EO Data for Rapid Response

"Utilization of Space based & Geospatial information for achieving the targets of the Sendai Framework for DRR"
04 – 08th December, 2018

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Outline of Presentation

- Geospatial Information; GIS: Basics
- Geospatial Technologies Utility in DM Cycle
- EO data advantages for Disaster Monitoring & Mitigation
- Case Studies of EO Data in DM
- Satellite Communication for DM
- Crowd Sourcing for DM
- Data Portals for DM
- International Initiatives

Learning Objectives

Familiarization with

➢EO data capabilities in disaster response, mapping & monitoring and mitigation.

What is Geospatial Information?

- The word geospatial is used to indicate that data that has a geographic component to it. This means that the records in a dataset have locational information tied to them such as geographic data in the form of coordinates, address, city, or ZIP code.
- GIS data is a form of geospatial data.
- Other geospatial data can originate from GPS data, satellite imagery, and geotagging.

What is GIS?

- GIS refers to a system where geographic information is stored in layers and integrated with geographic software programs so that spatial information can be created, stored, manipulated, analyzed, and visualized (mapped).

The terms GIS (which most commonly is an acronym for Geographic Information Systems) and geospatial are often used interchangeably. There are differences in what the terms GIS and geospatial mean.

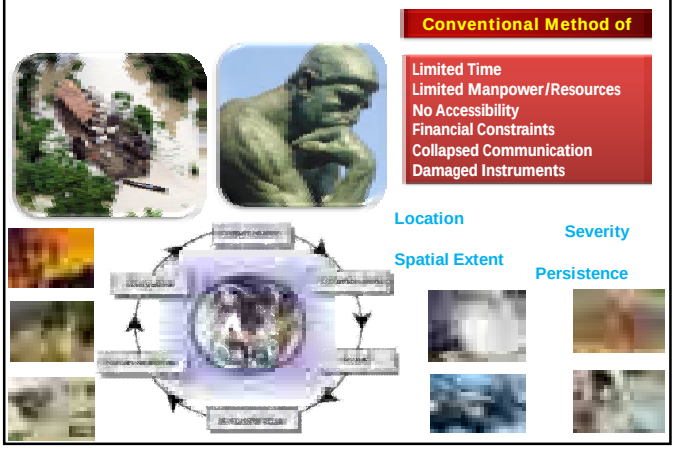
5

What is Geospatial Technology?

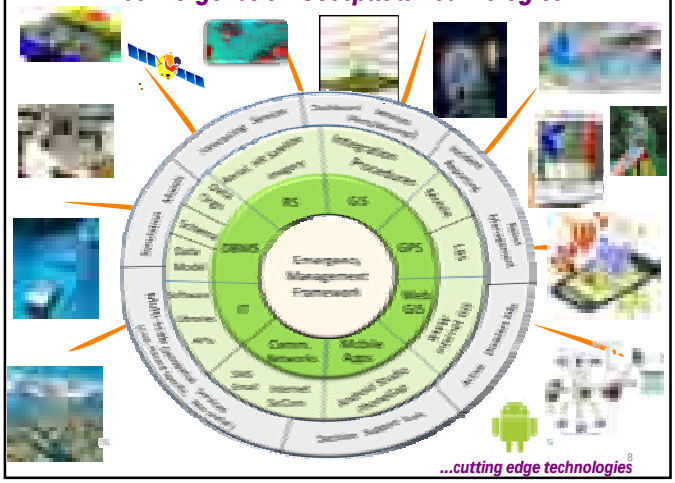
- With location becoming all-pervasive in our everyday life, we are witnessing an exponential growth in the amount of spatial data being generated and captured.
- Geospatial analysis is increasingly being taken seriously around the world to derive new information and make informed decisions.
- Geospatial market is expected to reach approximately $440 billion by 2020.

6

During Disaster Event

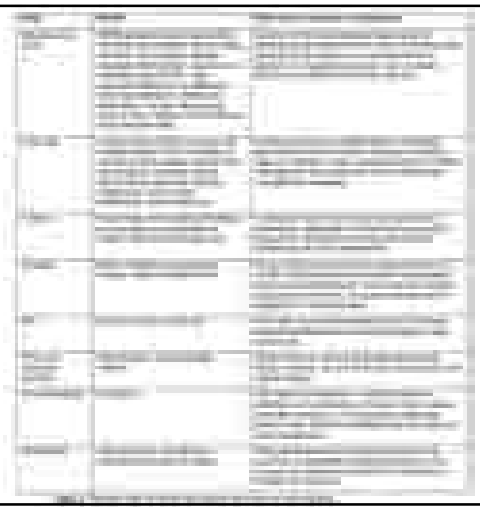


Convergence of Geospatial Technologies



8

- airborne sensors (airborne digital imaging, LiDAR, UAV), satellites, and terrestrial sensors (total station, GPS, video, terrestrial LiDAR, handheld devices).
- geospatial processing tools for fusing and integrating geospatial source content into software applications for the creation and update of geospatial data and information products.
- Information Cloud is the ability to manage, fuse, and share geospatial data across departments and regions, connecting to an organization's hub of geospatial data and information.
- fully leveraging the Information Cloud enables the delivery of geospatial data AND dynamic information products



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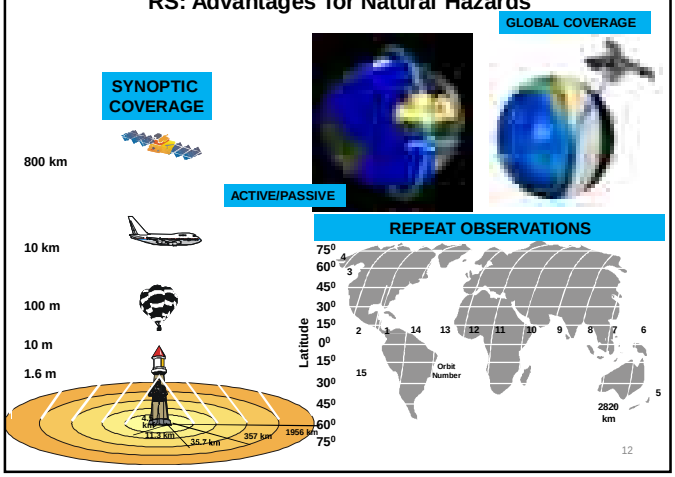
11

RS: Advantages for Natural Hazards



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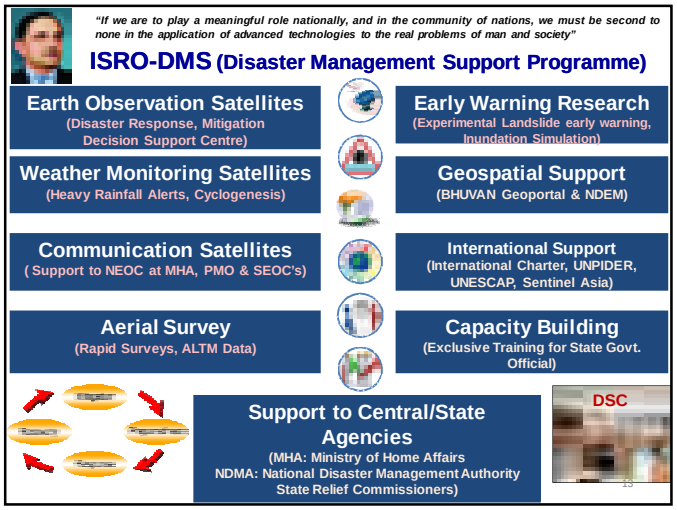
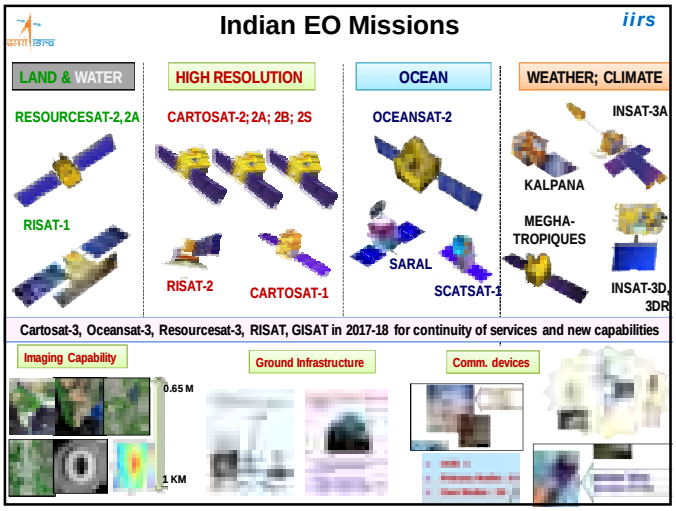

"If we are to play a meaningful role nationally, and in the community of nations, we must be second to none in the application of advanced technologies to the real problems of man and society"
ISRO-DMS (Disaster Management Support Programme)
Earth Observation Satellites
(Disaster Response, Mitigation Decision Support Centre)
Weather Monitoring Satellites
(Heavy Rainfall Alerts, Cyclogenesis)
Communication Satellites
(Support to NEOC at MHA, PMO & SEOC's)
Aerial Survey
(Rapid Surveys, ALTM Data)
Early Warning Research
(Experimental Landslide early warning, Inundation Simulation)
Geospatial Support
(BHUVAN Geoportal & NDEM)
International Support
(International Charter, UNPIDER, UNESCAP, Sentinel Asia)
Capacity Building
(Exclusive Training for State Govt. Official)
Support to Central/State Agencies
(MHA: Ministry of Home Affairs
NDMA: National Disaster Management Authority
State Relief Commissioners)
DSC


Indian EO Missions
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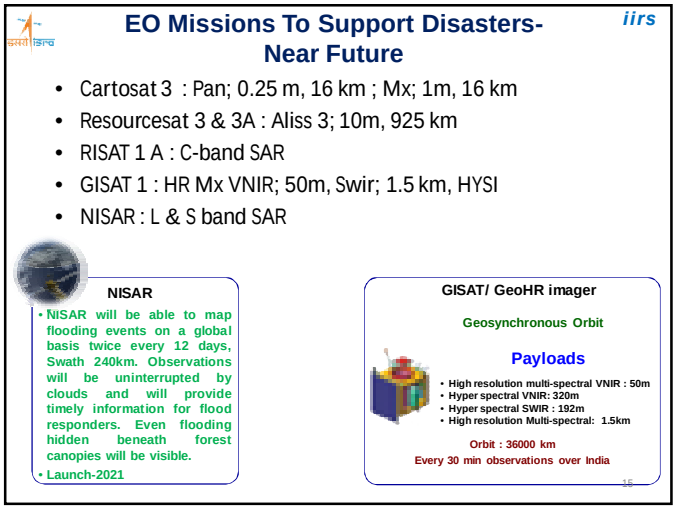
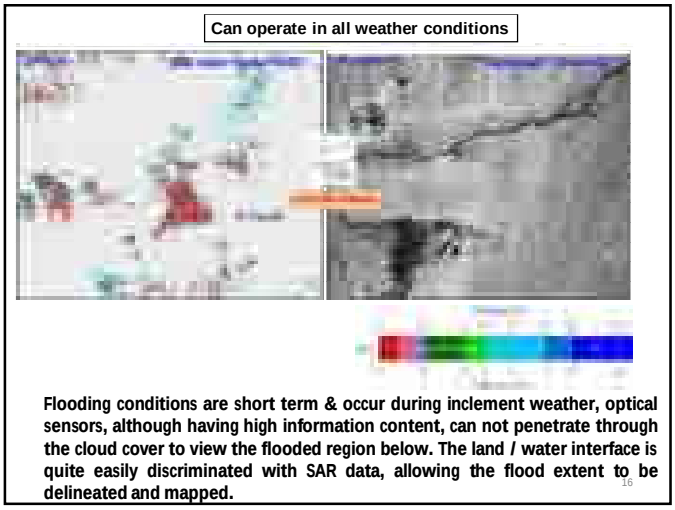
LAND & WATER
HIGH RESOLUTION
OCEAN
WEATHER; CLIMATE
RESOURCESAT-2,2A
RISAT-1
CARTOSAT-2; 2A; 2B; 2S
RISAT-2
CARTOSAT-1
OCEANSAT-2
SARAL
SCATSAT-1
INSAT-3A
KALPANA
MEGHA-TROPIQUES
INSAT-3D, 3DR
Cartosat-3, Oceansat-3, Resourcesat-3, RISAT, GISAT in 2017-18 for continuity of services and new capabilities
Imaging Capability
Ground Infrastructure
Comm. devices
0.65 M
1 KM


EO Missions To Support Disasters- Near Future
iirs
Cartosat 3 : Pan; 0.25 m, 16 km ; Mx; 1m, 16 km
Resourcesat 3 & 3A : Aliss 3; 10m, 925 km
RISAT 1 A : C-band SAR
GISAT 1 : HR Mx VNIR; 50m, Swir; 1.5 km, HYSI
NISAR : L & S band SAR
NISAR
NISAR will be able to map flooding events on a global basis twice every 12 days, Swath 240km. Observations will be uninterrupted by clouds and will provide timely information for flood responders. Even flooding hidden beneath forest canopies will be visible.
Launch-2021
GISAT/ GeoHR imager
Geosynchronous Orbit
Payloads
High resolution multi-spectral VNIR : 50m
Hyper spectral VNIR: 320m
Hyper spectral SWIR : 192m
High resolution Multi-spectral: 1.5km
Orbit : 36000 km
Every 30 min observations over India


Can operate in all weather conditions
Flooding conditions are short term & occur during inclement weather, optical sensors, although having high information content, can not penetrate through the cloud cover to view the flooded region below. The land / water interface is quite easily discriminated with SAR data, allowing the flood extent to be delineated and mapped.

Can provide synoptic view

MODIS

Terra and Aqua;

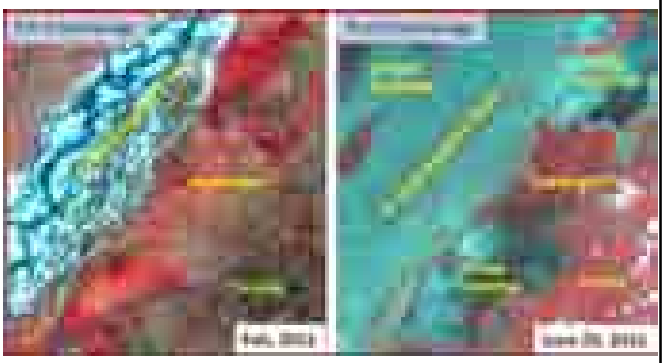
Terra's N-S 10:30,

Aqua S-N 13:30;

Swath 2,330 km.

17

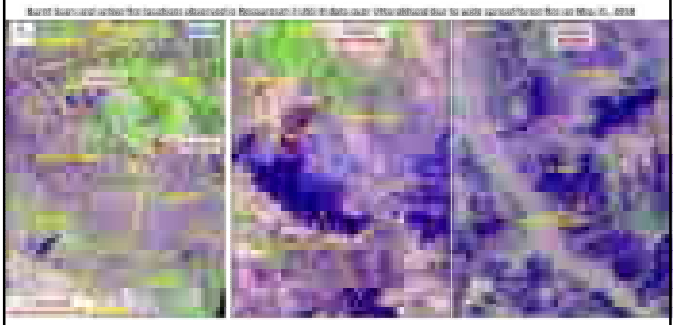
Pre and Post Comparisons



18

Inaccessible and hazardous areas can be sensed

Uttarakhand Forest Fire– May 2018

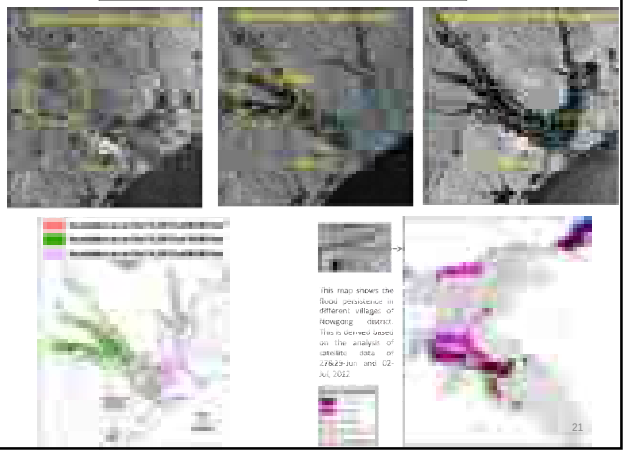


19

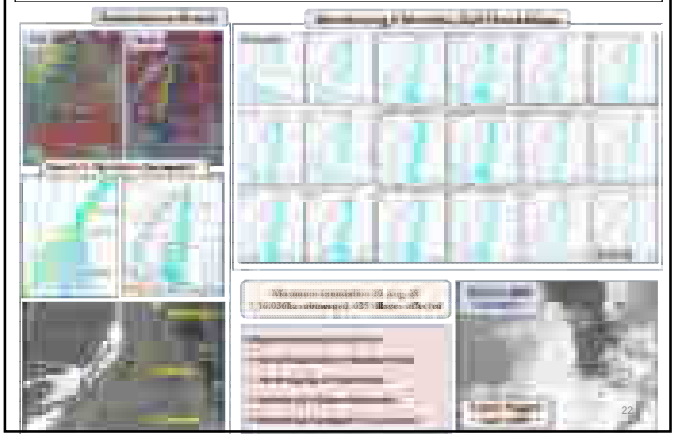
Active Fire Alerts

The VIIRS (Visible Infrared Imaging Radiometer Suite) Fire layer shows active fire detections and thermal anomalies, such as volcanoes, and gas flares. Fires can be set naturally, such as by lightning, or by humans, whether intentionally or accidentally. Fire is often thought of as a menace and detriment to life, but in some ecosystems it is necessary to maintain the equilibrium, for example, some plants only release seeds under high temperatures that can only be achieved by fire, fires can also clear undergrowth and brush to help restore forests to good health, humans use fire in slash and burn agriculture, to clear away last year's crop stubble and provide nutrients for the soil and to clear areas for pasture. The fire layer is useful for studying the spatial and temporal distribution of fire, to locate persistent hot spots such as volcanoes and gas flares, to locate the source of air pollution

Monitor Progression/Recession/Persistence



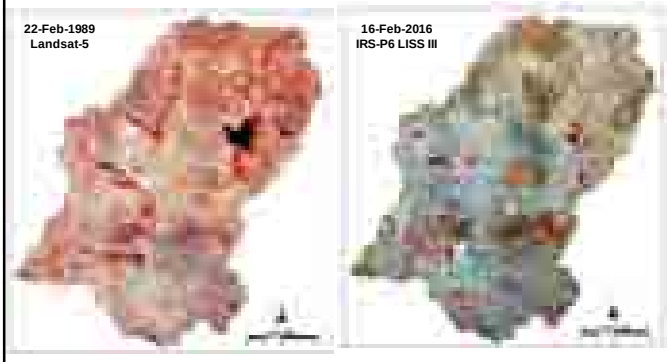
Measurements from satellites provide valuable additional input that can be used for a multitude of applications in support of disasters



Monitoring Urban Sprawl

22-Feb-1989
Landsat-5

16-Feb-2016
IRS-P6 LISS III



Monitoring Urban Sprawl

22-Feb-1989
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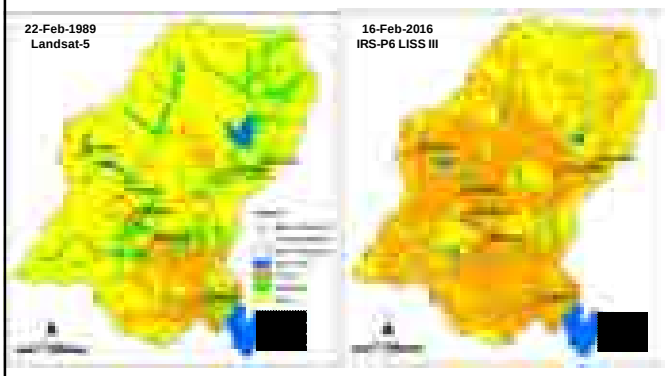


Transboundary Monitoring of Events

Sun Koshi River Blockade 2014

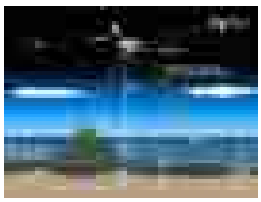
25

Rapid Damage Assessment; Compare Pre and Post Disaster Changes

26

Compliment insitu observations

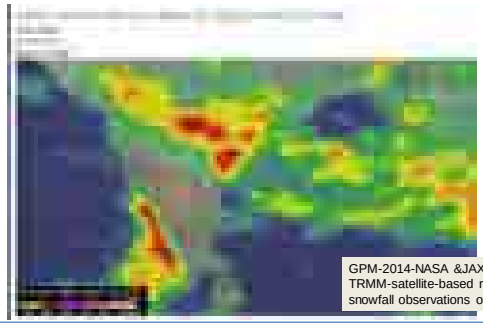
Satellite Altimetry: based on the measurement of the two-way travel time of short pulse of electromagnetic wave sent out by the satellite and reflected by a water surface. Short pulse of electromagnetic wave is received by Radar altimeter from space platform and range between the satellite and water bodies is measured by correcting atmospheric and geophysical signals. Difference between the satellite altitudes above a reference surface i.e. a conventional ellipsoid is determined through precise orbit computation.



SARAL-AltiKa

27

GPM IMERG



Global Precipitation Measurement (GPM) Integrated Multi-satellite Retrievals for GPM (IMERG) products provide quasi-global (60◦ N–60◦ S) precipitation estimates, beginning March 2014, from the combined use of passive microwave (PMW) and infrared (IR) satellites comprising the GPM constellation. The IMERG products are available in the form of near-real-time data, i.e., IMERG Early and Late, and in the form of post-real-time research data, i.e., IMERG Final, after monthly rain gauge analysis is received and taken into account.

28

Satellite observations : tracking, monitoring of cyclonic hazards

Ku band Scatterometer is the main sensor on board

SCATSAT-1 Flood Monitoring

The satellite used data based on backscattering and brightness temperatures of the Earth to monitor the flood situations.

SCATSAT-1 is for weather forecasting, cyclone prediction along with ocean state monitoring and prediction.

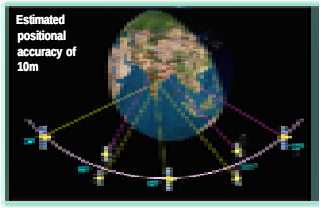
29

Satellite Navigation

IRNSS: Indian Regional Navigation Satellite System NAViC

NavIC ('Navigation with Indian Constellation')

- An Indigenous navigation system of 7 satellite constellation - for providing position, navigation, timing services over Indian region



Coverage area is about 1500 km beyond Indian territory

GAGAN: GPS Aided Geo Augmented Navigation

- Jointly implemented by ISRO & Airports Authority of India
- GAGAN payloads operational in GSAT-8 (2011), GSAT-10 (2012) and GSAT 15 (2015)

GAGAN has been certified for Approach with Vertical Guidance (APV) 1.0 aircraft landing

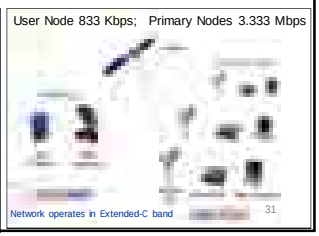
30

Satellite Communication

•During Disasters Terrestrial-Based Communication Fails.

❖DOS/ ISRO has implemented a broadband satellite based virtual private communication network (VPN) for Disaster Management Support (DMS), at national level, in India.

❖ This Network Capable of providing voice, data and video traffic between any two nodes.



31

Satellite Communication

Telemedicine

❖ In a major effort to improve emergency medical support to soldiers posted in high-altitude areas, especially Siachen, the Integrated Defence Staff of the Defence Ministry and the Indian Space Research Organisation (ISRO) signed a memorandum of understanding to set up telemedicine nodes in critical places across the country.

❖ During winter months, many of remote posts are cut off for several months because of adverse terrain & extreme weather, making emergency evacuation near impossible.

❖ ISRO telemedicine facility connects remote District Hospitals/Health Centres with Super Specialty Hospitals in cities, through INSAT Satellites for providing expert consultation.

32

Google Timelapse:

Global, zoomable video that lets you see how the Earth has changed over the past 32 years. It is made from 33 cloud-free annual mosaics, one for each year from 1984 to 2016, which are made interactively explorable by Carnegie Mellon University CREATE Lab's Time Machine library, a technology for creating and viewing zoomable and pannable time lapses over space and time.

Using Earth Engine, we combined over 5 million satellite images acquired over the past three decades by 5 different satellites. The majority of the images come from Landsat, a joint USGS/NASA Earth observation program that has observed the Earth since the 1970s. For 2015 and 2016, we combined Landsat 8 imagery with imagery from Sentinel-2A, part of the European Commission and European Space Agency's Copernicus Earth observation program.

https://skytruth.org/2014/05/timelapse-writhing-brahmaputra-river/

33

Tomnod

Team of volunteers (like you!) who work together to identify important objects and interesting places in satellite images. Use Tomnod to explore the Earth, solve real-world problems, and view amazing images of our changing planet. With the help of millions of volunteer contributions, we fulfill our purpose of seeing a better world.

https://www.tomnod.com/campaign/campaign_2390/question/35673

34

Global Agriculture Monitoring (GLAM)

Project is a collaborative project initiated between NASA, University of Maryland and the USDA Foreign Agriculture Service (FAS). The project's objective is to enhance the agricultural monitoring and the crop-production estimation capabilities of the FAS using the new generation of NASA satellite observations.

This system provides crop analysts with a suite of MODIS temporal composites of vegetation index data, false color imagery, and a dynamic crop mask. Complementing these data products is a range of web-based analysis tools that allow analysts to interrogate these data and to drill down to the pixel level of detail.

Using these data and tools analysts track the evolution of the growing season, make inter-annual comparisons of season dynamics and inform decision makers of agricultural conditions and impediments to worldwide food-security.

Internet-Mobile-Web Resources

36

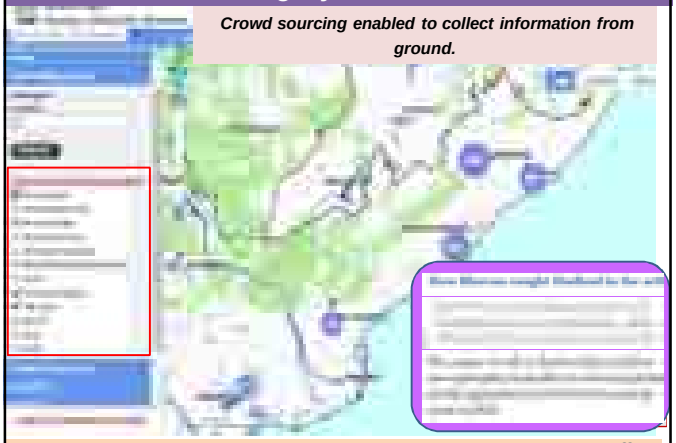
Crowd Sourcing: Chennai Floods 2015

Chennai Flood Map, an app that displays an interactive map of the city, and allows anyone to mark a street as flooded & visualize the flooded locations.

Received over one million views last monsoon has been recognized by the UN

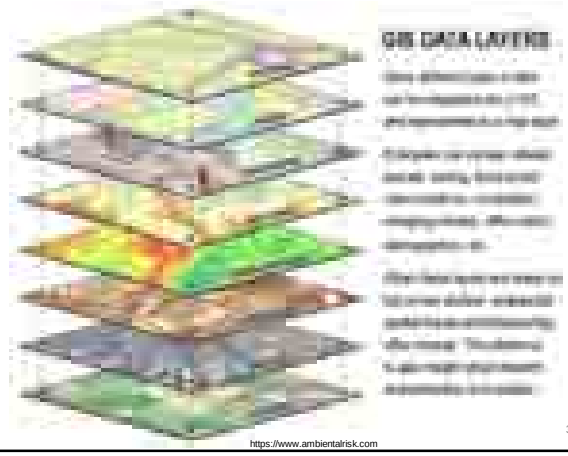
Crowd Sourcing:Cyclone HUDHUD 2014

Crowd sourcing enabled to collect information from ground.



House Damage-17192; Tree fallen-1031; Power-1636; ; Road-1078; Tank/Canal Breach-137

Geographical Information System (GIS)

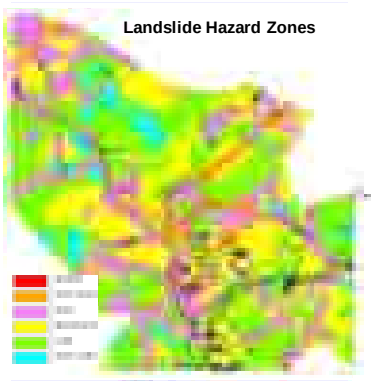


https://www.ambientalrisk.com

Mapping Hazard

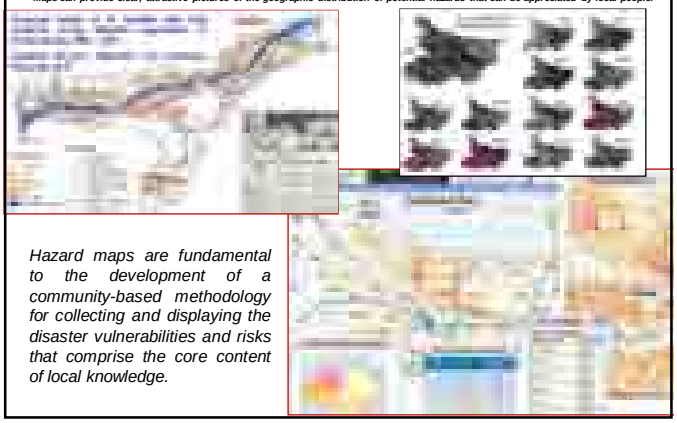
Parameters

- Geological Structure/ Proximity to Fault
- Lithology
- Slope –dip (bedding, joint) relation
- Slope Angle, slope aspect, morphology
- Geomorphology
- Drainage Densiy
- Lineament Density
- Lineament intersection
- Landuse/ cover
- Rock weathering
- Soil texture
- Soil depth



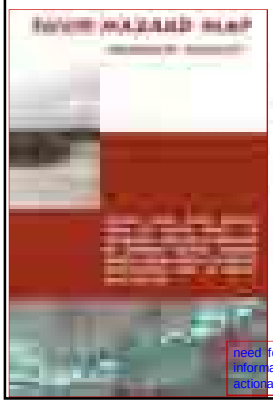
Identifying & Understanding Risk

Maps can provide clear, attractive pictures of the geographic distribution of potential hazards that can be appreciated by local people.



Hazard maps are fundamental to the development of a community-based methodology for collecting and displaying the disaster vulnerabilities and risks that comprise the core content of local knowledge.

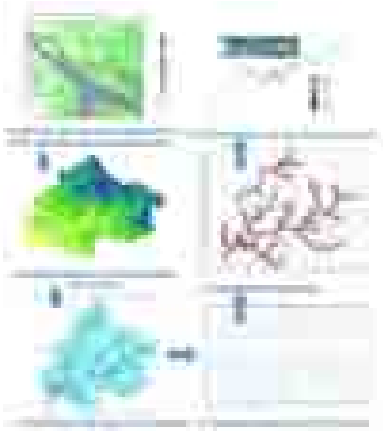
Translating hazard information into policy actions



need for focus to the production of risk information that is understandable & actionable for different kinds of users

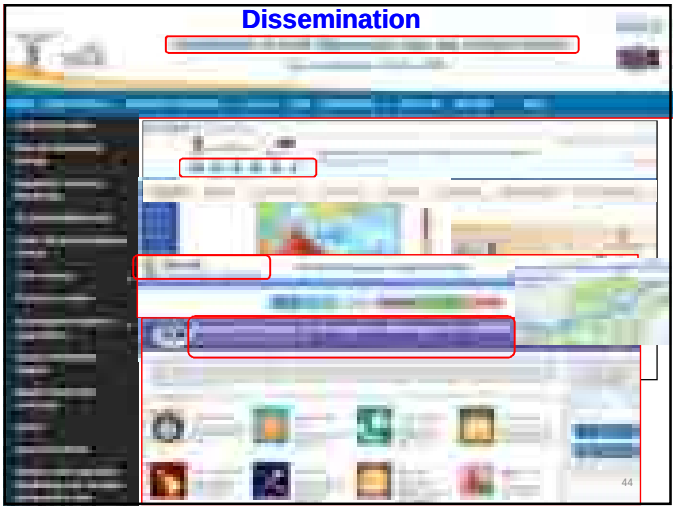
42

Simulate or Forecast Event



43

Dissemination



44

International Coordination

International Charter Space & Major Disasters

- The International Charter on Space and Major Disasters is the main mechanism globally by which countries can access satellite EO in support of their disaster response activities.
- The Charter (www.disasterscharter.org), is an international collaboration among space agencies to provide a unified system to access imagery for disaster response.
- With 17 members today, the Charter is able to provide rapid access to data from a virtual constellation of a series of satellites, both optical and radar, to help disaster management centers in relief actions.
- The Charter provides access to satellite data globally and at no cost to Authorized Users.
- Any national disaster management authority will be able to submit requests to Charter for emergency response, aimed towards Universal Access (UA).

45

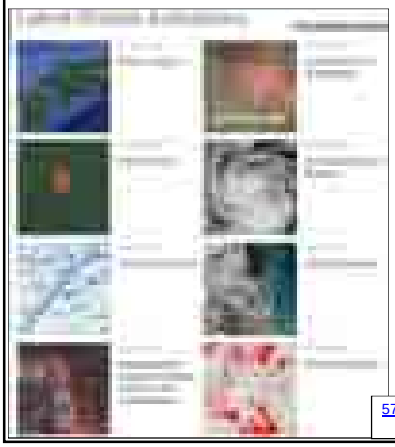
https://www.disasterscharter.org/

International Charter Space and Major Disasters

https://www.disasterscharter.org/

46

International Charter Space and Major Disasters



576 Activations; 124 Countries; 17 Charter Members; 34 Contributing Satellites

Sentinel Asia

- Sentinel Asia is a voluntary basis initiative (www.aprsaf.org/initiatives/sentinel_asia) led by the Asia-Pacific Regional Space Agency Forum (APRSAF) to support disaster management activity in the Asia-Pacific region by applying geospatial information and technologies, including EO satellite data.
- Its main activities include:
  - Emergency observation by EO satellites in case of major disasters (with working links to the Charter as required);
  - Acceptance of observation requests;
  - Wildfire monitoring, flood monitoring & GLOF monitoring;
  - Capacity building for utilization of satellite image/data for disaster management.
- SA primarily focuses on the response phases & has gradually expanded its activity to cover entire DRM cycle of pre-disaster monitoring, preparedness, & recovery.

ALOS-2 (Japan Aerospace Exploration Agency, Japan), IRS (Indian Space Research Organization, India), THEOS (Geo-Informatics and Space Technology Development Agency, Thailand), KOMPSAT-1 (Korea Aerospace Research Institute, South Korea), FORMOSAT (National Applied Research Laboratories, Taiwan), and XSAT (Centre for Remote Imaging, Sensing and Processing, Singapore), which are referred to as the DPN.

Thank You

This presentation is compiled from different sources in open domain.
All the Data, Figures utilized in this Lecture from various sources are thankfully acknowledged. 49