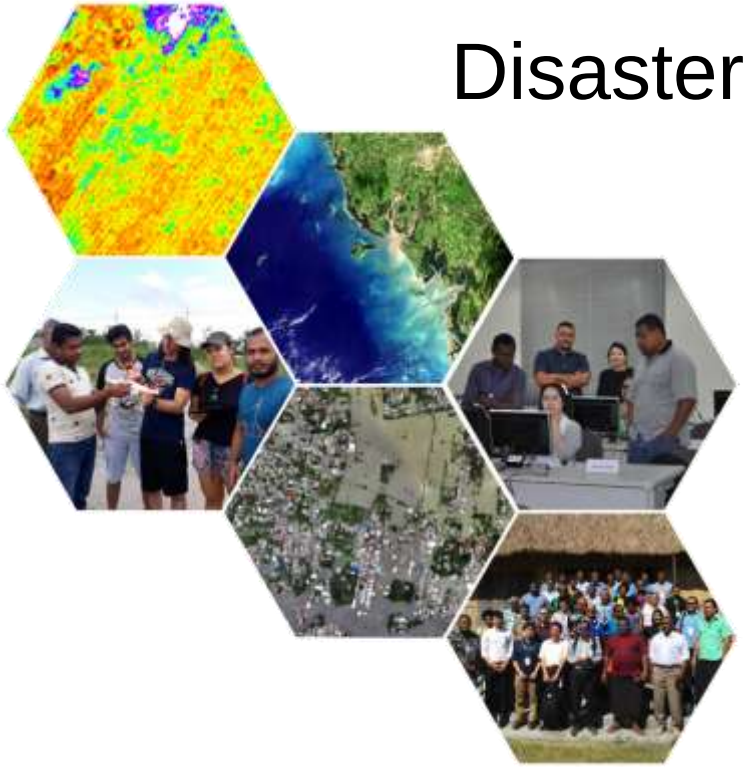
Role of Geospatial Data in Disaster Preparedness and Response



Kavinda Gunasekara, PhD

Geoinformatics Center
www.geoinfo.ait.ac.th
www.ait.ac.th

AIT Asian Institute of Technology

GIC

Outline

- Introduction to AIT
- Activities in disaster preparedness
  - DRA – National scale study in Tajikistan
  - DRA – State level study in India
- Activities in disaster response
  - Sentinel Asia (Regional framework)
  - International Disaster Charter

- Recent developments: platform/solutions

AIT
Asian Institute of Technology

Establish in 1959 as a Post Graduate School
Catering for higher education in Asia

Schools of AIT

- School of Engineering & Technology www.set.ait.ac.th
- School of Environment, Resources & Development www.serd.ait.ac.th
- School of Management www.som.ait.ac.th

- AIT Offers
  - Masters degrees: MBA, MEng, MSc
  - Executive Master Degree Programs
  - Doctoral Degrees: DEng, DTechSc, PhD
  - Diploma and Certificate Programs
  - An intensive English language and academic Bridging Program
  - Non-degree continuing education courses for practicing professionals

Outreach Centers of AIT

GIC

AIT
Asian Institute of Technology

GIC
Geoinformatics Center
Established in 1999

Our Expertise

REMOTE SENSING & GIS

ENVIRONMENT

DISASTER MANAGEMENT

TRAINING


GIC Family
Providing solutions far and wide with geoinformatics
GIC
AIT

Activities in Disaster Preparedness

- DRA – National scale study in Tajikistan
- DRA – State level study in India

Multi-Hazard Risk Assessment at National Scale for Tajikistan

Kavinda Gunasekara (AIT)

Cees van Westen (ITC)

Syams Nashrullah, Lakhmal, Rajita Athukorala (AIT-GIC), Bastian van den Bout, Vasily Kokorev, Janneke Ettema, Haydar Hussin (ITC), Tamo Tamarashvili (Georgia), Erkin Huseinov, Sulaymon Shobek (Tajikistan)
National experts: Anatoly Ischuk, Nicolai Ishuk, Mirzo Saidov (Tajikistan)

Objectives and partners

- To assess the vulnerability of communities and infrastructure to **earthquake, landslides, floods, mudflows, snow avalanches, windstorms** and **drought**),
- To determine their **degree of exposure** to future hazardous events and
- To develop **risk profiles** as a basis for development planning processes for all districts of Tajikistan.

1) Disaster Risk Assessment Methodology,
2) Capacity Building of Local Experts, and
3) Disaster Risk Information System.

UNDP 25 YEARS IN TAJIKISTAN
Empowered lives. Resilient nations.

AIT Asian Institute of Technology

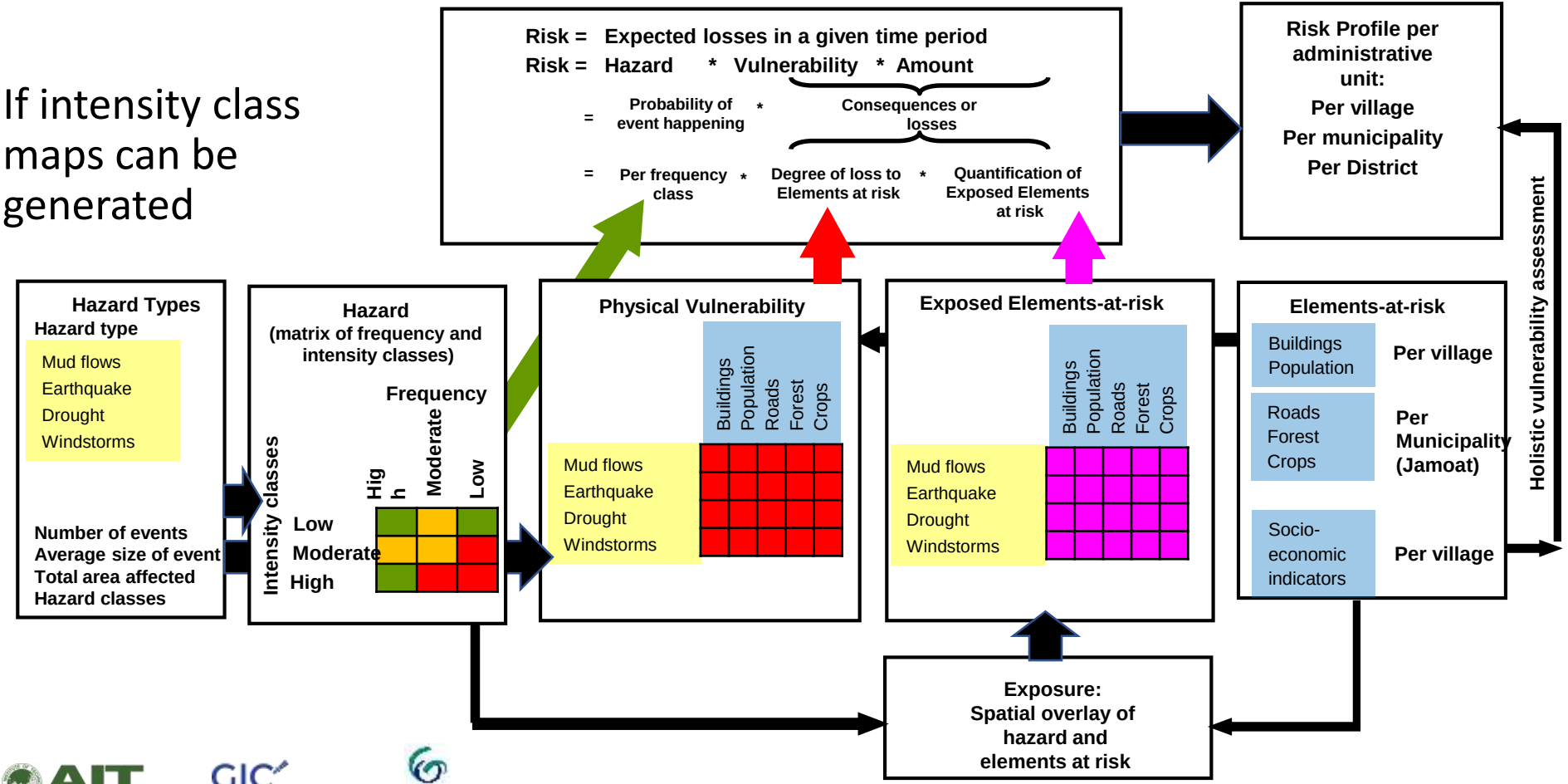
- AIT promotes technological change and sustainable development through higher education, research and outreach.

ITC UNIVERSITY OF TWENTE. www.itc.nl

- Capacity building and institutional development in professional and academic organizations as well as individuals specifically in countries that are economically and/or technologically less developed.

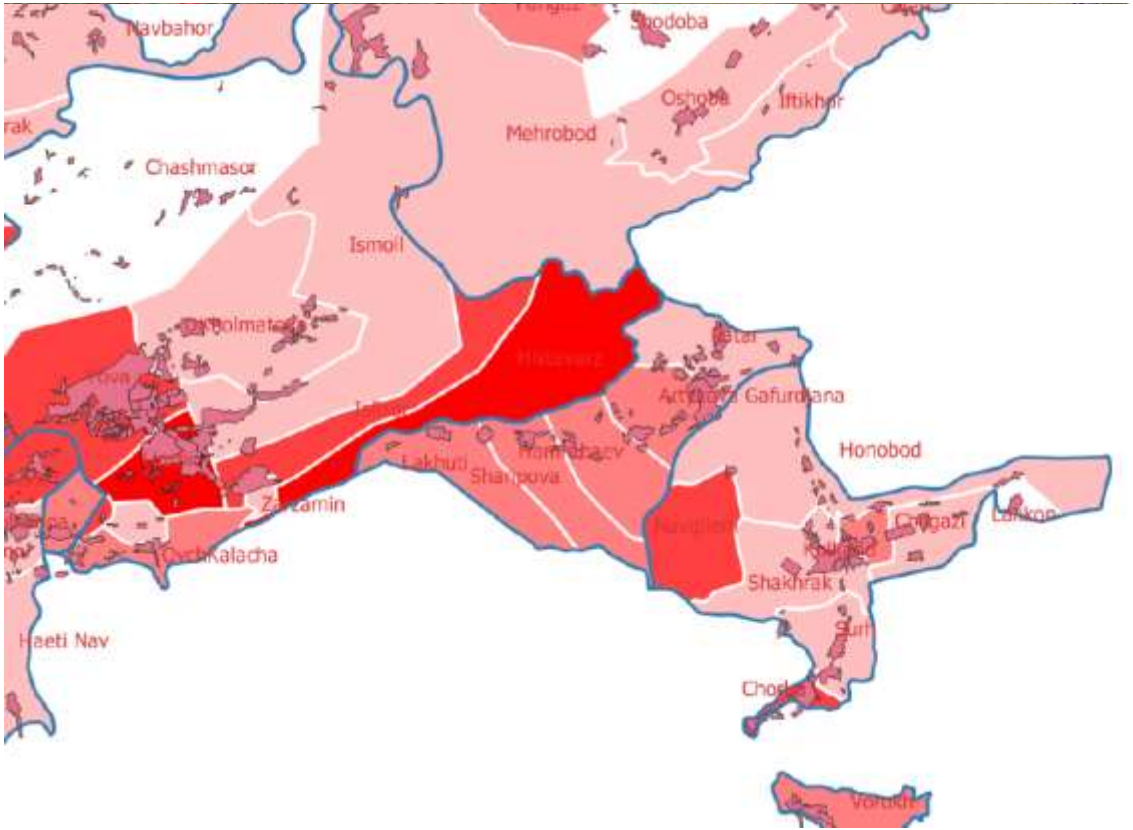
Proposed method for national scale risk assessment in Tajikistan

If intensity class maps can be generated



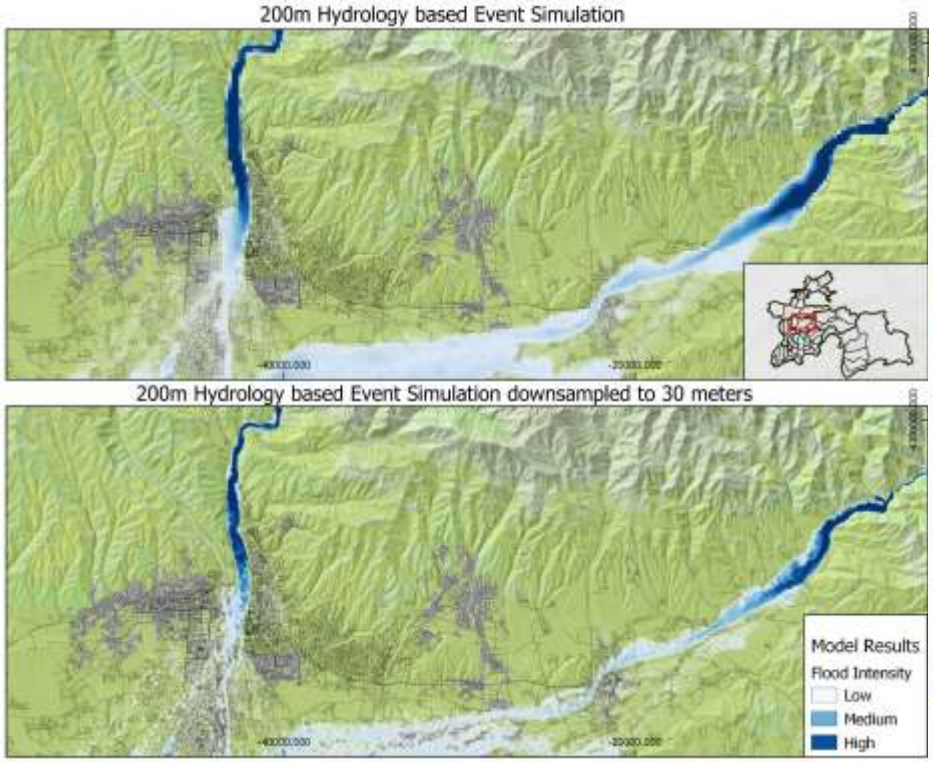
Data problems: Incorrect data

- Municipal boundaries do not link with settlements
- Names of settlements have changed.
- Socio-economic data on official portal does not match with settlements.



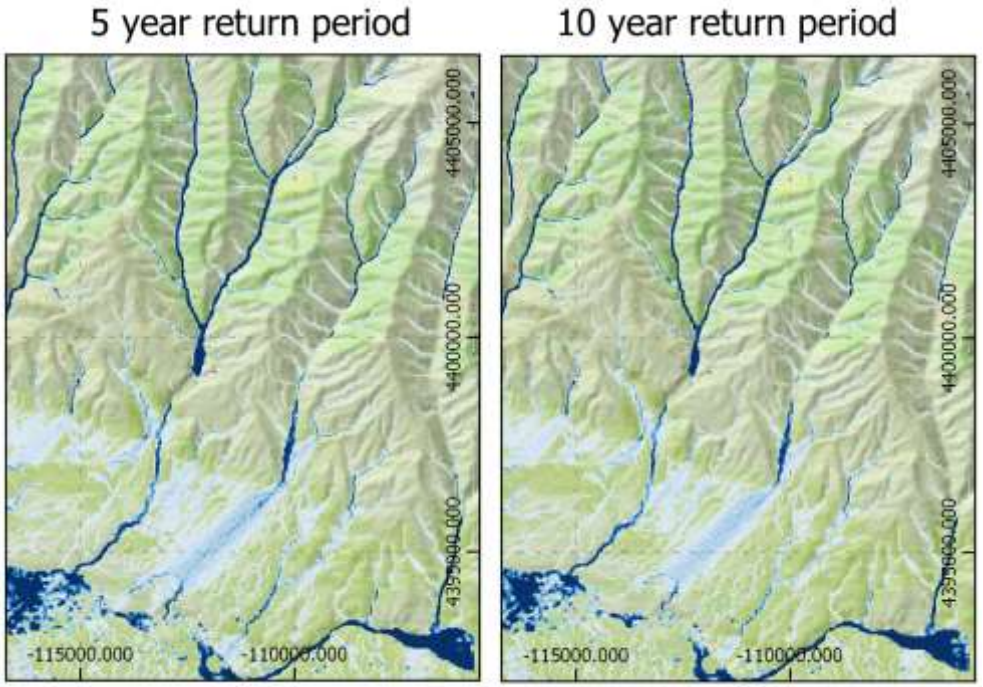
District level

200 m pixel level. Only intensity classes



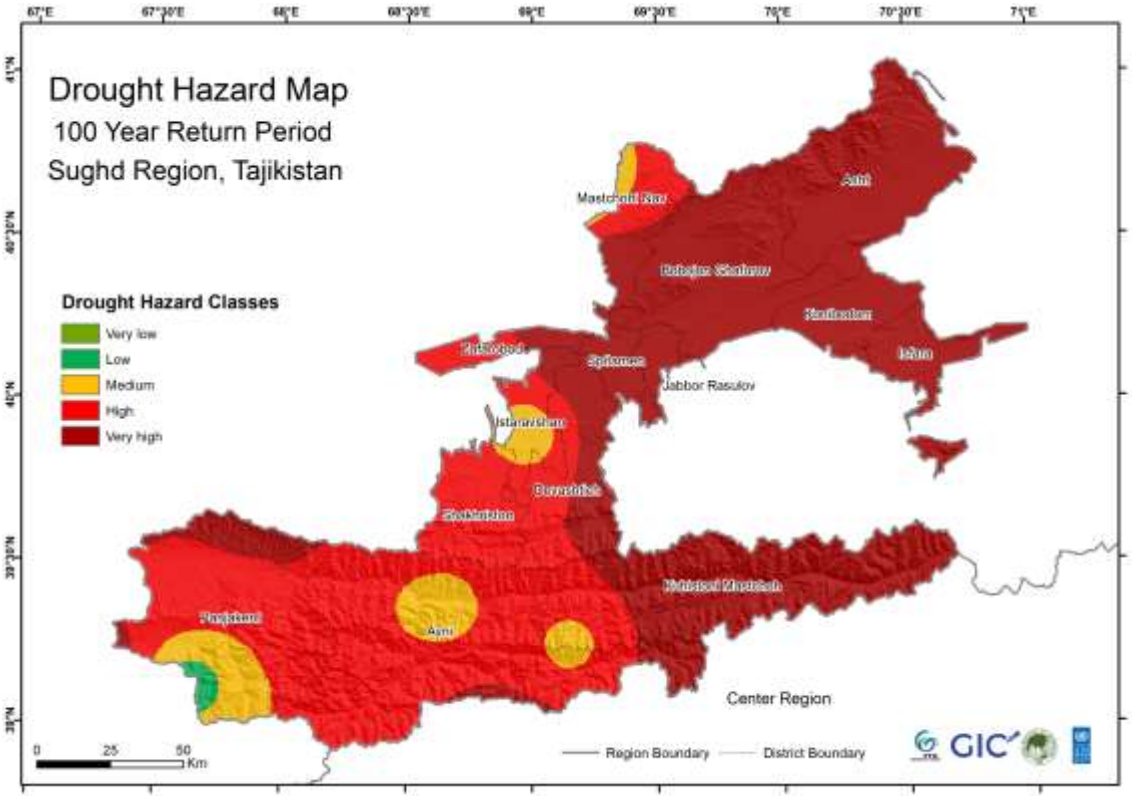
Local level

30 m pixel level. Cannot be done for entire country within this project, but training can be given



Drought hazard

- Hazard Assessment
  - Calculate exposure of drought
  - Calculate frequency, intensity and spatial extent
- Standardized Precipitation Index
  - Monthly rainfall from NSID & ERA-5 Reanalysis. Sughd: 36 station , 30 years
  - Drought intensity: the probability of precipitation over a specific period
  - Drought frequency: time scales
  - Spatial extent: interpolation
- Problem: Depending on stations. Drought is relative



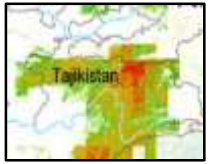
Exposure analysis

Hazard Maps

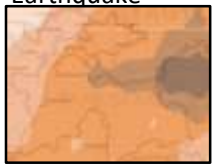
Landslides

Mudflow

Avalanches

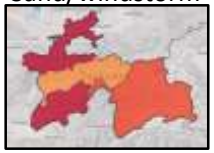


Earthquake



Drought

Sand/windstorm



Exposure Analysis

Calculate for each hazard type and hazard class the number of exposed elements-at-risk

	High	Moderate	Low
Landslide			
Mudflow			
Avalanche			
Earthquake			
Drought			
Sandstorm			

Districts

Calculate exposure per admin-unit

Jamoats

Elements-at-risk maps

Buildings

Population

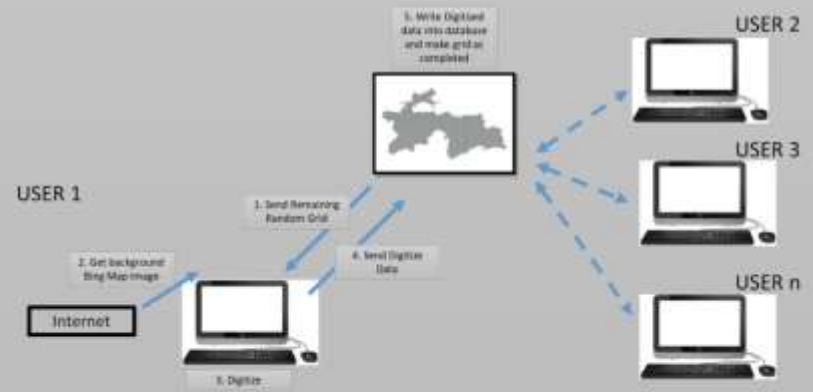
Roads

Forests

Crops

Crowdsourcing

Overall Architecture of GIC's Crowdsourcing Platform

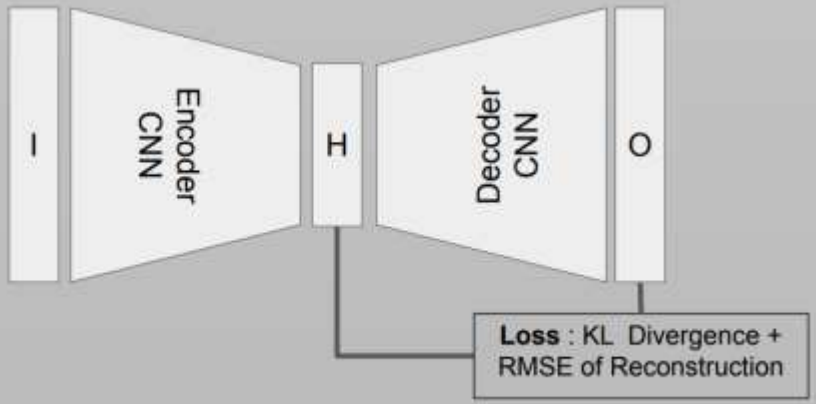


Number of Grids: ~100,000
Grid size: 1.5 km^2

Deep Learning

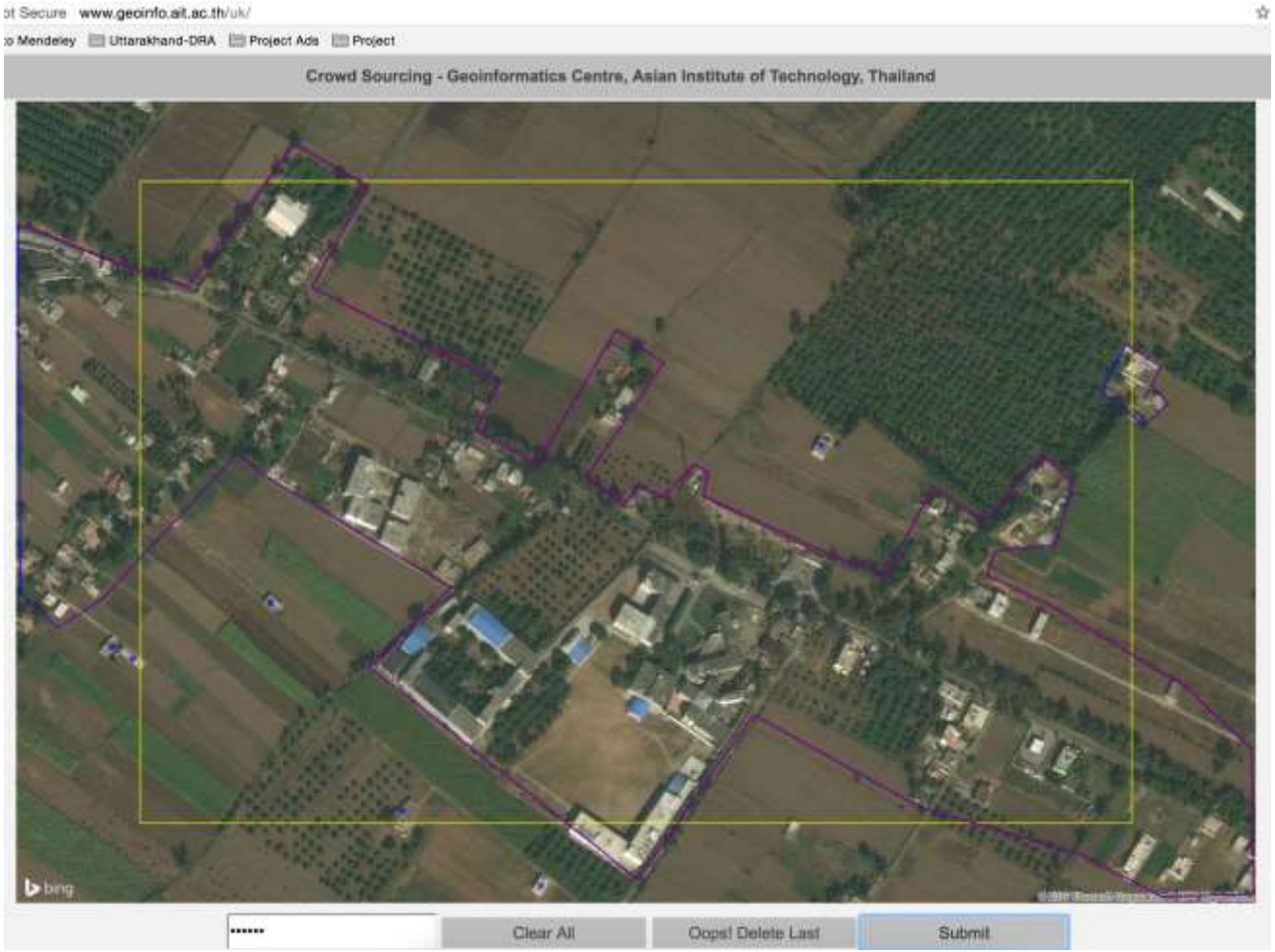
Convolutional Neural Networks (CNN) in Variational Autoencoder (VAE) Architecture were used

I - Input, H - Hidden vector, O - Output



Our Crowdsourcing Mapping Platform

- Web based
- Simple ways to map
- Faster
- Identification of user
- Training before the mapping
- Mappers: **AIT students**
- Quality control



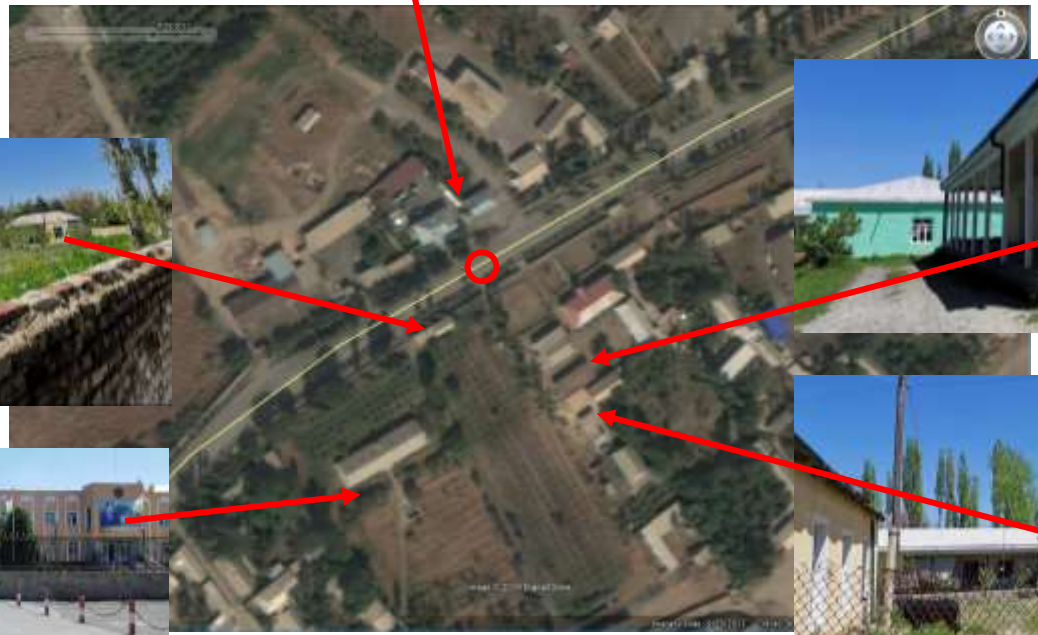
Settlement area: whole country

Mapping elements-at-risk using Ricoh Theta S and Mapillary

GIC Geoinformatics Center

AIT Asian Institute of Technology

2nd Stop (short) Shakhristan



View from the ground

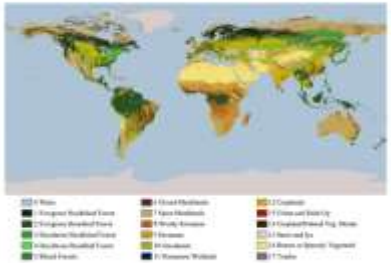
At Istaravshan city

Freely available Land cover data

MODIS Global Land Cover (MCD12Q1)

- Data input: Moderate Resolution Imaging Spectroradiometer (MODIS) instrument on NASA's Terra and Aqua satellite.
- Data period: 2001 to 2013.
- Spatial resolution: 500m
- Classification: IGBP (17 classes), and other 5 classification schemes.
- https://lpdaac.usgs.gov/dataset_discovery/modis/modis_products_table/mcd12q1

Global Land Cover Characterization (GLCC)



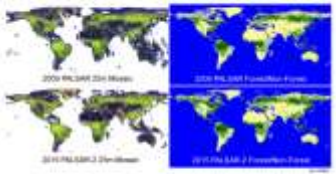
- Collaboration between U.S. Geological Survey's (USGS), the Earth Resources Observation and Science (EROS) Center, the University of Nebraska-Lincoln (UNL) and the Joint Research Centre of the European Commission
- Data input: 1-km AVHRR (Advanced Very High-Resolution Radiometer) 10-day NDVI (Normalized Difference Vegetation Index) composites.
- Ancillary data sources included digital elevation data, ecoregions interpretation, and country- or regional-level vegetation and land cover maps.
- Data period: April 1992 through March 1993.
- Spatial resolution: 1-km
- https://lta.cr.usgs.gov/GLCC

USGS Global Land Cover

- Collaboration between USGS and the University of Maryland, Department of Geographical Sciences.
- Input data: Landsat 7 ETM+ data
- Spatial resolution: 30-meter resolution raster
- Data period: Data layers for circa 2010 tree cover and bare ground and a persistent surface water layer 2000-2012.
- Classification: tree cover, bare ground, water.
- https://landcover.usgs.gov/glc/

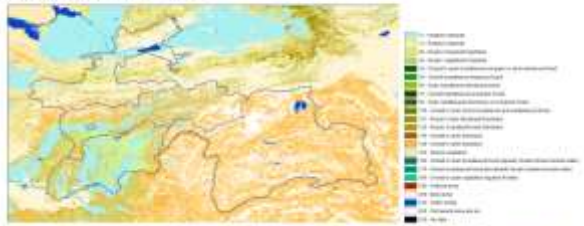
PALSAR Forest/Non-Forest map

- Input data: Japanese L-band Synthetic Aperture Radars (PALSAR and PALSAR-2) on Advanced Land Observing Satellite (ALOS) and Advanced Land Observing Satellite-2 (ALOS-2).
- Spatial resolution: 25m
- Data period: 2009 and 2015
- Classification: Forest/non-forest
- https://www.eorc.jaxa.jp/ALOS/en/palsar_fnf/fnf_index.htm



GlobeLand30

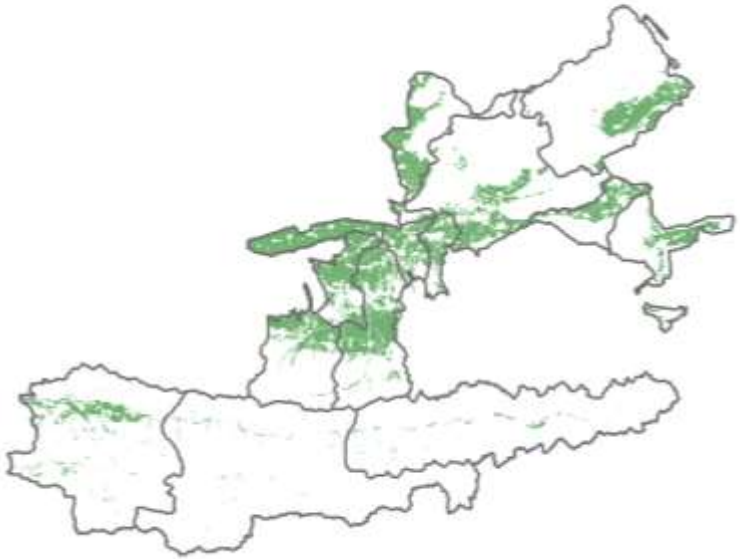
GlobCover



Hybrid Agriculture dataset produce using OSM

Before

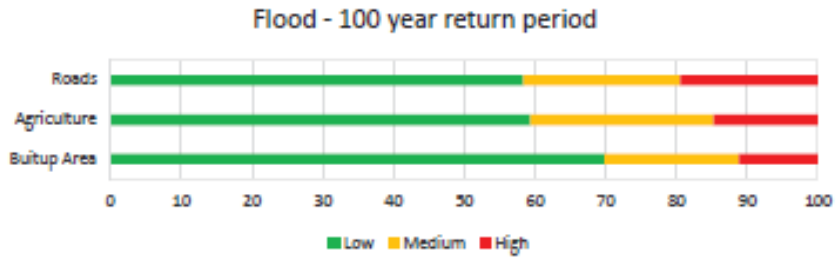
After

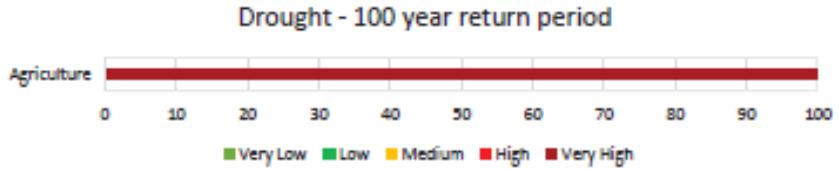


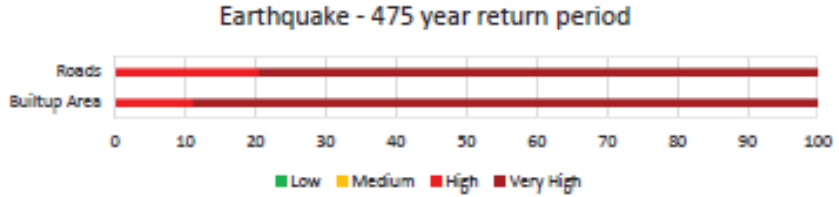
Ongoing work: Example of exposure profile

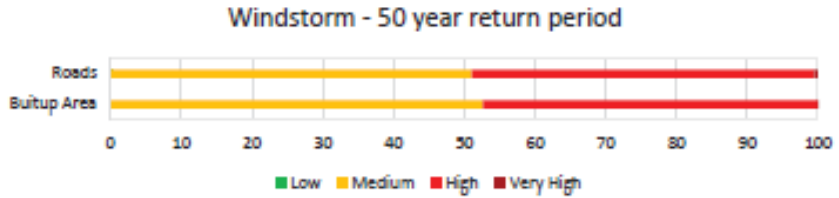
Disaster	Builtup area exposed in Hectares						Agri		
	Urban			Non Urban			Small scale agriculture within settlements		
	Low	Medium	High	Low	Medium	High	Low	Medium	High
Flood - 5 year return period	223	60	28	828	217	115	886	231	119
Flood - 20 year return period	246	64	37	923	249	136	989	264	142
Flood - 100 year return period	270	74	46	1050	285	164	1121	304	171

Disaster	Builtup area exposed in Hectares						R		
	Urban			Non Urban			Major roads		
	Low	Medium	High	Low	Medium	High	Low	Medium	High
Landslide	1099	209	0	4351	150	0	0	0	0
Mudflow	25	566	710	49	1843	2548	0	0	0
Snow Avalanche	59	0	0	39	0	0	0	0	0









Project details

In collaboration with the Earth Observatory Singapore

Disaster Risk Assessment of Uttarakhand

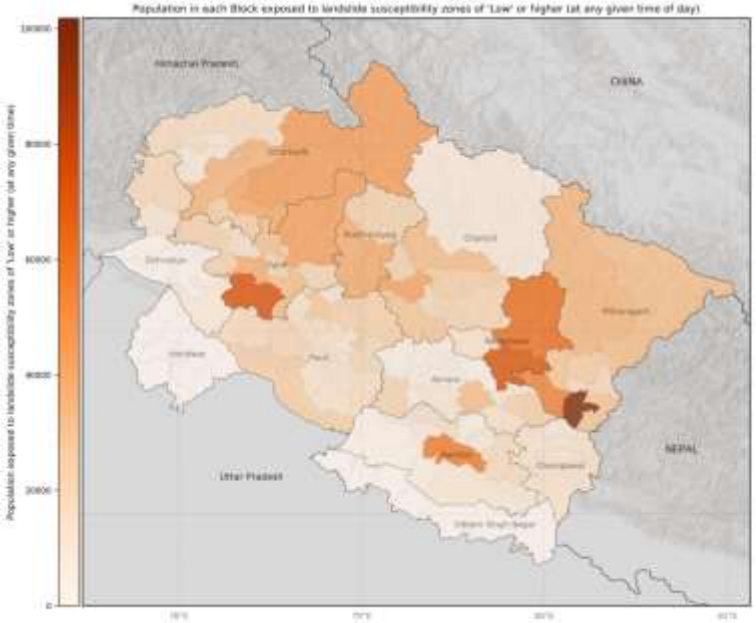
May 2016 - September 2018

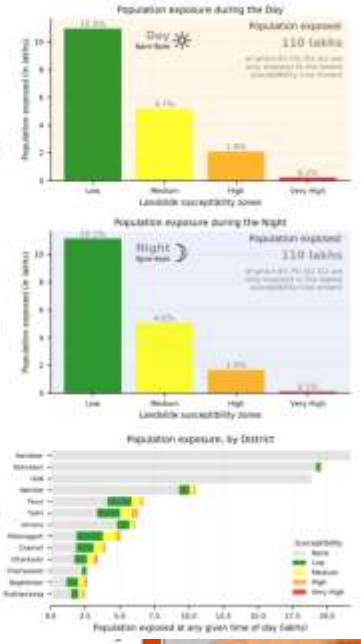
Funded by the World Bank and delivered for the Project Implementation Unit (TA & CBDRM), Uttarakhand Disaster Recovery Project (UDRP), Government of Uttarakhand.

http://www.uttarakhand-dra.in/

Facebook: https://www.facebook.com/UttarakhandDRA/

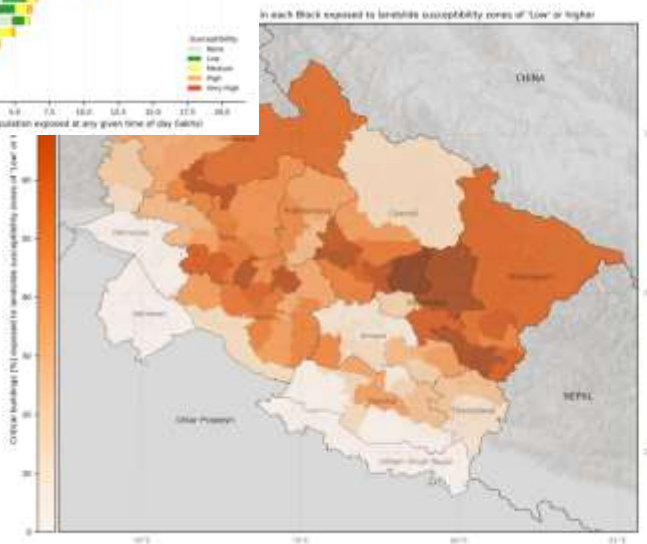
Final reports

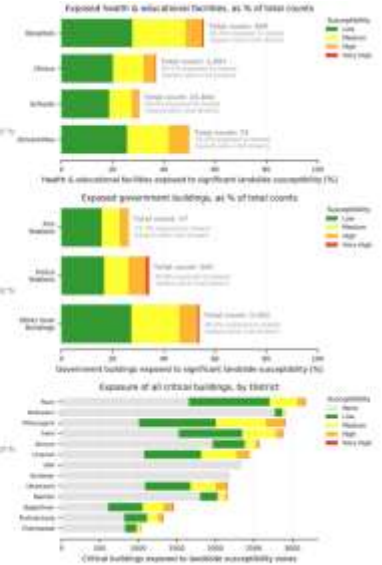




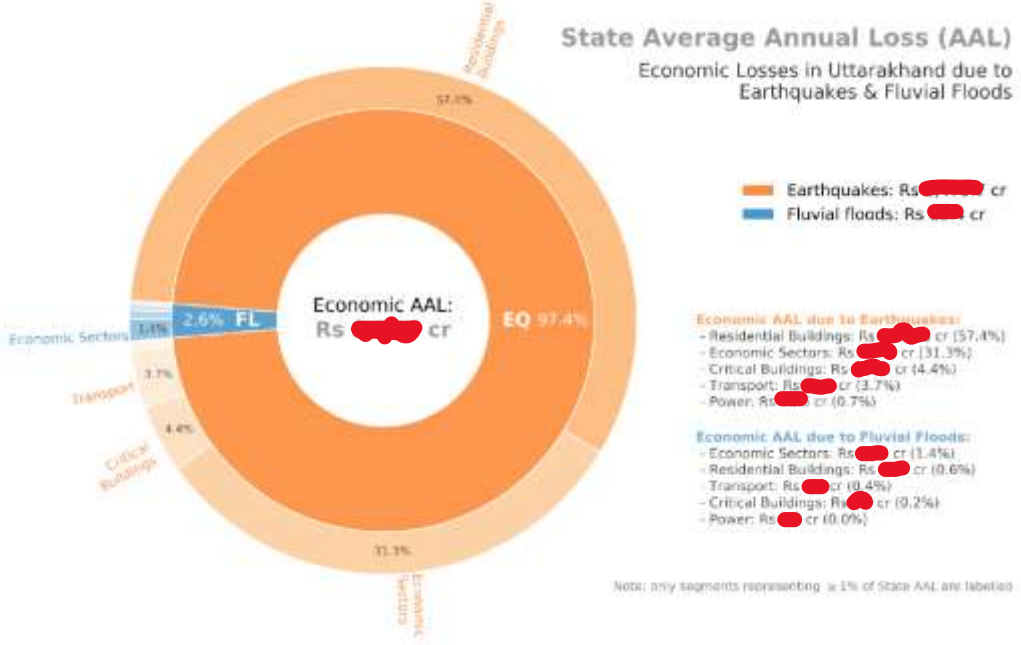
Population Exposure

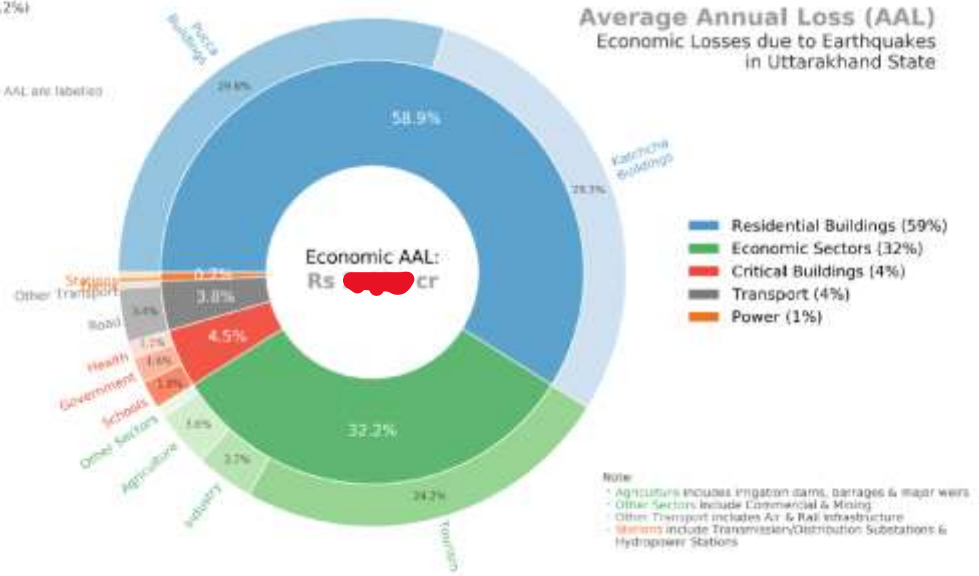
Building Exposure





Towards Risk Assessment

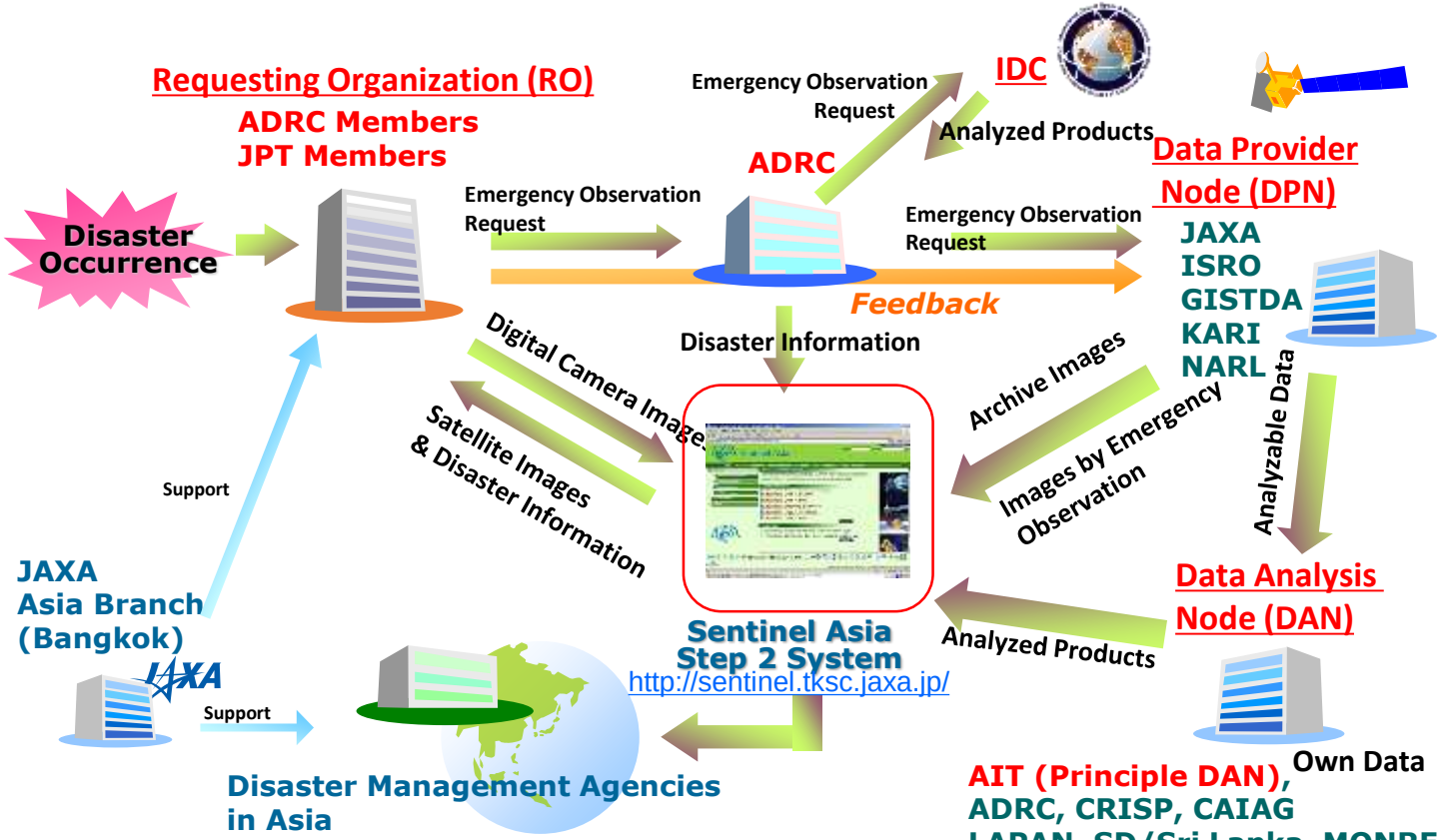

State Average Annual Loss (AAL)
Economic Losses in Uttarakhand due to Earthquakes & Fluvial Floods
Earthquakes: Rs [redacted] cr
Fluvial floods: Rs [redacted] cr
Economic AAL: Rs [redacted] cr
EQ 97.4%
FL 2.6%
Residential Buildings
57.4%
Economic Sectors
31.3%
Critical Buildings
4.4%
Transport
3.7%
Power
0.7%
Economic AAL due to Earthquakes:
- Residential Buildings: Rs [redacted] cr (57.4%)
- Economic Sectors: Rs [redacted] cr (31.3%)
- Critical Buildings: Rs [redacted] cr (4.4%)
- Transport: Rs [redacted] cr (3.7%)
- Power: Rs [redacted] cr (0.7%)
Economic AAL due to Fluvial Floods:
- Economic Sectors: Rs [redacted] cr (1.4%)
- Residential Buildings: Rs [redacted] cr (0.6%)
- Transport: Rs [redacted] cr (0.4%)
- Critical Buildings: Rs [redacted] cr (0.2%)
- Power: Rs [redacted] cr (0.0%)
Note: any segments representing ≥ 1% of State AAL are labeled


Average Annual Loss (AAL)
Economic Losses due to Earthquakes in Uttarakhand State
Economic AAL: Rs [redacted] cr
Residential Buildings (59%)
Economic Sectors (32%)
Critical Buildings (4%)
Transport (4%)
Power (1%)
Pucca Buildings
29.8%
58.9%
Kaccha Buildings
28.3%
32.2%
24.2%
Tourism
Industry
2.7%
Agriculture
3.6%
Other Sectors
1.8%
Schools
1.6%
Government
1.8%
Health
1.7%
Roads
3.4%
Other Transport
3.8%
Sewerage
0.4%
4.5%
Note:
- Agriculture includes Irrigation dams, barrages & major weirs
- Other Sectors include Commercial & Mining
- Other Transport includes Air & Rail infrastructure
- Sewerage include Transmission/Distribution Substations & Hydropower Stations

Activities in Disaster Response

- Sentinel Asia (Regional framework)
- International Disaster Charter

Sentinel Asia Emergency Observation Flow



Sentinel Asia

Sentinel Asia (SA) Activations in 2019

No.	Obs. ID	Occurred	Activation	Country	Disaster type	# VAP(s)
1	ERJPJX000088	17 Jan 2019	17 Jan 2019	Japan	Earthquake	-
2	ERIDLP000045	16 Mar 2019	18 Mar 2019	Indonesia	Flood	2
3	ERNPDH000004	31 Mar 2019	04 Apr 2019	Nepal	Typhoon	-
4	ERKRDM000003	04 Apr 2019	05 Apr 2019	Korea	Forest fire	1
5	ERPHVS000021	22 Apr 2019	26 Apr 2019	Philippines	Earthquake	1
6	ERPHVS000022	23 Apr 2019	26 Apr 2019	Philippines	Earthquake	-
7	ERINSR000048	02 May 2019	02 May 2019	India	Flood	(cancelled)
8	ERADRC000054	16 May 2019	26 May 2019	Turkey	Landslide	-
9	ERCNEA000006	17 Jun 2019	22 June 2019	China	Earthquake	2
10	ERBTHC000002	20 Jun 2019	22 Jun 2019	Bhutan	Flash flood	1
11	ERVNMN000054	24 Jun 2019	26 Jun 2019	Vietnam	Flash flood	-
12	ERIDLP000046	14 Jul 2019	15 Jul 2019	Indonesia	Earthquake	2
13	ERAHAC000007	08 Aug 2019	14 Aug 2019	Myanmar	Flood	5

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Disaster Emergency Response Maps

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Year 2019

Myanmar 08/August/2019

Monsoon rains and increased river levels have triggered flooding in pockets across eight states and regions with evacuations in several townships. A cumulative number of 78,000 people were displaced to 186 evacuation centres in Kachin, Rakhine, Chin, and Mon states, as well as Bago, Sagaing, Mandalay and Magway regions, according to the national Department of Disaster Management (DDM)

Indonesia 14/July/2019

+ Year 2019 (7)

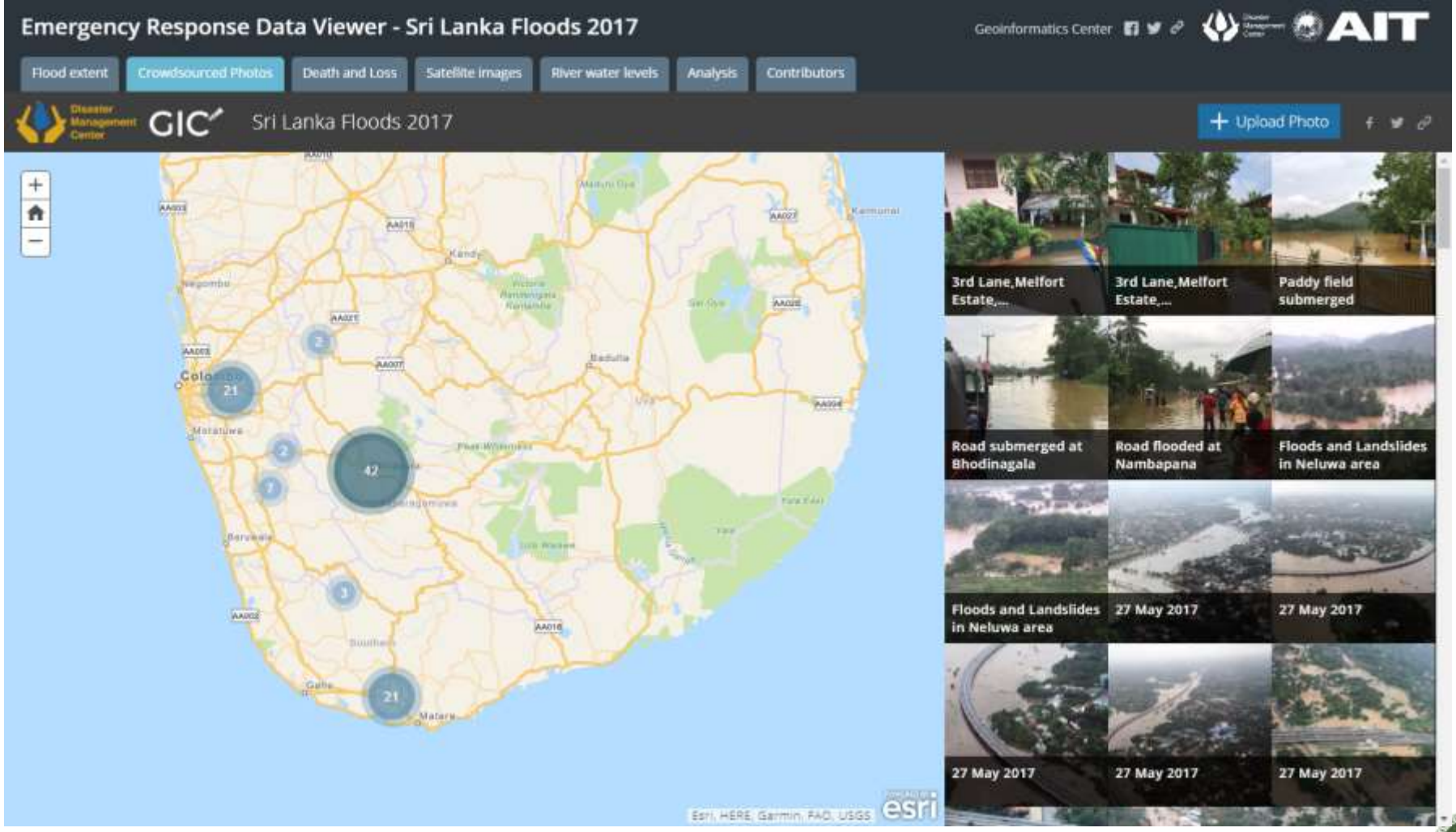
- China (1)
- Bhutan (1)
- Indonesia (2)
- Myanmar (1)
- Philippines (1)
- South Korea (1)

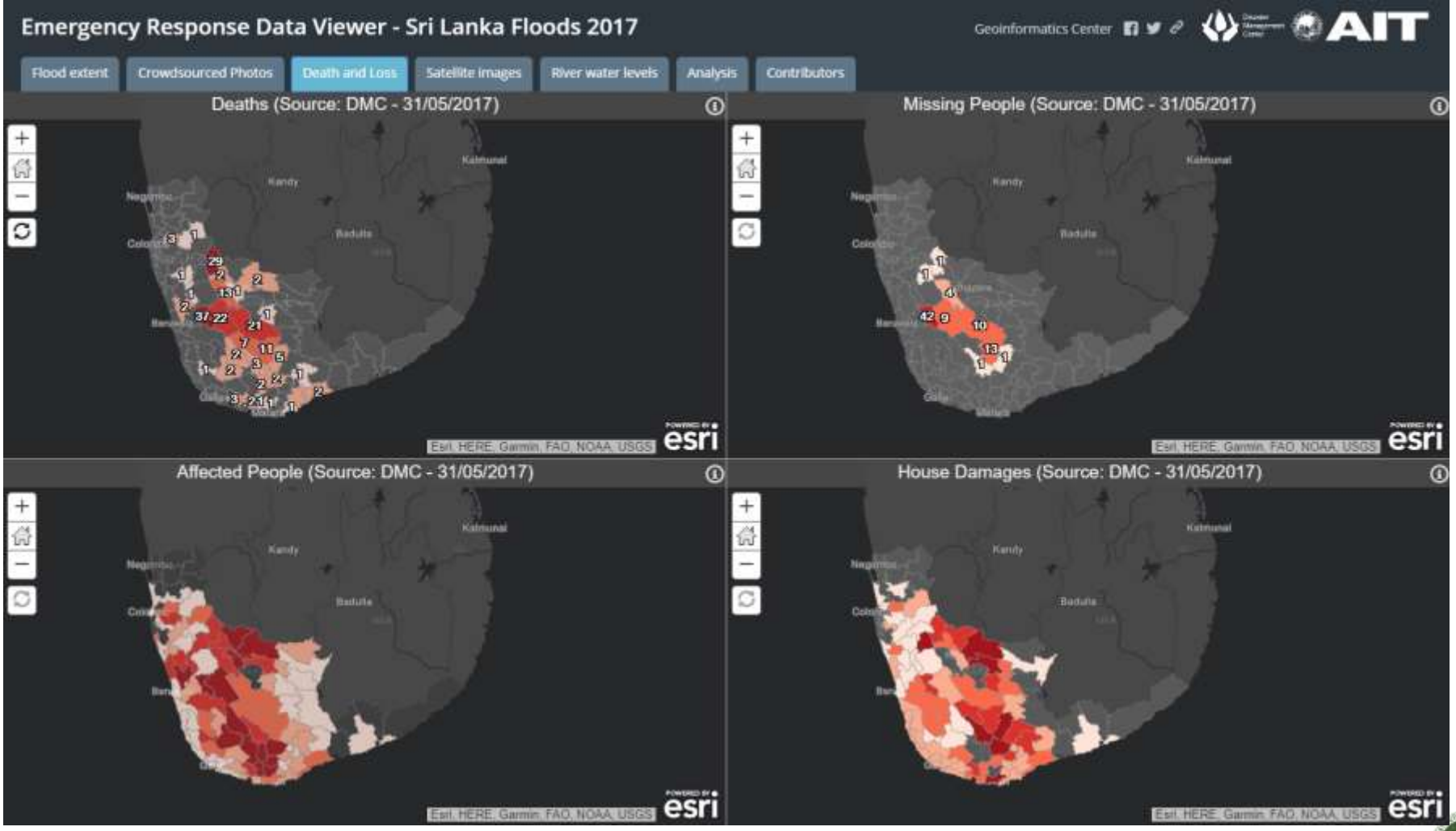
+ Year 2018 (15)

- India (1)
- Indonesia (2)
- Japan (2)
- Laos (1)
- Myanmar (2)
- Sri Lanka (1)

GIC

http://arcg.is/2r9Lw5m


Emergency Response Data Viewer - Sri Lanka Floods 2017
Geoinformatics Center
AIT
Flood extent
Crowdsourced Photos
Death and Loss
Satellite images
River water levels
Analysis
Contributors
Disaster Management Center
GIC
Sri Lanka Floods 2017
+ Upload Photo
21
42
21
3rd Lane,Melfort Estate,...
3rd Lane,Melfort Estate,...
Paddy field submerged
Road submerged at Bhodinagala
Road flooded at Nambapana
Floods and Landslides in Neluwa area
Floods and Landslides in Neluwa area
27 May 2017
27 May 2017
27 May 2017
27 May 2017
27 May 2017
Esri, HERE, Garmin, FAO, USGS
esri


Emergency Response Data Viewer - Sri Lanka Floods 2017
Geoinformatics Center
AIT
Flood extent
Crowdsourced Photos
Death and Loss
Satellite images
River water levels
Analysis
Contributors
Deaths (Source: DMC - 31/05/2017)
Missing People (Source: DMC - 31/05/2017)
Affected People (Source: DMC - 31/05/2017)
House Damages (Source: DMC - 31/05/2017)
Kilinochchi
Kandy
Badulla
Esri, HERE, Garmin, FAO, NOAA, USGS
esri

SATELLITE-BASED EMERGENCY MAPPING FOR EARTHQUAKE/TSUNAMI IN CENTRAL SULAWESI, INDONESIA

A powerful earthquake with magnitude 7.5 strike the central Island of Sulawesi in Indonesia on 28 September 2018, triggering a tsunami with 3 meter high waves. As of 3 October, the National Disaster Mitigation Agency (BNPB) reported the death toll reached 1,407 people, while the evacuees reached 70,821 people. The most affected areas are Palu city, Donggala, Sigi, and Parigi Moutong.

SENTINEL ASIA

DATA PROVIDERS

cnes, esa, USGS science for a changing world, CSA ASC, DLR, KARI, इसरो ISRO, JAXA, International Imaging, ROSCOSMOS, DigitalGlobe, planet.

PROJECT MANAGER

ASIAN INSTITUTE OF TECHNOLOGY 1959

VALUE ADDERS

LAPAN, UNOSAT, Copernicus Europe's eyes on Earth

END USERS

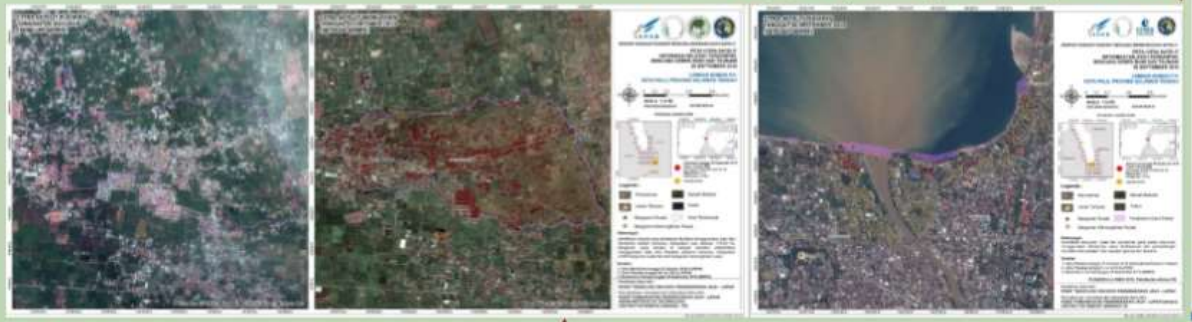
BNPB, BPBD INDONESIA

General Public, Media, NGOs, Volunteer

• EMERGENCY MAPPING

Emergency mapping provides on-demand crisis maps to help to identify severely affected and damaged areas using earth observation imagery, which play a vital role in disaster response and recovery activities.

Identifying damaged buildings due to earthquake/tsunami



Identifying liquefaction affected areas and damaged buildings

Identifying damaged buildings due to earthquake

More than 450 satellite images, from different data providers, were visually interpreted, using pre and post satellite imagery and geospatial analysis.

• FIELD SURVEY

Our staff was sent to the site of the disaster to aid in disaster response efforts, collecting data on damage, and provide the local communities, NGOs and volunteer with geospatial data and maps.

• MAPS USAGE IN THE FIELD

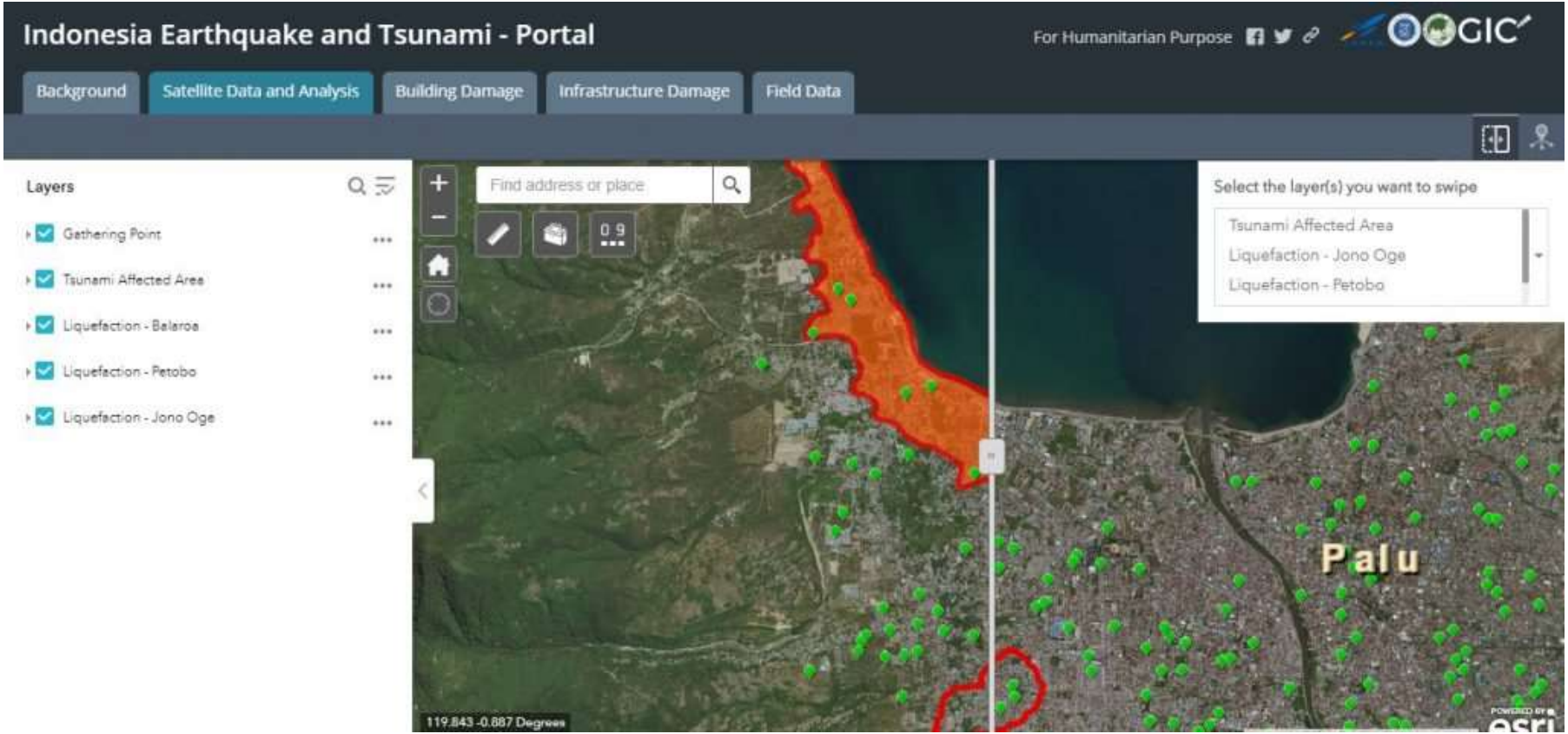
Maps were printed to support the humanitarian activities in the field.

• DISSEMINATION

Disseminating disaster maps and information to general public, relevant government agencies, NGOs, and other stakeholders.

Data and Analysis Portal for recent Indonesian disaster

http://arcg.is/15uObi



Recent developments: platform/solutions

- Sentinel Asia (Regional framework)
- International Disaster Charter

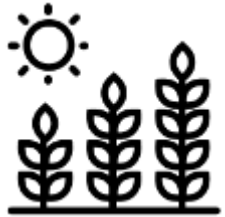
European Space Agency

Sen2Agri

Exploitation of Sentinel 2 from local to national level agriculture monitoring

Sen2Agri Products

Dynamic cropland mask



Cultivated crop type maps and extent of main crop groups

Composite of cloud-free surface reflectance

Biophysical vegetation status indicators like NDVI and LAI

Satellite data solutions

- Getting popular solutions/products rather than raw data
- Preprocessing of data is no longer needed
- Data subscription, pay based on what you use
- Some satellite constellation provide data daily/any place in the world

Thank you!

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