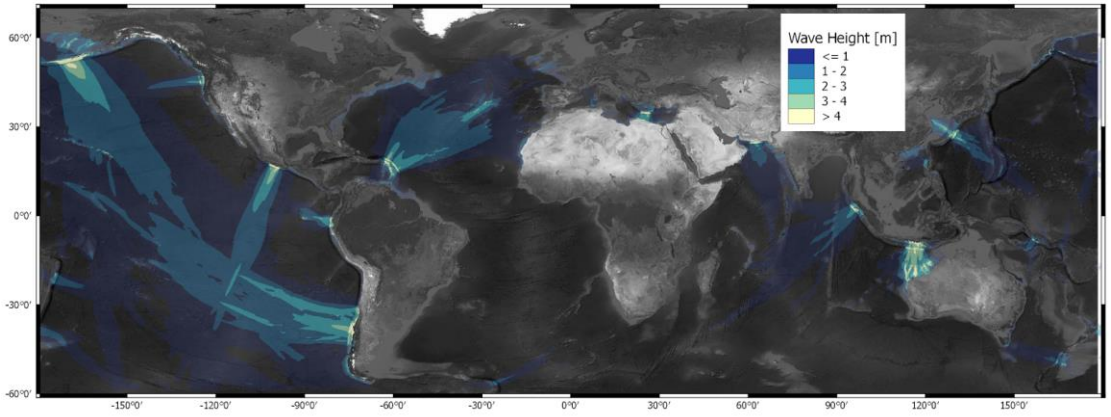
Criteria for comparison: Sectoral Considerations

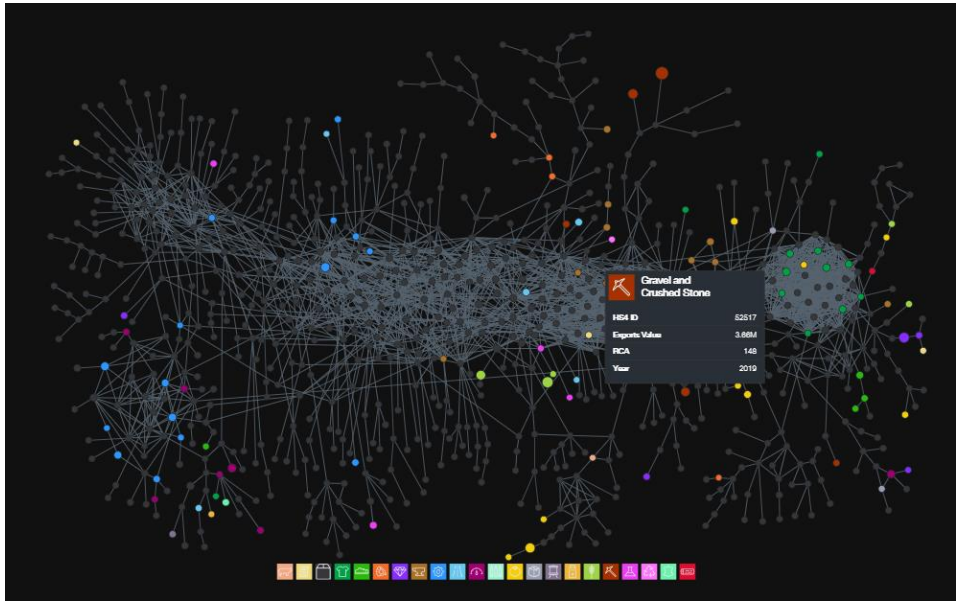
- What is each portal counting?

- What is the purpose, and which can be used?

i.e. agricultural risk portals like WFP etc.





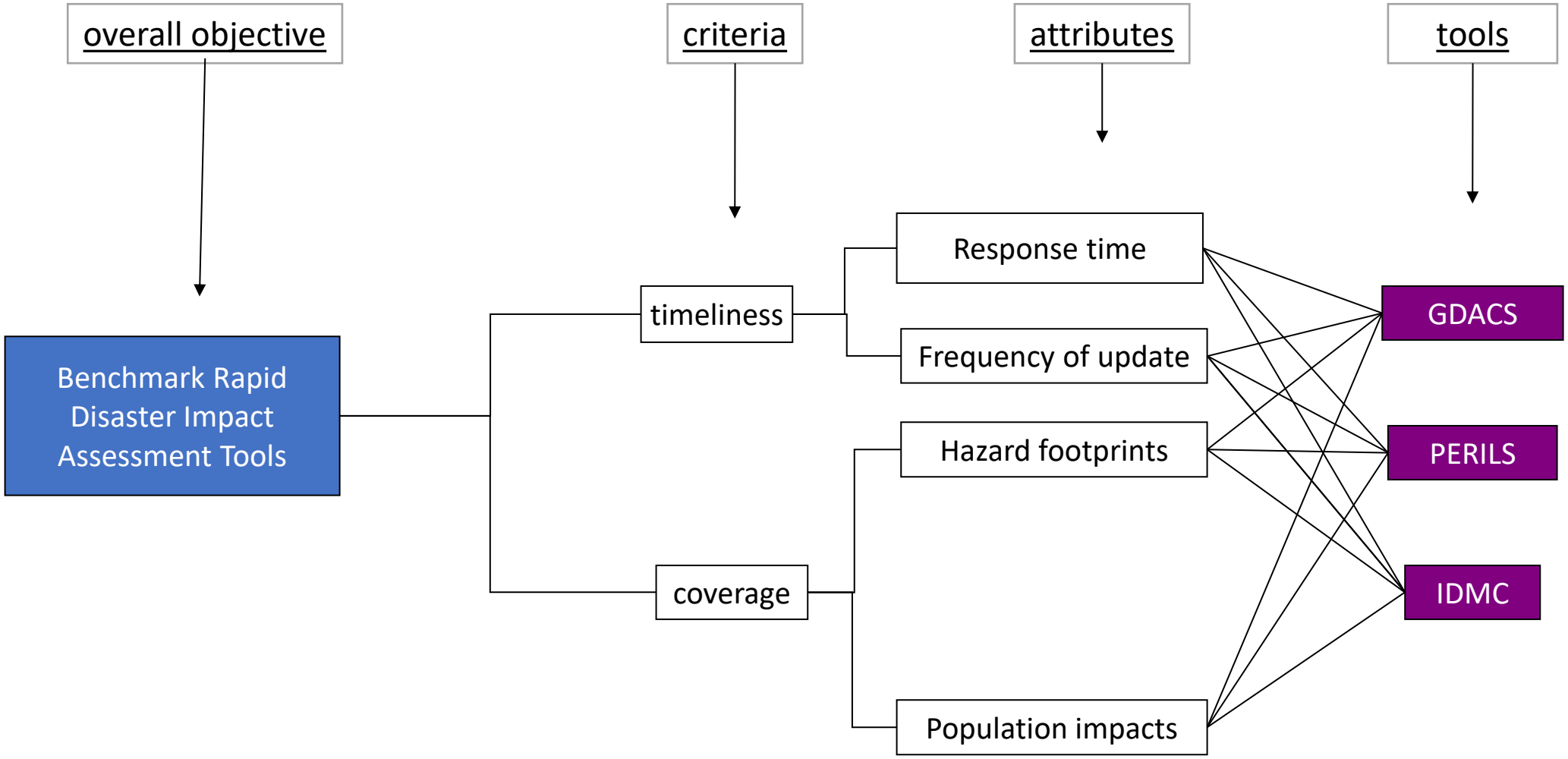


Developing a Decision Support System (DSS) for Benchmarking Rapid Post Disaster Assessments Tools

Benchmark and evaluate rapid post-disaster impact assessment tools to enhance EU Civil Protection's decision-making during disaster response.

- Develop criteria to assess tool suitability across hazards, geographic areas and response requirements.
- Create a Decision Support System (DSS) to help prioritize tools and datasets based on operational needs and expert input.

Problem Structuring aims at hierarchically modelling the decision criteria



Characterize different rapid damage assessment tools as a score based on multiple categories

(Some Example Categories and Criteria shown)

Category	Criteria	Attributes for Benchmarking and Ranking
Timeliness	Response Time	Immediate (0–24 hours), Short-Term (1–3 days), Medium-Term (4–10 days), Long-Term (>10 days)
	Frequency of Update	Real-Time, Periodic (Hourly/Daily), Event-Triggered, On-Demand
	Data Latency	Low latency (data available within minutes), Medium latency (within hours), High latency (days)
Coverage	Spatial Scale of Analysis	Full Disaster Area, Extensive, Moderate, Limited
	Damage Categories	People (fatalities, casualties, missing, need assistance), Environment (damage to sensitive areas, agricultural damage), Economy (direct damage, indirect losses, economic power loss), Infrastructure (buildings, hospitals, schools, roads, bridges, water, power), Intangibles (public security, political implications, cultural values)
	Hazard Types	Earthquakes, floods, fires, storms, multi-hazard capability
	Exposure Elements	Population, buildings, critical infrastructure, transportation, agriculture
	Socio-economic Data	Demographics, economic losses, income levels, social vulnerability
	Field Data Integration	Yes/No integration, frequency of updates, coverage extent, validation process
Quality	Accuracy	High (validated by multiple sources), Medium, Low (unvalidated or crowdsourced data)
	Reliability	High (consistent performance, minimal errors), Moderate, Low (variable or error-prone data)
	Predictive Accuracy	High accuracy (precise predictions), Moderate, Low (limited or uncertain predictions)
	Validation	Third-party validation, internal validation only, unvalidated
	Transparency	Fully transparent (public methodology and sources), Partially transparent, Not transparent
Usability	Data Accessibility	Public access, restricted access, subscription-based access
	User Interface	Intuitive, Moderate, Complex (ease of navigation and use under time constraints)
	Integration Capability	High (integrates with other systems easily), Moderate, Low (difficult to integrate)
	Data Format Compatibility	GIS layers, CSV, APIs, other standard formats available
	Reporting and Visualization	High-quality maps, dashboards, automated reports, minimal visualization

Country-Specific Post Disaster Damage Assessment Tool Recommendations

DOWNLOAD COUNTRY REPORT

1. SELECT A COUNTRY

Spain

2. SELECT A PERIL

EARTHQUAKE | WINDSTORM | FLOOD

3. SELECT A SCALE OF USE

MULTI-COUNTRY | NATIONAL | REGIONAL | COMMUNITY | BUILDING

4. SELECT TIMELINESS OF DATA

REAL-TIME | IMMEDIATE (<1 DAY) | SHORT (1-3 DAYS) | LONG (1-3 DAYS)

This page allows you to explore the Rapid Damage Assessment Tools and damage data available for a specific country. The information provided aims to answer the question, *'What is available for country X and what can/can't it be used for?'*.

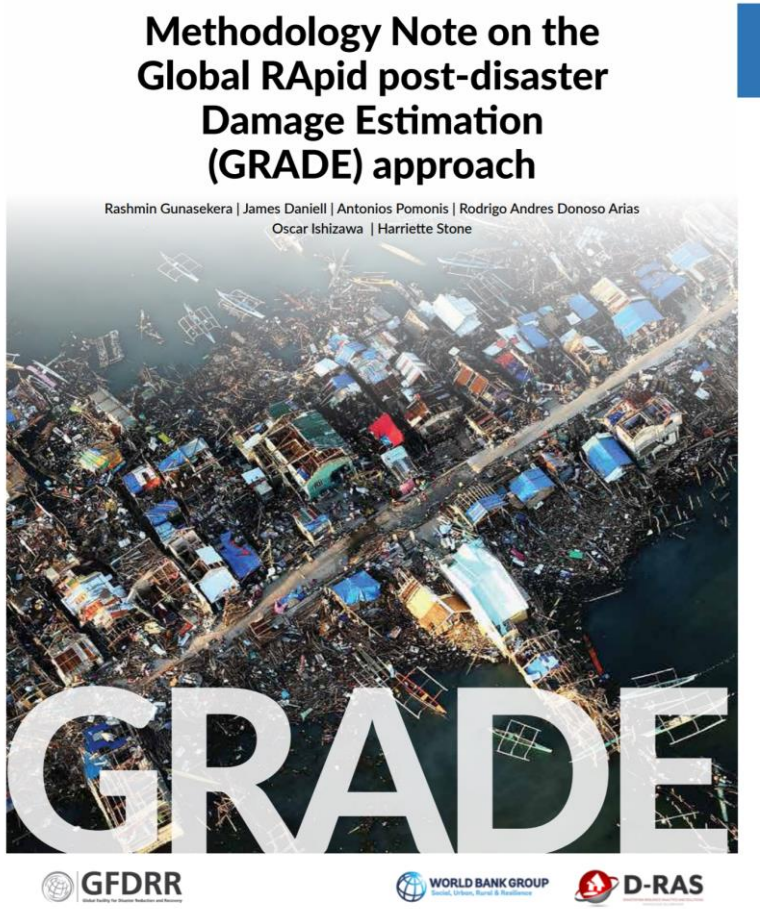
Instructions:

1. Select the country, hazard type, and scale (e.g., regional, or community-level) that you are interested in.
2. Expand the boxes below to see which Rapid Damage Assessment Tools are suitable, how their results compare, and their technical information.

Suitable Uses for the Available Rapid Disaster Assessment Tools and Data

Tool	Spatial Scale of Analysis	Timeliness: Response Time	Timeliness: Frequency of Update	Timeliness: Data Latency	Coverage: Loss Categories	Coverage: Hazard Types	Coverage: Exposure Elements	Coverage: Socio-economic Data	Coverage: Field Data Integration	Quality: Accuracy	Quality: Reliability	Quality: Predictive Accuracy	Quality: Validation	Quality: Transparency	Useability: Data Accessibility	Usability: User Interface	Usability: Reporting and Visualization
GDACS	*Full*	*Pre-, near real-time*	*Event-triggered, Automated*	*Low*	*People-focused, minimal economy*	*Multi-hazard*	*Basic infrastructure and population data*	*Yes*	*No*	*Moderate*	*High*	*Moderate*	*Partially validated*	*High*	*Public*	*Intuitive*	*Comprehensive Mapping and Standalone File*
PAGER	*Full*	*Near real-time to short-term*	*Event-triggered, Automated*	*Medium/Low*	*People-focused*	*Earthquake*	*Detailed building, economic and population models*	*Yes*	*Partial*	*Low -> Moderate*	*Moderate*	*Low*	*Internal Validation*	*High*	*Public*	*Intuitive*	*Standalone File Mapping*
PERILS	*Full*	*short-term*	*Event-triggered*	*Medium/High*	*Economy-focused, limited exposure*	*Multi-hazard (financial focus)*	*Detailed economic exposure models*	*Yes*	*Yes*	*Moderate -> High*	*High*	*High*	*Third Party Validated*	*Moderate*	*Subscription-based*	*n/a*	*Limited visualization and files*
RSOE EDIS	*Full*	*Pre-, near real-time*	*Event-triggered*	*Low*	*Basic people and infrastructure*	*Multi-hazard*	*Basic exposure*	*Yes*	*Partial*	*Moderate*	*Moderate*	*Moderate*	*Partially validated*	*High*	*Public*	*Intuitive*	*Limited visualization and files*
IFRC AlertHub	*Limited/ Moderate*	*Pre-, near real-time*	*Event-triggered, Automated*	*Low*	*Humanitarian, minimal coverage*	*Multi-hazard*	*Basic exposure*	*In Comments*	*Partial*	*Low*	*Moderate*	*None*	*Partially validated*	*Moderate*	*Public*	*Intuitive*	*Limited visualization and files*
Copernicus EMS	*Limited/ Moderate*	*Generally short-term*	*Event-triggered – manual curation*	*Low/Medium*	*People, environment, infrastructure*	*Multi-hazard (Europe-focused)*	*Building footprints where possible, infrastructure*	*Yes*	*Partial*	*Moderate*	*Moderate*	*Moderate*	*Partially validated*	*High*	*Public*	*Complex*	*Comprehensive Mapping and Standalone File*
UNOSAT	*Limited/ Moderate*	*Generally short-term*	*Event-triggered – manual curation*	*Low/Medium*	*People, environment, infrastructure*	*Multi-hazard*	*Building footprints where possible, infrastructure*	*Yes*	*Partial*	*Moderate*	*Moderate*	*Moderate*	*Partially validated*	*High*	*Public*	*Complex*	*Comprehensive Mapping and Standalone File*

Thank you!!



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