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UN-SPIDER / DLR / GloFAS / ZFL International Training Workshop Space Technologies for Flood Management

Martin Hilljegerdes UNOOSA/UN-SPIDER Bonn Office

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UN-SPIDER Recommended Practice on Flood Mapping using Sentinel 1 (SAR) Imagery and Google Earth Engine

Martin Hilljegerdes UNOOSA/UN-SPIDER Bonn Office

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Outline

- 1. Flood information products for the entire disaster management cycle
- 2. Radar remote sensing basics
- 3. Hands On:
 - UN-SPIDER Recommended Practices on SAR-based flood mapping using Google Earth Engine
- 4. Further learning opportunities
- 5. Q&A and discussion

Flood trends



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Centre for Research on the Epidemiology of Disasters (CRED). Disasters in Numbers 2021, p.4. Brussels: CRED; 2022.

www.unoosa.org

Flood information for the entire disaster management cycle



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Satellite remote sensing sensors

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□ Passive Sensors

Sensors detect only what is emitted from the landscape, or reflected from another source (e.g. reflected sunlight).



□ Active Sensors

Instruments emit their own signal and the sensor measures what is reflected back to the sensor (e.g. Synthetic Aperture Radar, SAR).



Satellite remote sensing sensors



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□ Passive Sensors

- + Easy interpretation
- Depends on weather and lighting conditions -



- □ Active Sensors (e.g. Synthetic Aperture Radar, SAR)
 - Independent of weather and lighting conditions +
 - **Requires pre-processing**



Flood information for the entire disaster management cycle



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Flood mapping using optical imagery

- Landcover classification or
- □ Calculation of indices that make use of spectral reflectance of water
 - □ Reflectance higher in visible than in NIR and SWIR channels
 - Using the Normalized Difference Water Index (NDWI)
 - Near-infrared (NIR) and short-wave infrared (SWIR)
 - Or green and NIR
- □ NOAA global flood map products

(https://floods.ssec.wisc.edu/?products=RIVER-FLDglobal.75¢er=0,0&zoom=2&basemap=s atellite&labels=-×tep=1d)



Advantages	Limitations	
No backscatter, double bounce or overlay issues	No cloud penetration	
Easily separates water from soil and vegetation	NDWI cannot separate well water from built-up areas	





Synthetic Aperture Radar (SAR) principles











Interpretation: Advantages and Limitations



e-Geos COSMO-SkyMed



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How does a radar image work?







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Ground parameters (variable)

- Topography 1.
- Surface roughness 2.
- **Object geometry** 3.
- **Object orientation** 4.
- Dielectric constant (water content 5. dependant)



Colima Volcano- México TerraSAR-X, band C, view angle: 33°







Backscattering





Speckle



(Globe – SAR 2006)

SAR Reflection Types

□ Specular Reflection

- Occurs on smooth surfaces (e.g. water)
- Appears dark due to low backscatter intensity





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□ Diffuse Reflection

Occurs on rough surfaces (e.g. soil) Appears bright due to high backscatter intensity



Limitation: Double bounce backscatter

Urban Areas

- Multiple reflections at urban geometries
- Appears bright due to high backscatter intensity





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□ Flooded Vegetation

Multiple reflections in vegetation Appears bright due to high backscatter intensity



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- □ Radar Parameters: Polarizations
- HH: Horizontal Transmit, Horizontal Receive
- HV: Horizontal Transmit, Vertical Receive •
- VH: Vertical Transmit, Horizontal Receive •
- VV: Vertical Transmit, Vertical Receive
- Quad-Pol: all polarizations are measured •
- □ For the UN-SPIDER Recommended Practice we use *VV...*





(Applied Remote Sensing Training Program-NASA)





ΗH







VV

Composite

VH

Interpretation





Atmospheric artifacts



Advantages/Limitations





Advantages	Limitations
Cloud penetration	Backscatter signal of rough water surfaces
Daylight independence	Geometric distortions
Open data & free access to archive	Double-bounce effect in vegetated or urban areas
Dielectric constant alteration	Radar shadow

Methods for flood identification



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Principal methods for flood mapping:

1. Thresholding - Radiometric correction and setting of db limit on after-event image



Methods for flood mapping



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Principal methods for flood mapping:

2. Ratios and change detection (using before and after-event SAR images)





UN-SPIDER Recommended Practices



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Radar-based Flood Mapping

- □ https://www.un-spider.org/advisorysupport/recommendedpractices/recommended-practice-radar-basedflood-mapping
- □ Uses Sentinel-1 SAR data obtained from Open Access Hub
- □ SNAP (free desktop software) or Python (Jupyter Notebook online)
- □ Result can be imported into QGIS / Google Earth





<u>https://un-spider.org/advisory-support/recommended-</u>

practices/recommended-practice-google-earth-engineflood-mapping

□ Uses Sentinel-1 SAR data obtained from Google Earth Engine (delayed data provision)

UN-SPIDER Recommended Practices

Flood Mapping and Damage Assessment Using Sentinel-1

SAR Data in Google Earth Engine

□ Result can be imported into QGIS or other software





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Hands-on exercise



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Google Earth Engine training script: <u>https://tinyurl.com/unspider-flood-training2023</u>

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Hands-on exercise





Export and visualize the data in QGIS or Google Earth Pro



Learning resources



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- □ EO College MOOC Echoes in Space Introduction to Radar Remote Sensing (https://eo-college.org/courses/)
- □ University of Alaska Fairbanks Synthethic Aperture Radar: Hazards (https://www.edx.org/course/sar-hazards)
- NASA ARSET (<u>https://appliedsciences.nasa.gov/what-we-</u> do/capacity-building/arset)
- □ Copernicus Research and User Support (RUS) (https://ruscopernicus.eu/portal/)
- □ Regularly updated list of free online training opportunities categorized by hazard at https://un-spider.org/links-andresources/online-training-opportunities
- □ UN-SPIDER YouTube channel (https://www.youtube.com/channel/UCTwI1Al7To1f2hlSrLOOz ZW
- Natural Resources Canada (NRCAN) Tutorials (https://www.nrcan.gc.ca/maps-tools-andpublications/satellite-imagery-and-air-photos/tutorialfundamentals-remote-sensing/9309



Before we head to coffee break...



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□ Prepare for Victor's session...

Hands-on exercise



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Google Earth Engine original (full) script: <u>https://tinyurl.com/unspider-flood-full</u>

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Thank you

Martin.Hilljegerdes@un.org

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