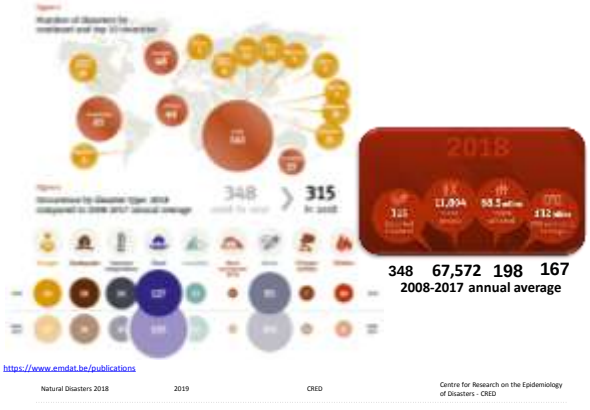
Potential of Satellite Remote Sensing & GIS for Flood Hazards Mapping, Monitoring & Early Warning

Learning Objectives:

Session will help in familiarizing about EO data applications for

- ***Flood hazards mapping,***
- ***Flood hazards monitoring &***
- ***Flood hazards early warning.***

Natural Disasters Occurrence



South Asia & Floods

- ✓ **Coastal areas currently home to 300 million people will be vulnerable by 2050 to flooding made worse by climate change.**
- ✓ **More than two-thirds of the populations at risk are in China, Bangladesh, India, Vietnam, Indonesia and Thailand.**
- ✓ **Destructive storm surges fueled by increasingly powerful cyclones and rising seas will hit Asia hardest.**

Rainfall Variability-Short Intense Spells

Nature of 2019 monsoon Indian Express on Oct 5, 2019 reported, quoting IMD Sources that number of extreme rainfall events during 2019 monsoon were:

	2015	2016	2017	2018	2019
June	70	39	36	64	52
July	110	93	106	117	161
Aug	57	76	90	96	282
Sept	20	29	29	41	68
TOTAL	257	326	361	318	563

Monsoon season of 2019 Indian rivers have crossed Highest Flood Level (HFL) at around 37 Level Forecasting and Level Monitoring sites.

Monitoring, Forecasting & Risk Assessment is very important for DRR and meeting goals of Sendai Framework for DRR (SFDRR)

Reduce	Increase
Mortality	Countries with National & Local DRR strategies
Affected People	International Cooperation
Economic Loss	Availability & Access to multi hazard early warning systems and disaster risk information and assessment
Damage to critical infrastructure/basic services	

7 GLOBAL TARGETS

4 PRIORITIES

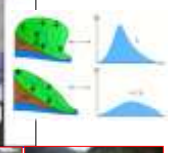
Priority	Action
Priority-1	Understanding Disaster Risk
Priority-2	Strengthening Disaster Risk Governance
Priority-3	Investing in DRR for resilience
Priority-4	Enhancing disaster preparedness for effective response and to "BBB" in recovery, rehabilitation & reconstruction

http://www.unisdr.org/

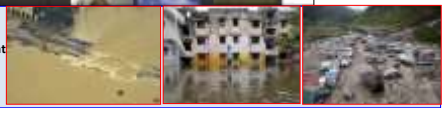
Flood Hazard

- **A flood is a relatively high flow which overtakes natural channel provided for runoff (Chow, 1956).**

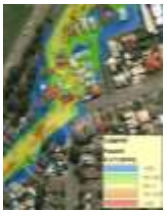
Kosi-2008
Chennai-2015
Kedarnath-2016
Kerala-2018
Bihar, Gujarat-2019



Heavy Rainfall
Dam Break
Breaching of embankment
Drainage congestion
Storm Surge
Glacial Lake outburst



During Disasters



Decision Maker

Conventional Method of

Limited Time
Limited Manpower/Resources
No Accessibility
Financial Constraints
Collapsed Communication
Damaged Instruments

Location
Spatial Extent
Severity
Persistence
Depth

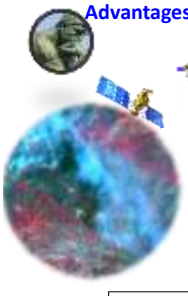
Time Line

Vulnerable Areas
Relief Shelters
Shortest Routes

Changes in River Course
Embankment Status
Basin Characteristics

Precipitation
Soil Moisture
Land use

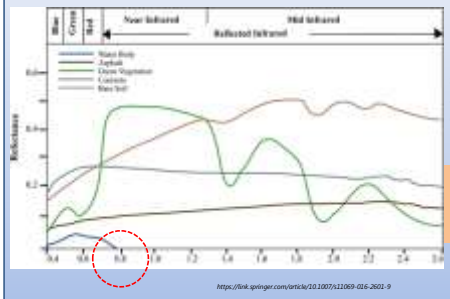
Advantages: Remote Sensing for Hydro-meteorological Hazards



ACTIVE/PASSIVE

- Can provide synoptic view
- Can provide global coverage
- Can operate in all weather conditions
- Inaccessible & hazardous areas can be sensed
- Identifying the Disaster Location & Spatial Extent
- Transboundary Monitoring of Events
- Satellite observations provides temporal monitoring
- Rapid Damage Assessment; Compare Pre and Post Disaster Changes

Spectral Reflectance of Water



https://link.springer.com/article/10.1007/s11069-016-2601-9

- Water looks blue or blue-green due to stronger reflectance at shorter λs which decreases as λ increases.
- Distinctive character of water is its absorption in NIR & beyond

- Variance in water spectral patterns is detected in shorter wavelengths (blue and green) which is related to depth of water, content of materials in suspension (chlorophyll, clays, and nutrients), & roughness of surface.

Optical Imaging Satellites for Flood Mapping

Microwave Imaging of Floods: Advantages & Disadvantages

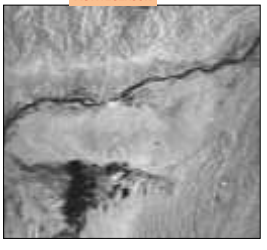
Advantage:

- Nearly all weather capability
- Day or night capability
- Penetration through the vegetation canopy
- Penetration through the soil
- Minimal atmospheric effects
- Sensitivity to dielectric properties (liquid vs. frozen water)
- Sensitivity to structure

Disadvantage:

- Information content is different than optical & sometimes difficult to interpret
- Speckle effects (graininess in image)
- Effects of topography

ACTIVE SENSOR



Parameters affecting the backscatter

Radar observation parameters:

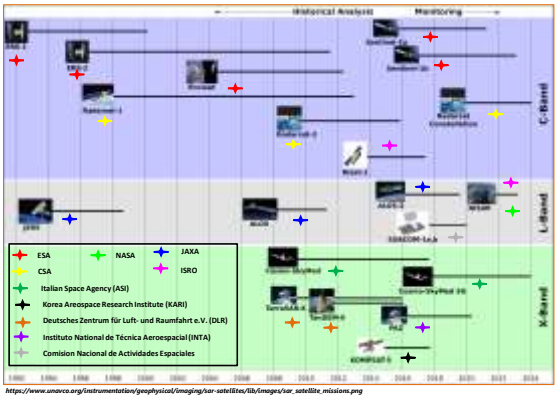
- Frequency/Wavelength
- Polarization
- Incidence Angle

Combination of wave length, incidence angle and polarization play a major role in influencing the interpreter's ability to segregate flood areas from the non-flooded ones.

Surface and terrain parameters:

- Roughness (in relation to frequency)
- Terrain relief / viewing geometry
- Dielectric properties

Microwave Satellites for Flood Mapping

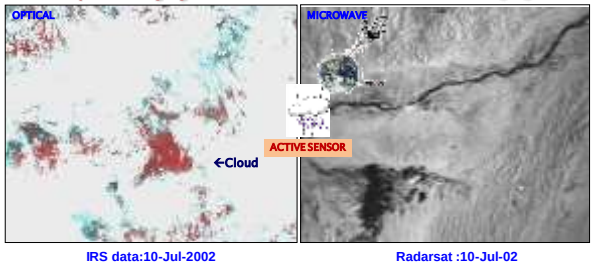


https://www.unavco.org/instrumentation/geophysical/imaging/sar-satellites/lib/images/sar_satellite_missions.png

Detection of Flooded Areas: Monsoons

Can operate in all weather conditions

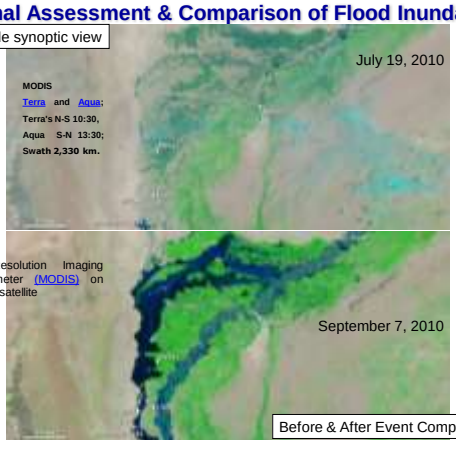
Optical Imaging | **Microwave Imaging**



IRS data:10-Jul-2002 | **Radarsat :10-Jul-02**

Regional Assessment & Comparison of Flood Inundation

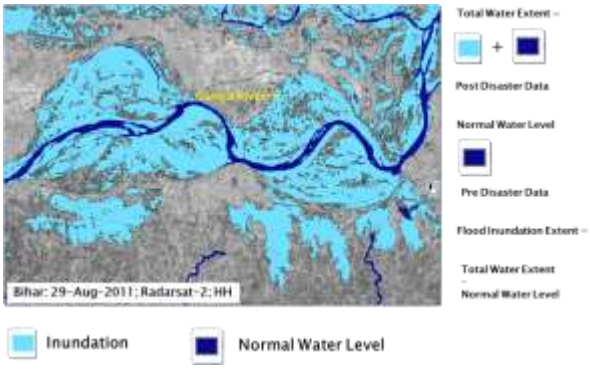
Can provide synoptic view



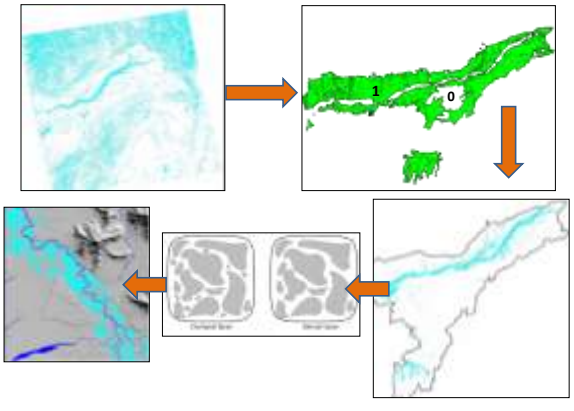
Moderate Resolution Imaging Spectroradiometer (MODIS) on NASA's Terra satellite

Before & After Event Comparisons

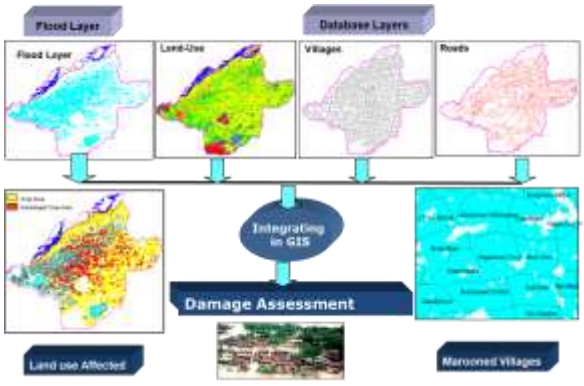
Flood Inundation Delineation-Methodology

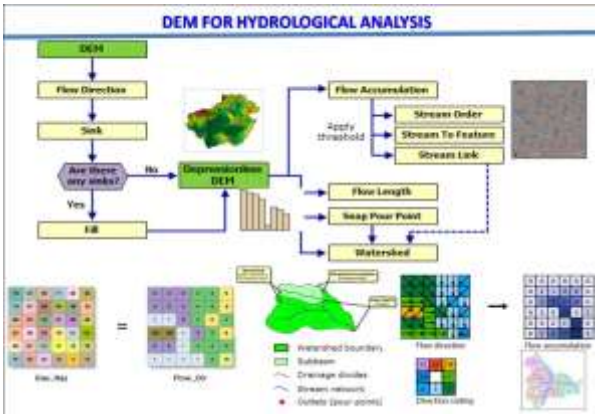


Flood Inundation Delineation-Methodology

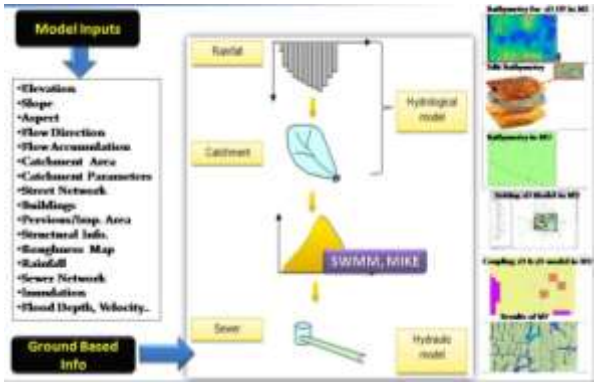


Flood Damage Assessment





Flood Routing



Acknowledgements

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Lecture slides made are only for Capacity Building