Introduction and Demonstration of the NOAA Global Flood Products

AOMSUC-12 Training Event

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Acknowledgements: Sanmei Li (GMU), Sean Helfrich (NOAA/NESDIS), Mitch Goldberg (NOAA/NESDIS), and the stakeholders who provide invaluable feedback

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Overview

- The intention of this presentation is to give a brief overview of the VIIRS, ABI and AHI Flood Mapping products for emergency response stakeholders and how to access and use them.

- This is **not** a technical presentation. Users who wish to have the specific scientific information, such as which bands are used, can refer to the last slide at the end of this presentation or contact the developers (information listed on slide 26).

- A set of useful links to access the products is also provided.

Flood Products Overview

- The VIIRS, ABI and AHI flood products provide flood areal extent and can be used for situational awareness.

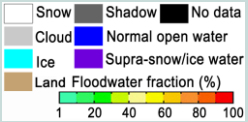
- On a daily basis, the joint VIIRS/ABI or VIIRS/AHI flood product provides the best coverage in regions covered by ABI or AHI.

- Under clear-sky conditions in the VIIRS and ABI/AHI images, the VIIRS flood product is recommended for use because of its more accurate floodwater details.

- The ABI and AHI flood maps filter out clouds using a multiple composition process. This means that they may be able to provide flood extent in regions which are cloudy during the two daytime VIIRS overpasses. In this case, the ABI and AHI flood maps may be used for flood mapping with spatial resolution at about 1 km instead of 375 meters.

Lists of VIIRS/ABI/AHI Flood Products

Products	Spatial resolution	Availability	Coverage	Production latency	Description
Suomi-NPP &NOAA-20/VIIRS near real-time flood product	375m	2-3 daytime passes for each satellite	Global land between 80°S and 80°N	Available 3 hours after pass	Daytime-only flood extent in water fractions (open water percentage in a satellite pixel)
Suomi-NPP &NOAA-20/VIIRS daily composited flood product	375m	Once per day	Global land between 60°S and 75°N	All tiles available by 1030Z	
Suomi-NPP &NOAA-20/VIIRS 5-day composited flood product	375m	Once per day	Global land between 60°S and 75°N	All tiles available by 1030Z	
GOES-16&17/ABI flood product	1-km	Every hour	Land in America (135° W ~ 17° W, 50.5°S ~ 50.5°N)	every hour	
Himawari-8&9/AHI flood product	1-km	Every hour	Land in East Asia and Oceania (90° E ~ 180° E, 47.5°S ~ 50.5°N)	every hour	
Joint VIIRS/ABI flood product	375m~1km	Once per day	Land in America (135° W ~ 17° W, 50.5°S ~ 50.5°N)	Available at 07Z	
Joint VIIRS/AHI flood product	375m~1km	Once per day	Land in East Asia and Oceania (90° E ~ 180° E, 47.5°S ~ 50.5°N)	Available at 18Z	



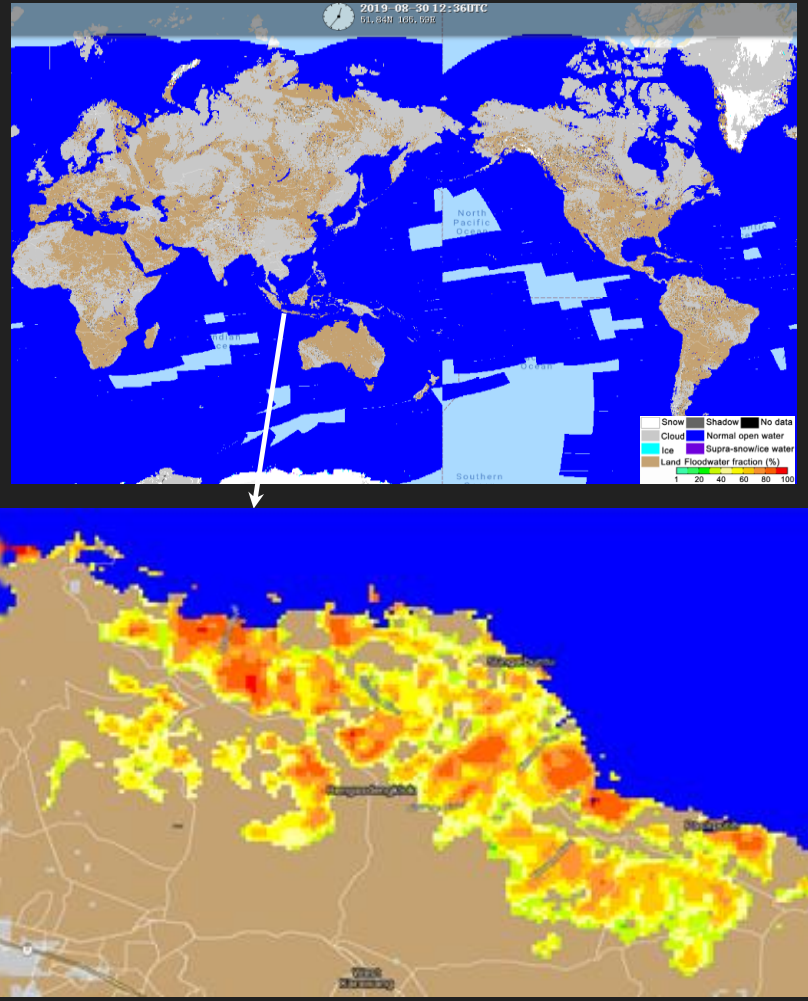
Question 1

Under what flood conditions do you think that an optical flood detection algorithm would find challenging to detect flooding?

a. Flash flooding from thunderstorms and squall lines.
b. Flooding from cloud bands i.e. Meiyu-Baiyu-Changma front, SPCZ.
c. Flooding from slow moving Tropical Cyclones, Monsoons or Tropical Lows
d. Flooding from an active Monsoon.
e. Floodwaters moving down a long river from heavy precipitation upstream.
f. b and c
g. don't know

VIIRS NRT Flood Product

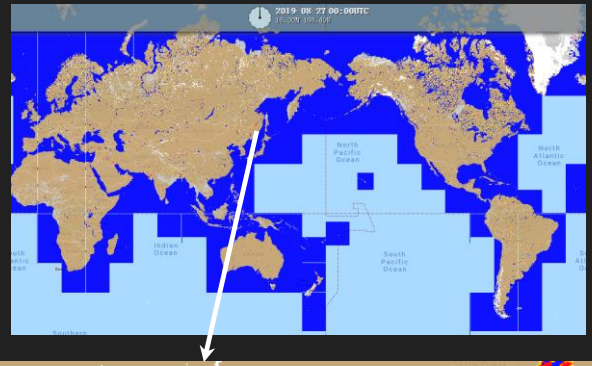
- The VIIRS 375-m Flood Product, is a near real-time product derived from daytime VIIRS imagery from Suomi-NPP and NOAA-20.
- The VIIRS Flood Map reflects the current flood status at the time of the overpass along with additional information on the weather and land conditions.
- Suomi-NPP and NOAA-20 are low earth orbiting satellites, which means only two daytime observations can be derived per day over a given Region of Interest (ROI) with a ~50 min interval.
- Observations are taken ~2-3pm local solar time. The latency of the product is about 3 hours after a pass is complete.

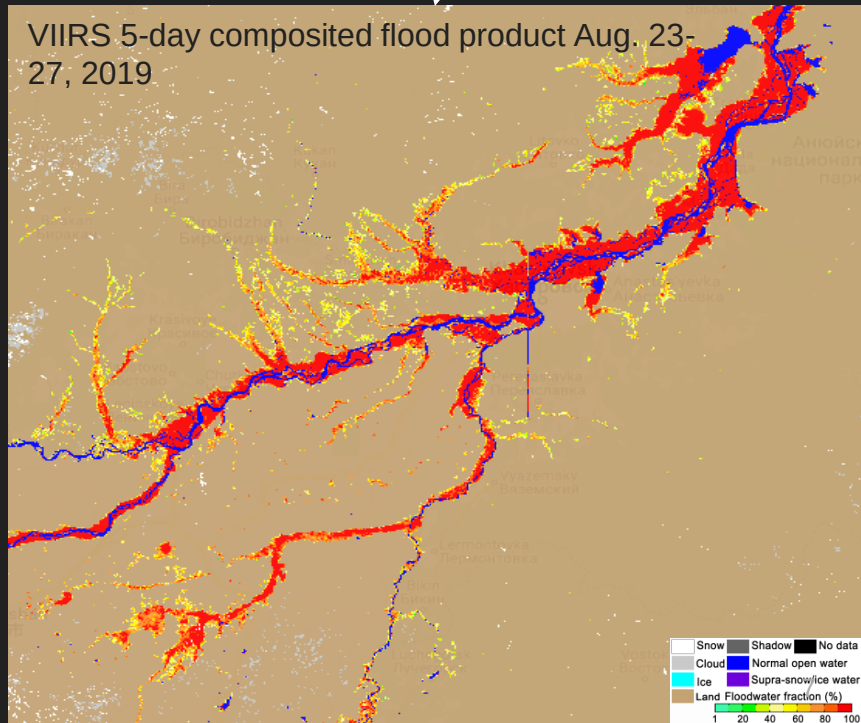


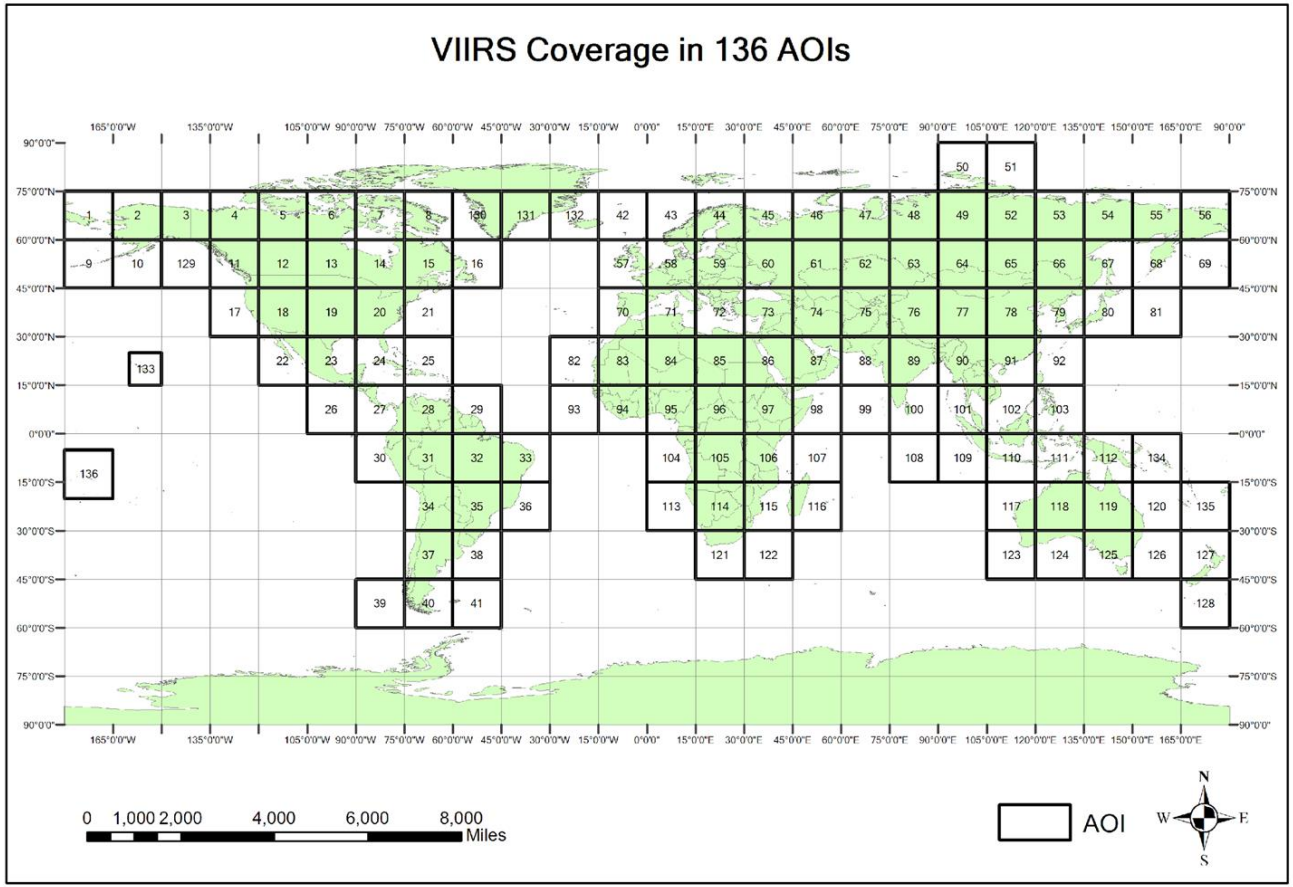
VIIRS Composited Flood Products

- The VIIRS Composited Flood Products are used to filter out cloud cover through a maximal water-fraction composition process and thus derive the maximal flood extent during a flood event from the VIIRS NRT flood maps of Suomi-NPP and NOAA-20.
- The routinely global VIIRS Composited Flood Products include daily composited flood product and 5-day composited flood product.

- The composition process is done by dividing the global land into 136 AOIs.







The global land is divided into 136 AOIs for the VIIRS composition process and data archive.

Question 2

A). For determining the approximate amount of cropland and population impacted by flooding for a long lived flood event, would a 1-day or 5-day maximal flood extent?

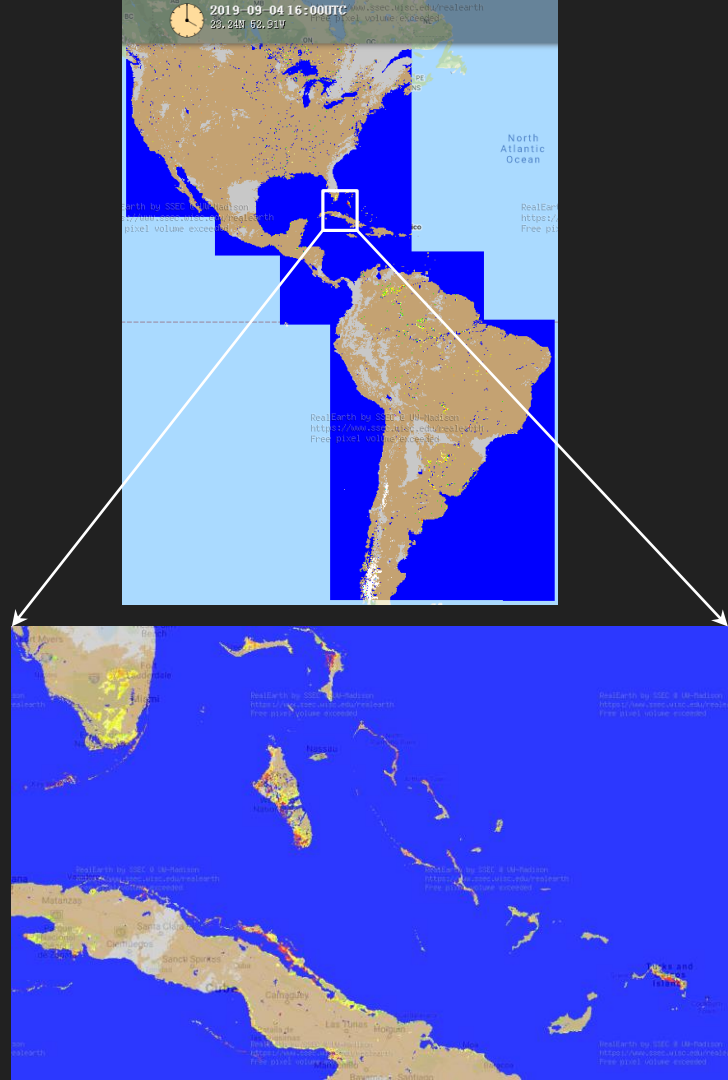
B). Why would this be the best product to use?

ABI Flood Product

- The ABI Flood Product is a rolling composited result based on the 10-minute ABI flood maps with hourly updates. Each hourly-updated flood map shows the average flood water fractions from the first 10-minute flood map to the latest one (example shown right).

- At the end of a day, the ABI Flood Map is the composited result of all the 10-minute ABI flood maps during daytime and thus shows the flood extent under the daily maximal clear-sky coverage.

- Data from ABI is acquired using the GOES Rebroadcast (GRB) downlink, which provides short latency in acquiring the ABI data.

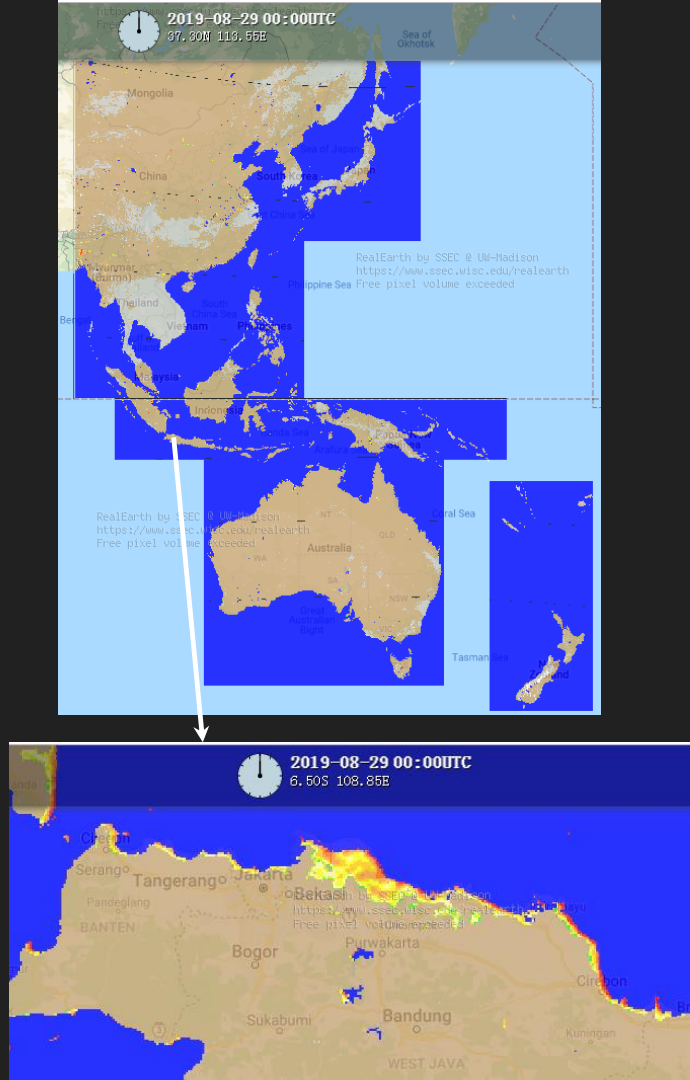


AHI Flood Product

- The AHI Flood Product is a rolling composited result based on the 10-minute AHI flood maps with hourly updates. Each hourly-updated flood map shows the average flood water fractions from the first 10-minute flood map to the latest one.

- At the end of a day, the AHI Flood Map is a daily flood composite, and shows the flood extent under the daily maximal clear-sky coverage (example shown right).

- Data from AHI is acquired using the Himawari Cloud to STAR and then provided to CIMSS for processing.

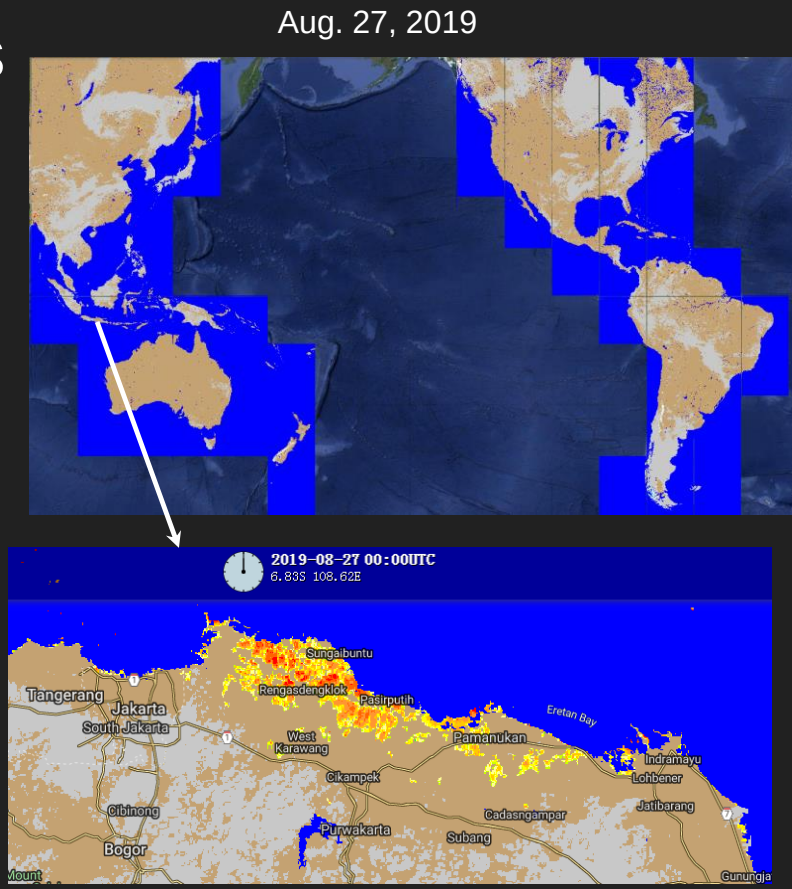


Joint VIIRS/ABI/AHI Flood Products

- The joint VIIRS/ABI or VIIRS/AHI Flood Products blend the daily flood detection results from VIIRS, ABI and AHI. It is based on the VIIRS 375-m daily composited flood maps, and uses the 1-km ABI or AHI daily clear-sky detection results to fill the gaps of clouds and cloud shadows in the VIIRS maps.

- Thus, it shows the flood extent under the maximal clear-sky coverage derived from ABI or AHI during daytime, and keeps the more accurate floodwater details from VIIRS.

- **IMPORTANT NOTE - The current Joint VIIRS/ABI or VIIRS/AHI Flood products are experimental products using overlapping process. The 1-km ABI/AHI flood water fractions have not been fully fused with the VIIRS results, so the resolution of the current products vary from 375m to 1km.**

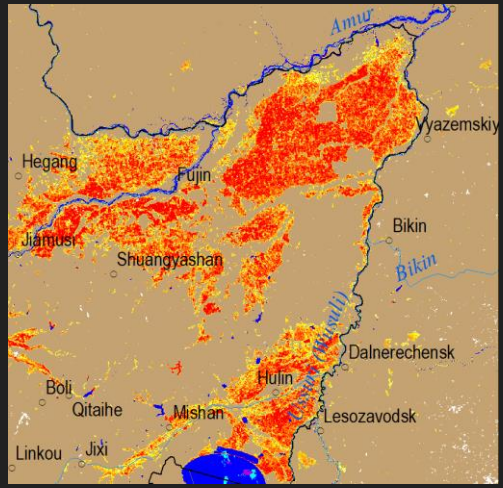


Question 3

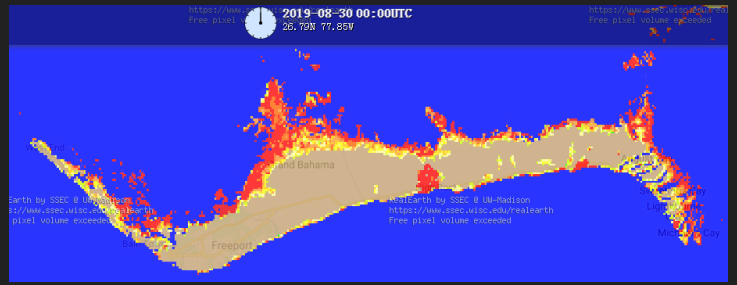
Do you think an optical (or SAR) flood product show "normal" tidal inundation? Yes/No??

Issues to be aware of

- **Agricultural-related flooding:** Some flooding water shown in the VIIRS flood maps may not be any hazard-related flooding, but from agriculture-related activities such as rice paddy planting and aquaculture.
- **Tides and Marsh lands:** In some regions especially coastal areas, consistent flooding may be detected in the flood maps. These floods are mostly caused by the tides or occur over marsh lands, which do not pose any social impact.
- **Water reference map:** The current water reference map we use for global flood mapping is from global water bodies of ESA CCI and MODIS global water mask (MOD44W Version 006). It might not reflect the new reservoirs and other hydraulic projects built after 2015, which may take some normal water as flooding water.
- **Solar Eclipses:** For granules that are flagged as an “eclipse”, the flood product will not be produced.



The widespread flooding water in the northeast of China from May 03 to 09, 2018 was not hazard-related flooding, but the “flooded” rice paddy areas during planting season.



Flooding caused by the tides in Great Bahamas is a natural phenomenon.

Question 2

Which types optical flood products provide the most accurate early morning maximal flood extent the quickest?

a. Daily geostationary/Leo Joint flood composites
b. First hourly geostationary composite
c. Daily geostationary composite from the previous day
d. a and b
e. I don't know

Example of how the products can be used during the day

- The ABI/AHI flood maps are available from the early morning to the late afternoon, and thus are recommended for use during the periods when VIIRS flood products are unavailable.

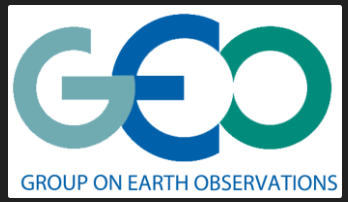
- Once the high resolution (**375 m**) flood product from VIIRS become available (3-4pm local solar time over a given region, assuming DB availability), assessments can be revised using finer and more accurate details of the flood extent, depending on cloud cover over ROI at time of S-NPP and NOAA-20 passes.

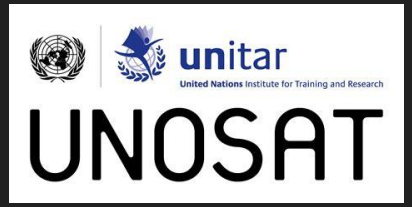
- When available, the Joint VIIRS/ABI or VIIRS/AHI Flood products are highly recommended for an initial evening assessment, since they provide the best coverage from ABI or AHI and the more accurate floodwater details from VIIRS.

- When it is always partially cloudy during a period, the VIIRS daily or 5-day composited flood products are also recommended for use as they filter out the cloud cover through a maximal water-fraction composition process and can reflect the maximal flood extent during a day or the latest five days.

- Remember that the all of the flood products are produced during **daytime only**, thus the products will not be updated overnight

International and US Users





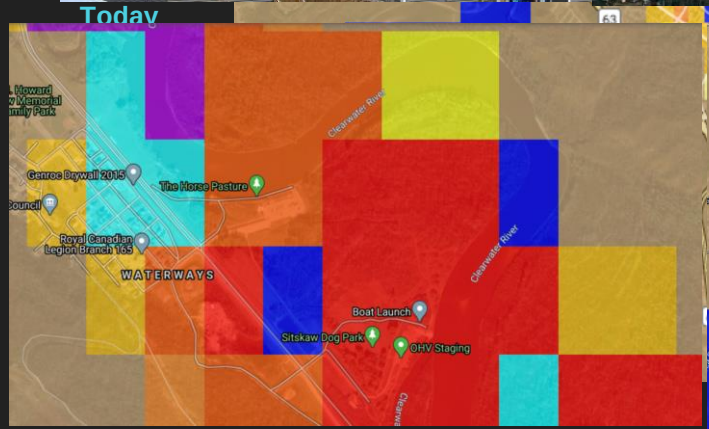
And many others!

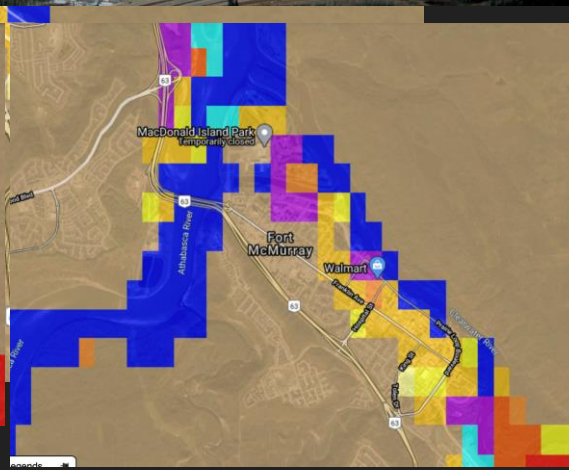
Example cases – Flooding in Canada

- 27 April 2019, a major ice jam and melting waters caused massive flooding in downtown Fort McMurray.
- This forced over 15,000 people to be evacuated and a mandatory "boil water" order
- Clear skies on 28/29 April allowed the VIIRS 1-day composite to observe the flooding in areas observed from aerial observation

Image courtesy of Fort McMurray Today

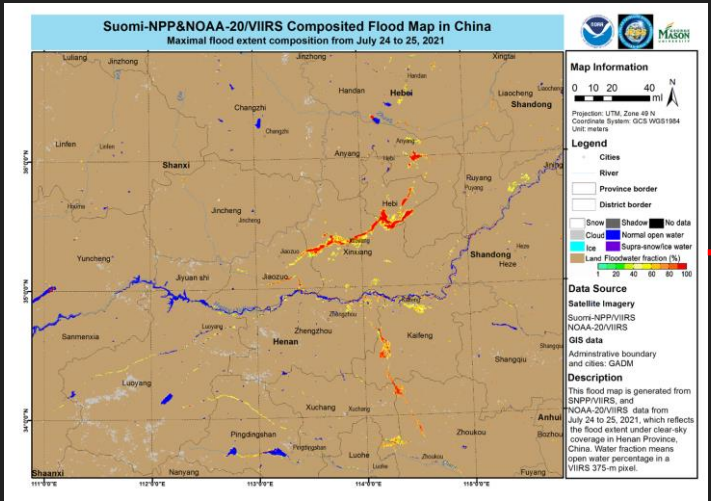
Image from McMurray Aviation



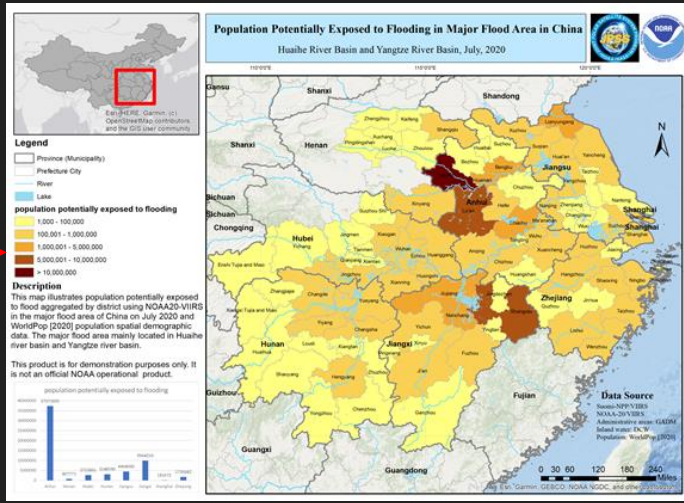


Example case – Flooding in China - Summer 2020

Population database



ArcGIS



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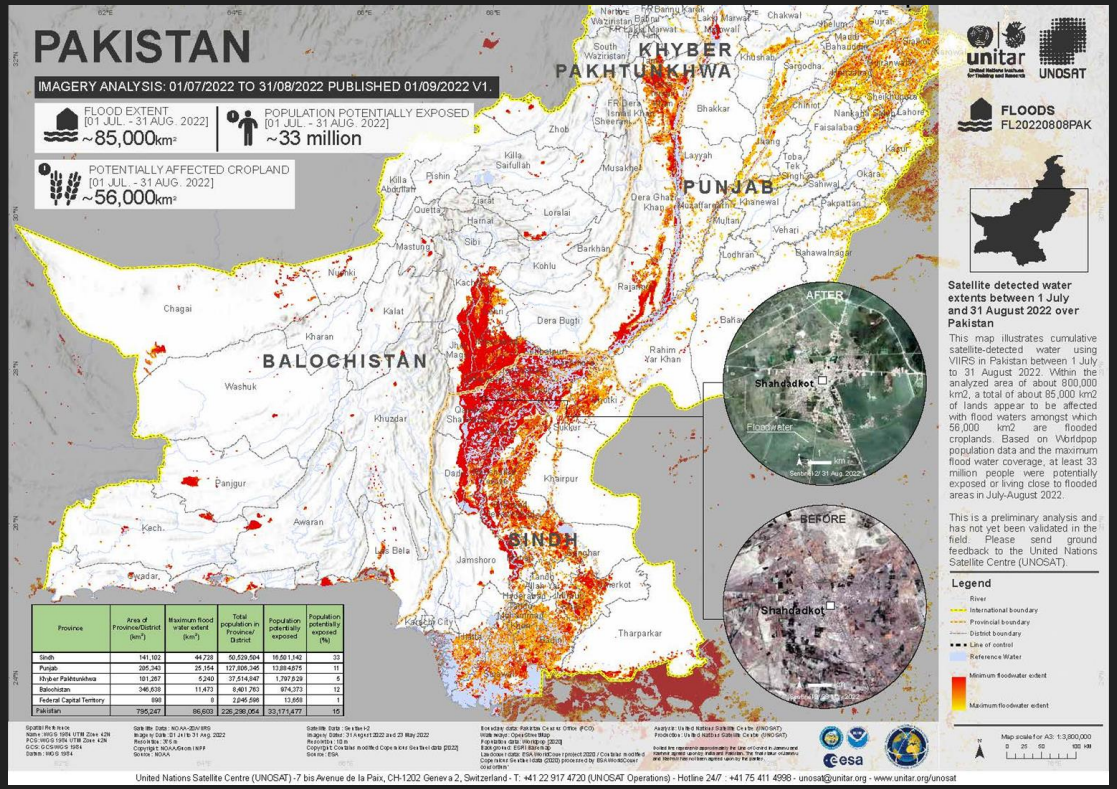
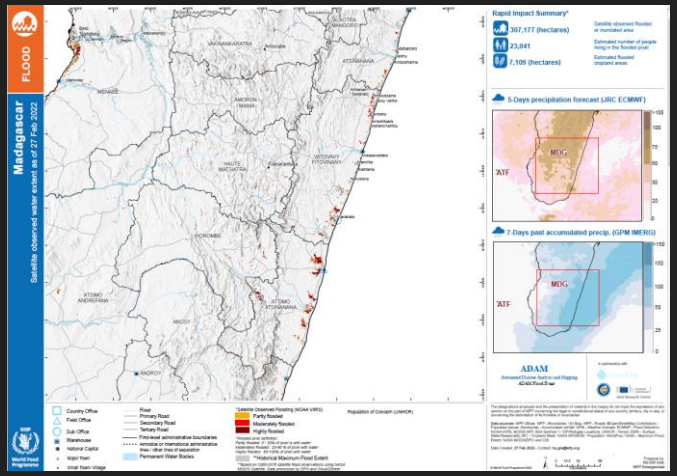
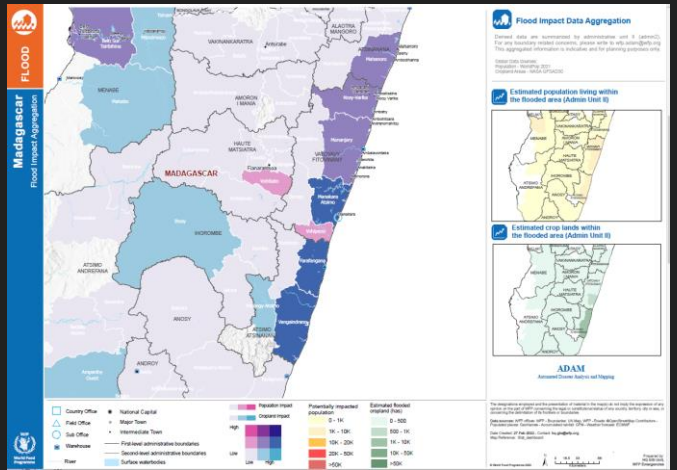
Example cases – International Charter/WFP



Province	Area of Province/District (km²)	Maximum flood water extent (km²)	Total population in Province/ District	Population potentially exposed	Population potentially exposed (%)
Sindh	141,102	44,729	50,529,504	16,60 1,142	33
Punjab	205,343	25,164	127,896,346	13,86 4,676	11
Khyber Pakhtunkhwa	101,267	5,240	37,514,847	1,797,629	5
Balochistan	346,638	11,473	8,401,763	974,373	12
Federal Capital Territory	998	8	2,245,598	13,859	1
Pakistan	795,247	86,603	226,236,054	33,171,477	15





Satellites as a tool to assess flood risk

By utilizing derived flood maps, one can create a global or regional assessment of the number of days a given area is flooded for a given year (or longer time period).

This can help assess where the most flood prone regions are and help with flood mitigation/preparedness efforts

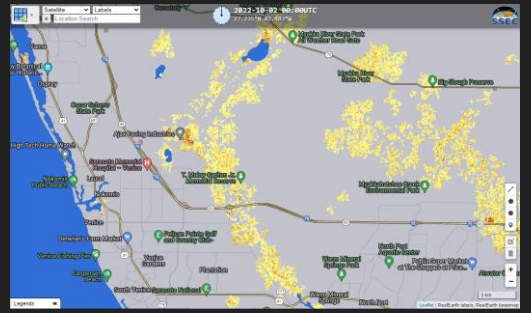
Currently NOAA has derived optically based VIIRS daily and 5-day flood maps for (2012-2020) to begin this effort, making it freely available to users for analysis.

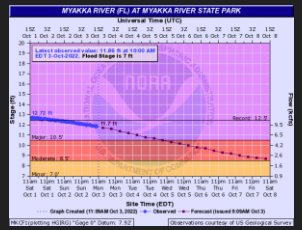
Future Work

- **Downscaled VIIRS Product:** The VIIRS 375-m floodwater fraction products to 30-m 3-D flood products using the 30-m SRTM/DEM and a series of ancillary datasets based on level-4 Hydrologic Unit Code (HUC-4). This product is currently being run in near-realtime globally and displayed within RealEarth

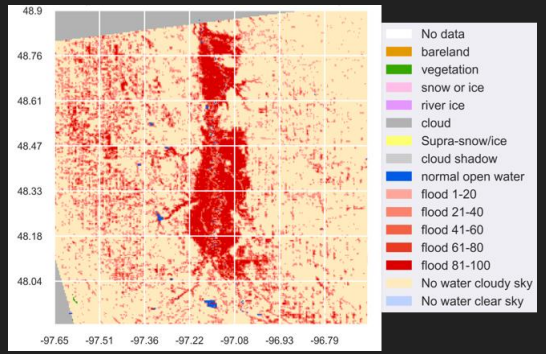
- **Automated SAR Flood Product:** NOAA currently is developing an automated SAR flood detection product utilizing a machine learning approach, which will be able to produce high resolution SAR flood extent maps.

- **Blended LEO/GEO/SAR Flood Product:** NOAA is also working on blend LEO/GEO and SAR flood mapping. This will enhance the flood products by providing the highest resolution possible flood maps as well as areas which are flooding under cloud





(Win McNamee/Getty Images)



The NOAA flood map blended with prototype RAPID-based Sentinel-1 and VIIRS flood products on 1 May 2022 over the Red River. Sentinel-1A/B acquired by ESA/Copernicus, Contains modified Copernicus Sentinel data 2022

Accessibility and Contact information

- Online
  - Online visualization page : https://www.ssec.wisc.edu/flood-map-demo/flood-products/
  - Links to the single flood products:
    - VIIRS real-time flood maps: http://floods.ssec.wisc.edu/?products=RIVER-FLDglobal
    - VIIRS daily composites: https://floods.ssec.wisc.edu/?products=RIVER-FLDglobal-composite1
    - VIIRS 5-day composites: http://floods.ssec.wisc.edu/?products=RIVER-FLDglobal-composite
    - ABI Daily composites: http://floods.ssec.wisc.edu/?products=River-Flood-ABI
    - AHI Daily composites: http://floods.ssec.wisc.edu/?products=RIVER-FLD-AHI
    - Joint VIIRS/ABI: http://floods.ssec.wisc.edu/?products=RIVER-FLD-joint-ABI
    - Joint VIIRS/AHI: http://floods.ssec.wisc.edu/?products=RIVER-FLD-joint-AHI
  - Also available on RealEarth App (available for Android and Apple)

- The flood products via Web Mapping Service (via Real Earth) and FTP are available

- Note that these products are not supported 24/7 but do have a high reliability of uptime.

Contact information

- Any questions can be referred to William Straka (wstraka@ssec.wisc.edu), Bill Sjoberg (bill.sjoberg@noaa.gov) and Mitch Goldberg (mitch.goldberg@noaa.gov)

- Any technical and scientific issues can be referred to Jay Hoffman (jay.hoffman@ssec.wisc.edu), Sanmei Li (slia@gmu.edu) and Donglian Sun (dsun@gmu.edu)

References

Sanmei Li, DonglianSun, Mitchell Goldberg, Bill Sjoberg, David Santek, Jay P. Hoffman, Mike DeWeese, Pedro Restrepo, Scott Lindsey, Eric Holloway (2017). Automatic near real-time flood detection using Suomi-NPP/VIIRS data, *Remote Sensing of Environment,* 204 (2018) 672–689

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