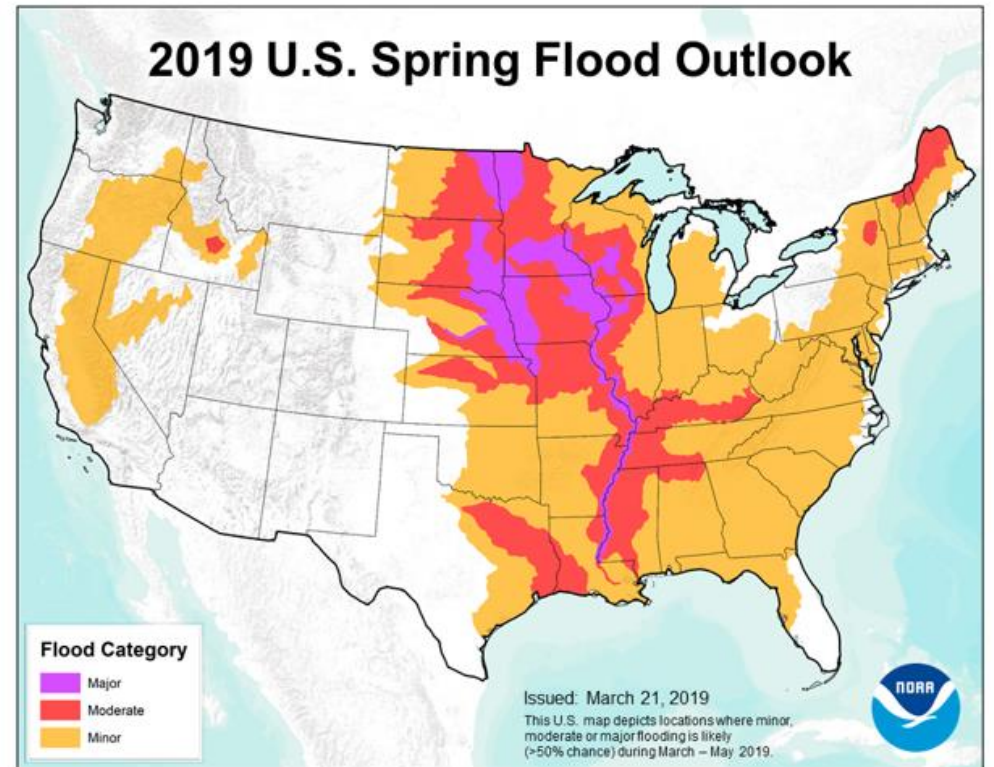


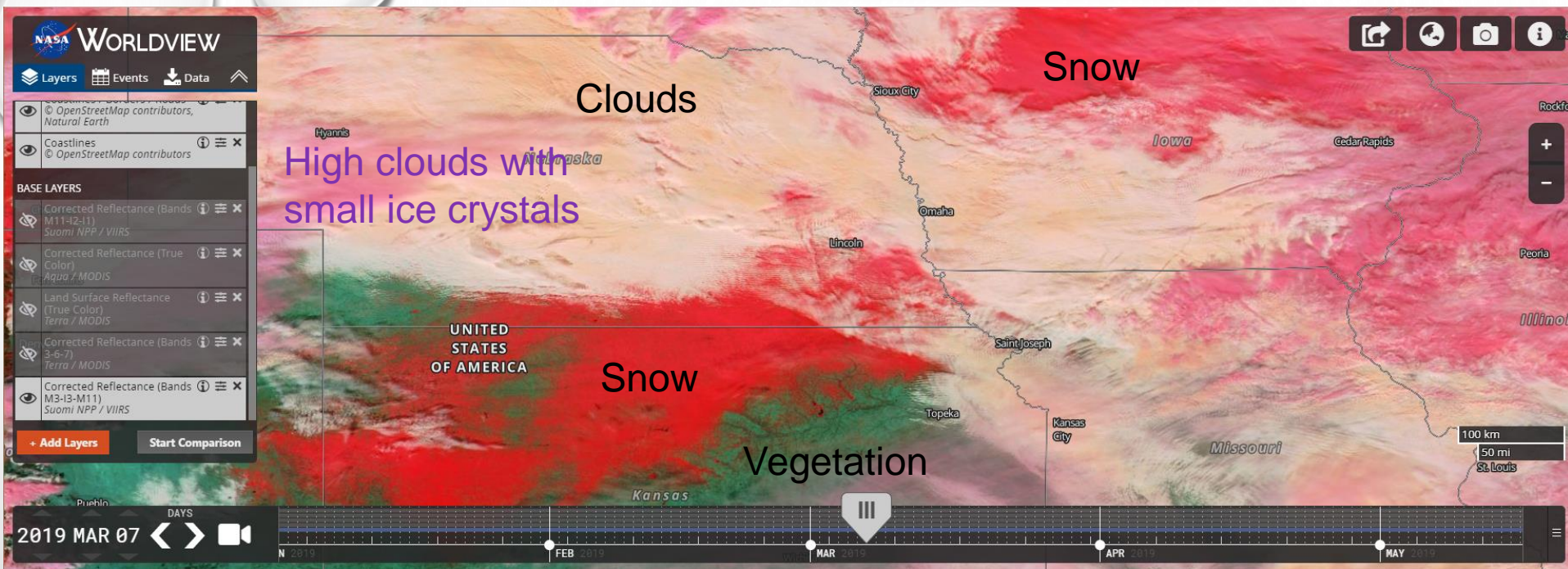
LEVERAGING SATELLITE REMOTE SENSING FOR THE MONITORING OF THE 2019 SPRING FLOODS

LORI A SCHULTZ, JORDAN R. BELL, ANDREW L. MOLTHAN,
RONAN LUCEY, JEREMY KIRKENDALL, GARRETT W. LAYNE,
DALIA KIRSCHBAUM, DAVID S. GREEN

EVENT BACKGROUND

- HEAVY AND CONSISTENT SNOWFALL THROUGH THE UPPER MIDWEST CULMINATING WITH A BOMB CYCLONE ON 3 MARCH 2019.
- MARCH 13TH: UNSEASONABLY WARM TEMPERATURES CAUSES RAPID SNOW MELT AND RUNOFF. ICE JAMS TRAVEL DOWNSTREAM CAUSING FLOODING AND DAMAGE TO LEVEES, DAMS AND PROPERTY
- MARCH 14TH: HEAVY RAINS AND SEVERE WEATHER HIT THE AREA, CAUSING RIVER GAUGES TO SHOW AT OR ABOVE FLOOD STAGE
- 2019 US SPRING FLOOD OUTLOOK WAS ISSUED 21 MARCH 2019

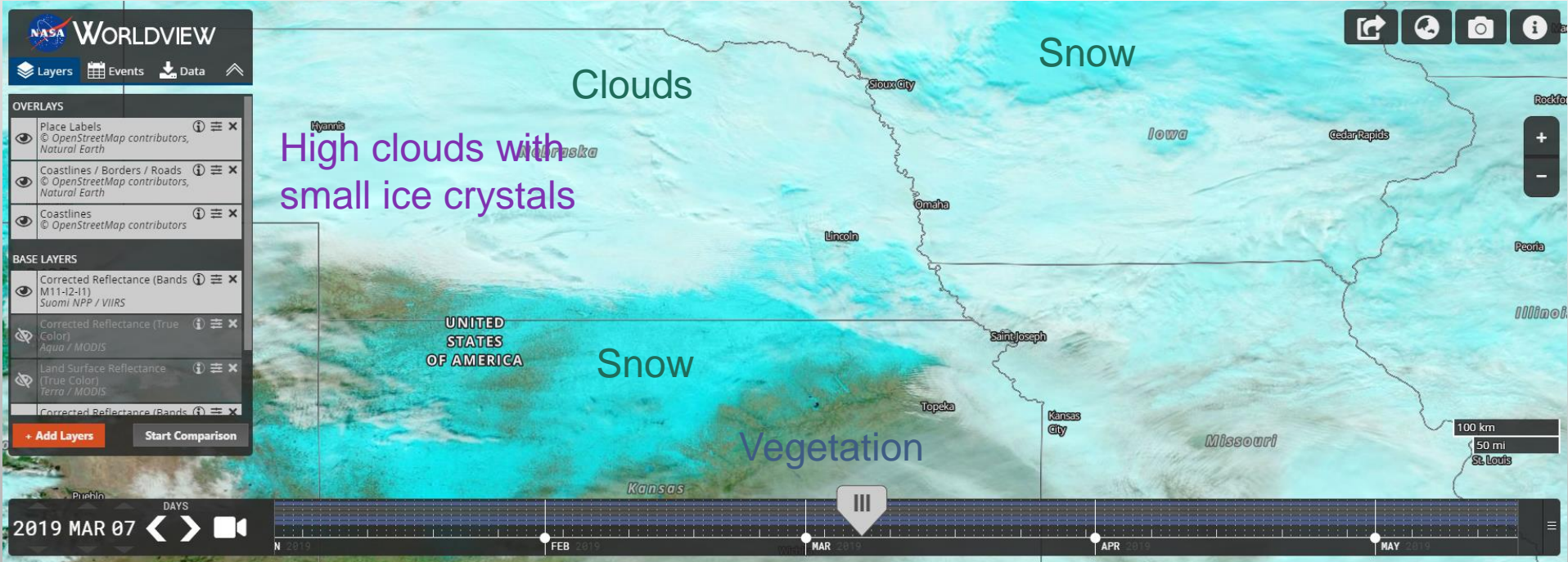




Suomi NPP-VIIRS

False color Recipe
(Snow/Cloud)

- R: Blue (M3)
- G: Short Wave IR (I3)
- B: Short Wave (M11)

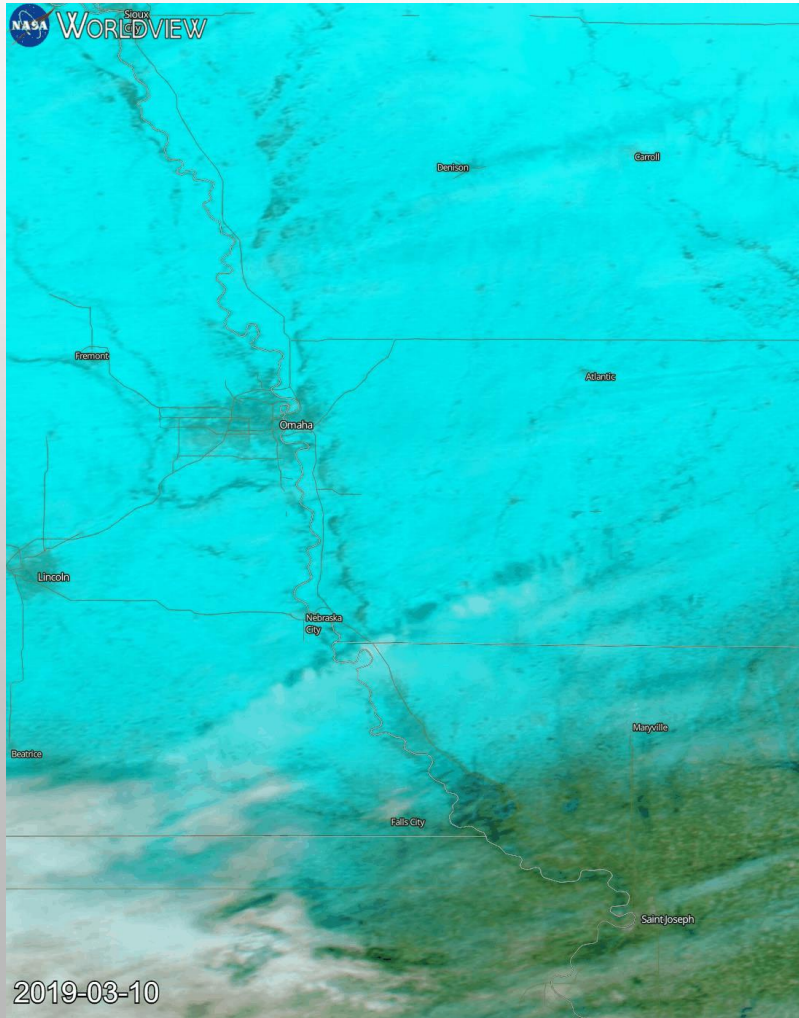


False Color Recipe
(Natural Color)

- R: Short Wave (M11)
- G: Near IR (I2)
- B: Red (I1)

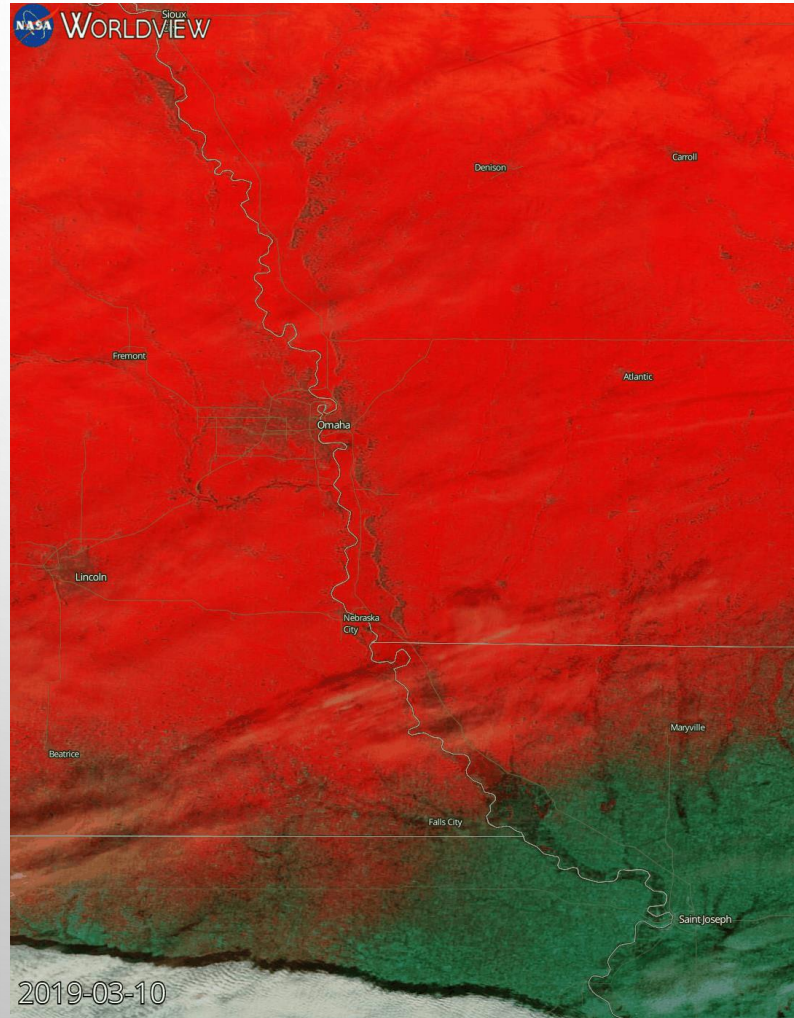
Aqua MODIS Corrected Reflectance

- Bands 7-2-1 (SWIR, NIR, Red)



Aqua MODIS Corrected Reflectance

- Bands 3-6-7 (Blue, SWIR, SWIR)



WATCH THE EVENT UNFOLD...

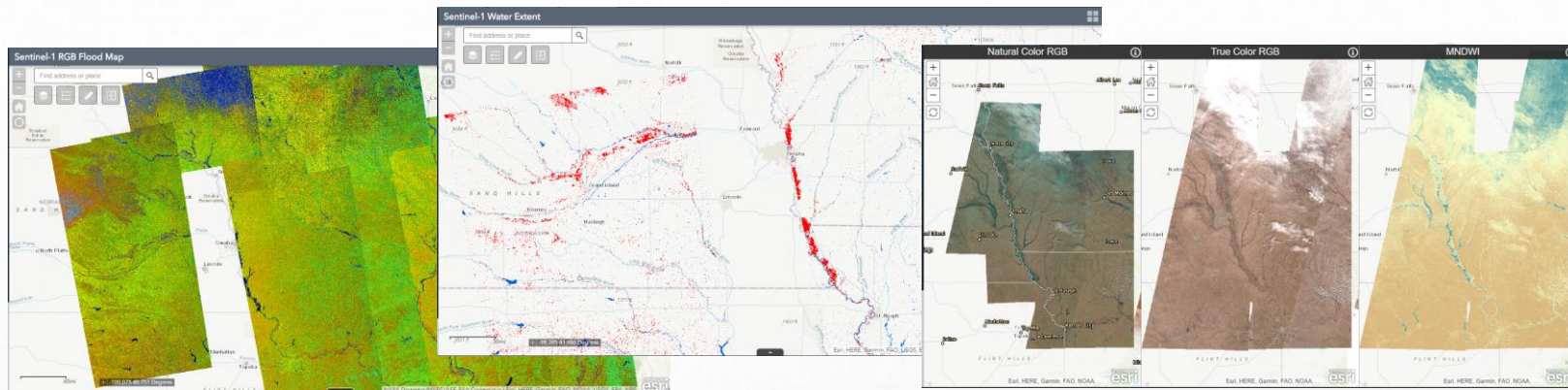
Animated gifs of both the Natural color and Snow/Cloud RGBs as seen in NASA Worldview (worldview.earthdata.nasa.gov)

Animations span from 10 – 30 March 2019 over the Missouri River region.

18 March 2019: FEMA Region VII sends an RFI to FEMA-HQ concerning ice jams and flooding in Iowa, Nebraska, Missouri and Illinois. This RFI was shared with FEMA partner agencies

13 March 2019: Heavy Snowfall hits the Midwest

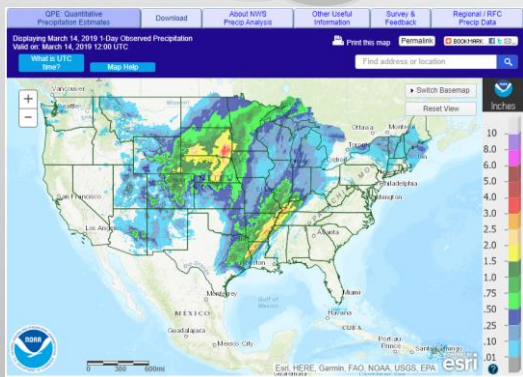
Interagency Coordination calls begin



NASA Disasters produced imagery products from Sentinel 1 A/B, Sentinel 2 and Landsat 8 as well as shared MODIS and VIIRS false color RGBs and MODIS flood detection maps from GSFC from early March to early April and then again from mid-May through early June

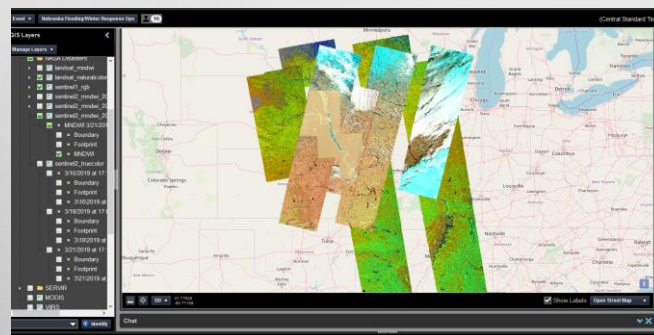
Early to Mid-March

Early to Mid-June

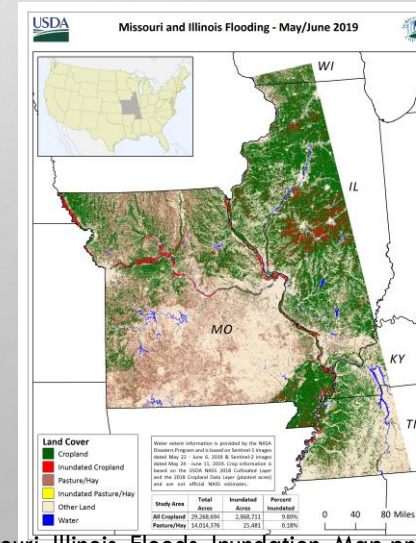
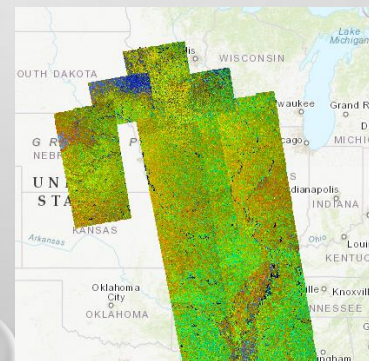


20 March 2019: All available layers provided to the NGB DAART system

26 March 2019: Coordinated with USDA National Agricultural Statistics Service (NASS) on the use of the geotiff and vector forms of the data for their in-house analyses. Provided by FTP download



Unseasonable warm weather and heavy rainfall caused rapid melting along the Missouri River from South Dakota south to Kansas City in the coming weeks

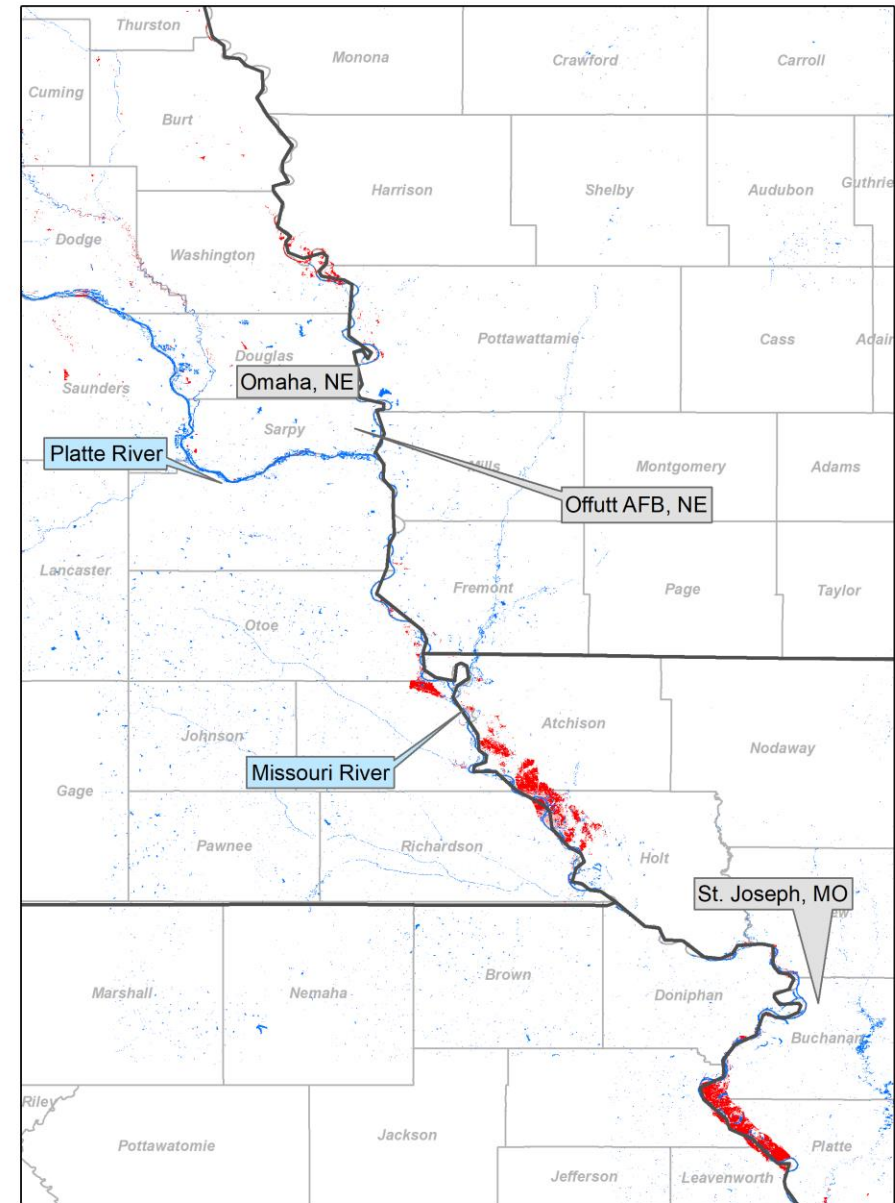


HOW BAD WAS IT?

Imagery produced or made available by the NASA Disasters team from Sentinel 1 A/B (in cooperation with the Alaska Satellite Facility), Sentinel 2A/B, Landsat 8, Aqua/Terra MODIS to multiple partners through the NASA Disasters mapping portal (<https://arcg.is/OTWjqK>)



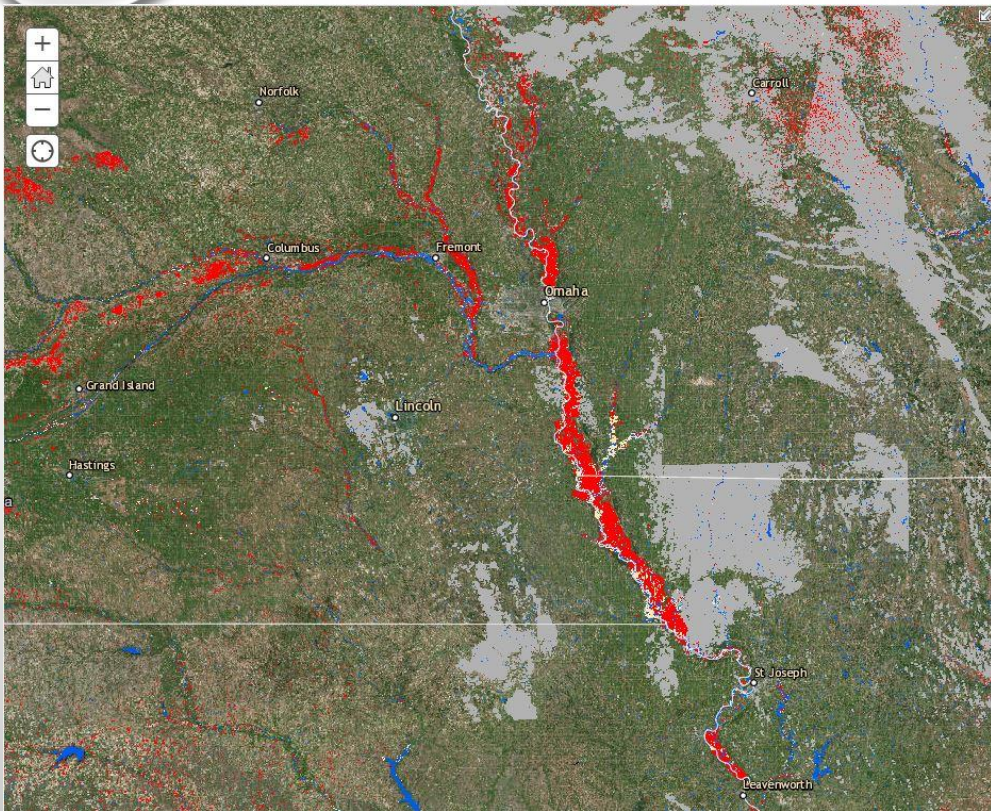
26 March 2019



[MSFC, ASF DAAC](#) 2019, contains modified [Copernicus](#) Sentinel data 2019

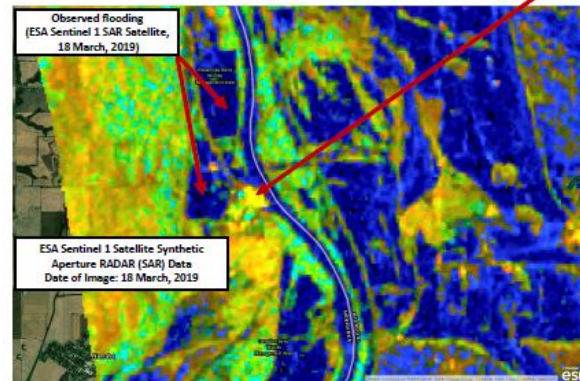
MSFC 2019, Sentinel-2 (ESA) data courtesy of the U.S. Geological Survey and contains modified Copernicus Sentinel data 2019

ASF DAAC 2019, contains modified Copernicus Sentinel data 2019



Sentinel-1A/B Red-Green-Blue False Color Product, Midwest Flooding, Nebraska, 18 March 2019

Cooper Nuclear Power Station



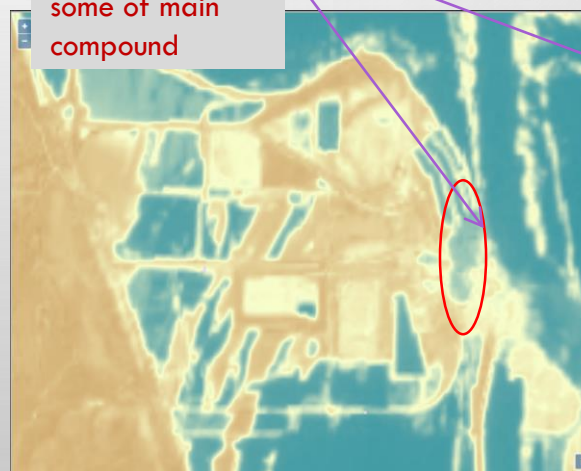
Sentinel 1 RGB (above) and Sentinel 2 mNDWI imagery used by the Kansas Air National Guard's Processing, Assessment and Dissemination (PAD) unit in support of the State of Nebraska

“Because of the magnitude and extent of the Spring 2019 Floods, NASS was able to **successfully utilize NASA Disaster Program’s web services and water extent products** to provide quantitative and qualitative data products for a near real-time response at the request of the NASS Nebraska Regional Field Office as well as the NASS Agricultural Statistics Board in preparation for the March Prospective Plantings Report.”

Rick Mueller, USDA NASS

Cooper Power Plant

River breached here, flooding some of main compound



SOURCE: NASA Sentinel2 21/03/2019

SOURCE: GE 07/2018

MSFC 2019, Sentinel-2 (ESA) data courtesy of the U.S. Geological Survey and contains modified [Copernicus](#) Sentinel data 2019



SOURCE: GE
(4 Jun 2018)

ANALYST COMMENT: Flooded image is from 16MAR2019. The following slide shows 5 days later.

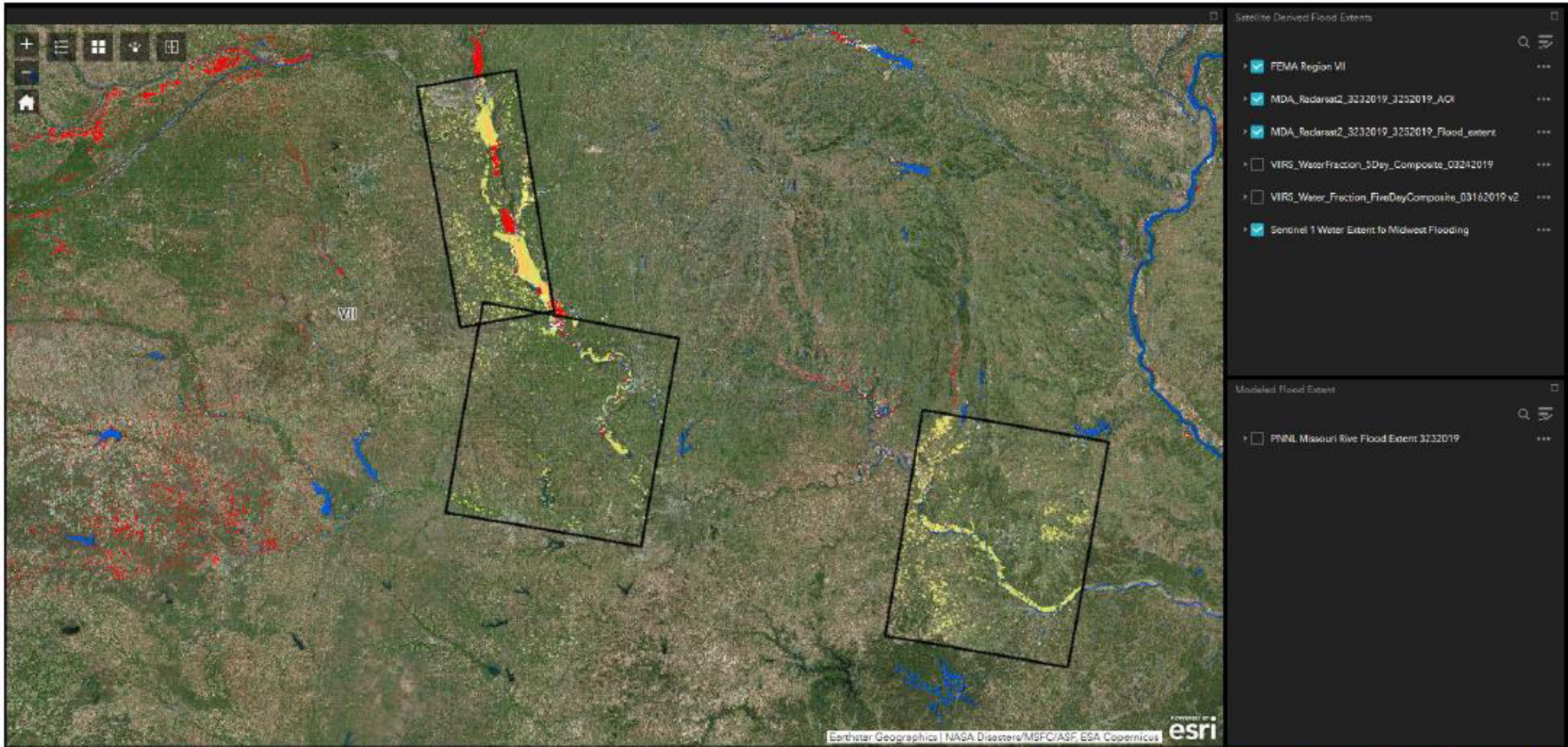


ANALYST COMMENT:
The waters are beginning to recede in this image; the road begins to reappear and the grounds around the facility are showing again.



SOURCE: DAART

Satellite and Modeled Flood Extents Dashboard



Pacific Northwest National Laboratory (PNNL)

<https://apps.pnnl.gov/portal/home/webmap/viewer.html?webmap=ac691715c08b4ee3b196f20fe7575140>

<http://fema.maps.arcgis.com/apps/webappviewer/index.html?id=dfef88a4b3d14f4288795312bde7366c>

LESSONS LEARNED AND CONCLUSIONS

- LARGE SCALE EVENT OVER A LONG PERIOD OF TIME MADE THE USE OF SATELLITE IMAGERY AND DERIVED PRODUCTS (10-30 M) A COMPLEMENTARY OPTION TO CAP AND AIRCRAFT DAMAGE SURVEYS
 - MOST SEVERELY DAMAGED AREAS WILL ALWAYS REQUIRE HIGH-RES OR GROUND SURVEYS BUT MEDIUM RESOLUTION SATELLITE DATA CAN OFFER A LARGE SCALE VIEW
- SATELLITE AGNOSTIC APPROACH ALLOWED FOR GREATER SPATIAL COVERAGE AND QUICKER REPEAT TIMES
- TRAINING AND FEEDBACK IS IMPERATIVE TO ENSURE THE PRODUCTS ARE BEING USED CORRECTLY AND MEETING THE EXPECTATIONS OF EACH USER
 - ONE USER'S FLOOD IS ANOTHER USERS' NOISE
 - USERS WILL HAVE A WIDE RANGE OF SKILLS
- NEAR-REAL-TIME IMAGERY IS REQUIRED BY ALL BUT GIS FORMATS REQUIRED BY USERS VARY GREATLY
 - BE PREPARED TO ADJUST ON THE FLY

THANK YOU!

- MSFC DISASTER EVENT COORDINATOR
 - LORI SCHULTZ: LORI.A.SCHULTZ@NASA.GOV
- MSFC DISASTERS LEAD:
 - ANDREW MOLTHAN: ANDREW.MOLTHAN@NASA.GOV
- NASA DISASTERS WEB MAPPING PORTAL/ GIS LEAD:
 - JEREMY KIRKENDALL: JEREMEY.J.KIRKENDALL@NASA.GOV
- NASA EARTH SCIENCE DISASTERS PROGRAM MANAGER:
 - DAVID GREEN: DAVID.S.GREEN@NASA.GOV