Pakistan floods 2024: Evaluating crop production losses

Floods in Pakistan

- Sindh river/Sindh province
- Disastrous floods in 2010, 2011, 2022
- Affects crop production

Rise in temperature → Glacial Himalayan melting during summer → Monsoon rainfall season (June-September)

Methods used in paper

- Reference paper: Qamer, F.M., Abbas, S., Ahmad, B. et al. A framework for multi-sensor satellite data to evaluate crop production losses: the case study of 2022 Pakistan floods. Sci Rep 13, 4240 (2023)

SAR

- Sentinel-1
- Synthetic Aperture Radar
- Observes through cloud cover
- Water appears very dark

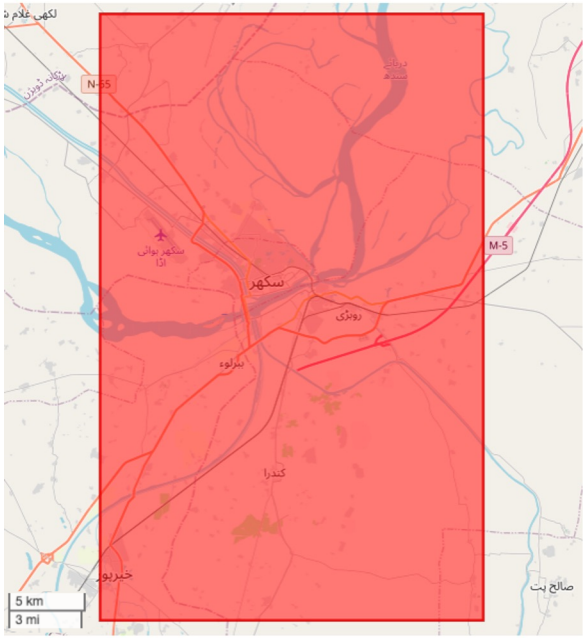
Optical

- Sentinel-2
- NIR and Red optical bands
- Crop health - NDVI
- Frequent revisit

Our goal

- Replicate the analysis for 2024, a year with flooding
- Compare flood extent and crop damages between both years
- Analyse biomass greenness tendencies
- Reflect on their causes/consequences

Area of interest



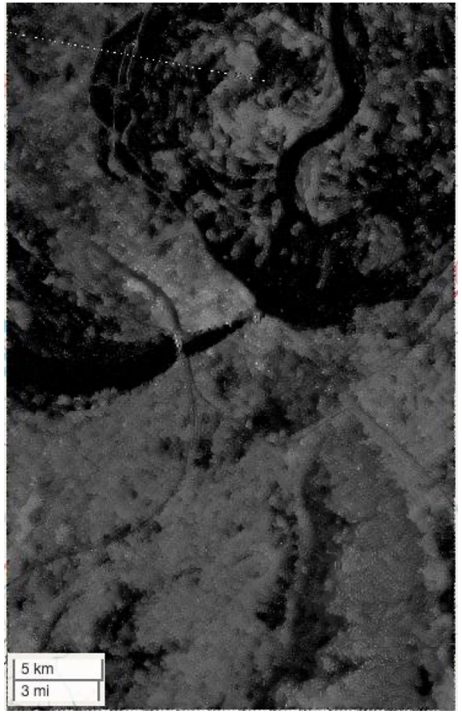
The area of interest in Sindh province was reduced from [[[67,27],[69, 27],[69, 28],[67,28]]] to [[[68.75, 27.5], [69, 27.5], [69, 27.85], [68.75, 27.85]]], due to insufficient RAM memory of our laptops for the post-processing of SAR data.

SAR – UN / LEE filter to remove image speckle

Before UN filter (2022)

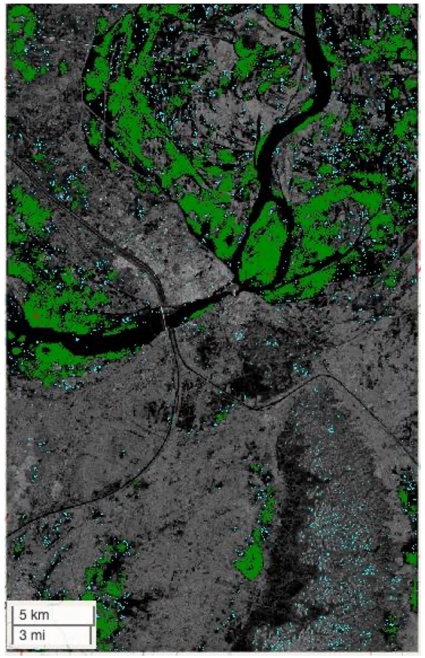
After UN filter (2022)

After LEE filter (2022)

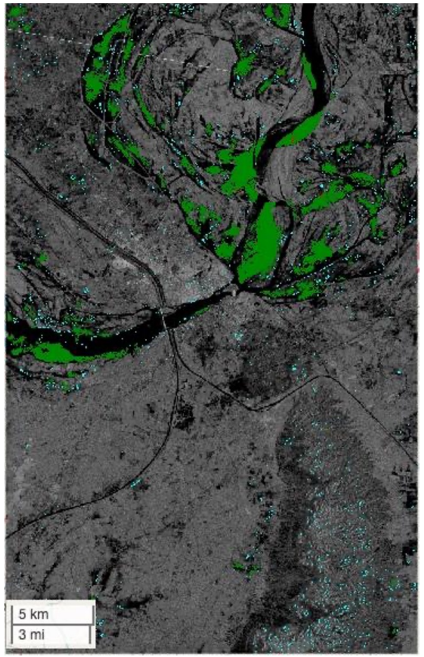


SAR Flooded zone (LEE filter)

2022



149 km²



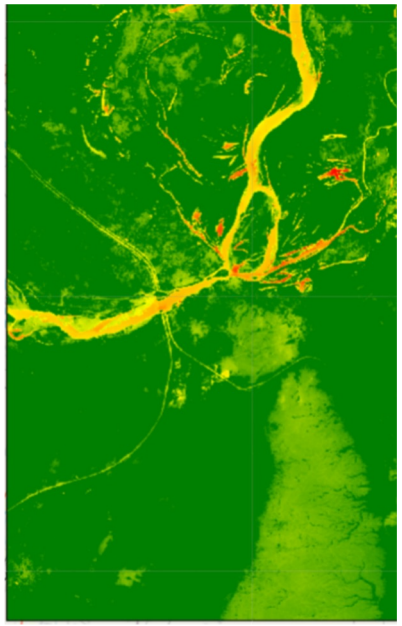
86 km²

2024

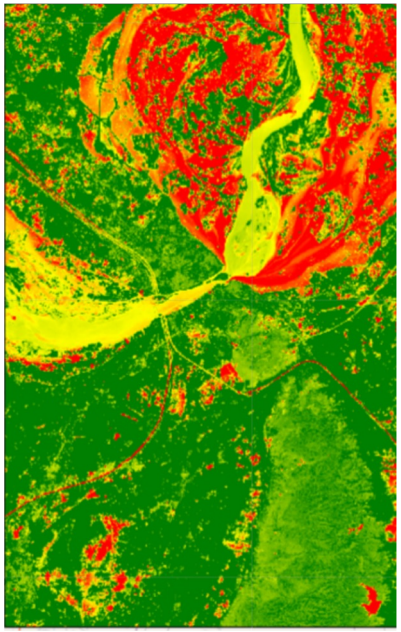
Flood legend:
Blue = without permanent water bodies.
Red = without isolated pixels and permanent water bodies.
Green = final flood zone
= without slope and isolated pixels and permanent water bodies.

NDVI values

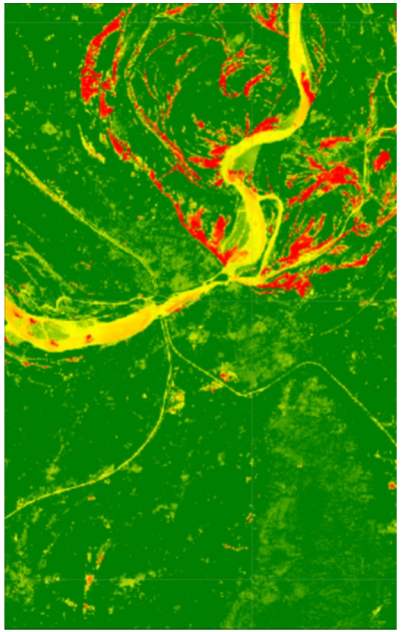
2021



2022



2024

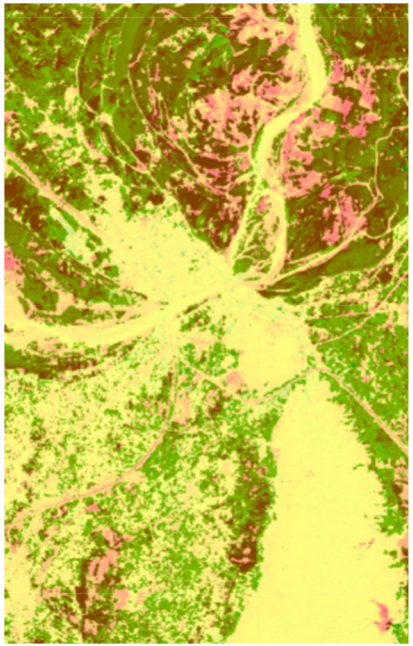


NDVI legend:

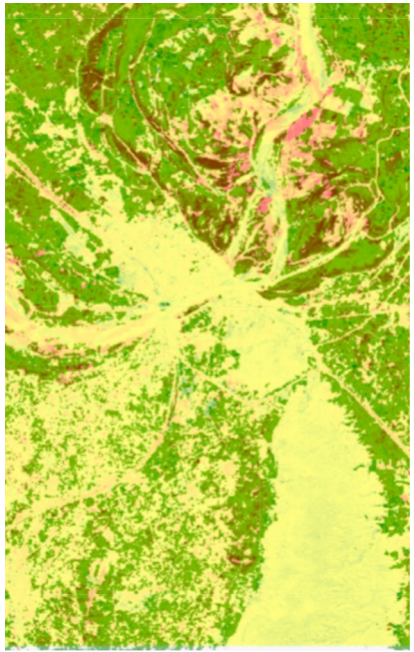
Red = Very bad vegetation health
Yellow = Moderate vegetation health
Green = High vegetation health

Delta NDVI compared to 2021

2021 - 2022



2021 - 2024



NDVI legend:

Red = Negative Delta NDVI

Green = ESA cropland mask

5 km
3 mi

Impacted crop areas: 2022 and 2024

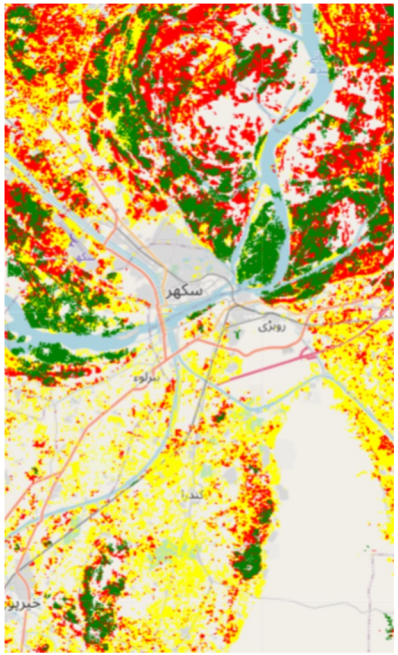
- Delta NDVI layer (less than -0.2, considered “moderate damage” in paper)
- ESA Cropland Mask

- Total affected area with moderate, severe or very severe crop damage in 2022: 231,68 km²
- Total affected area with moderate, severe or very severe crop damage in 2024: 71,64 km²

⇨ Less cropland area damaged in 2024

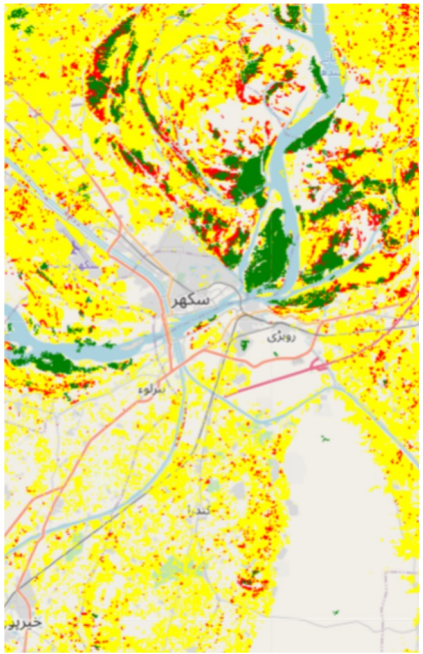
Overlap of damaged cropland and flood extent

2022



100 km²

2024



32 km²

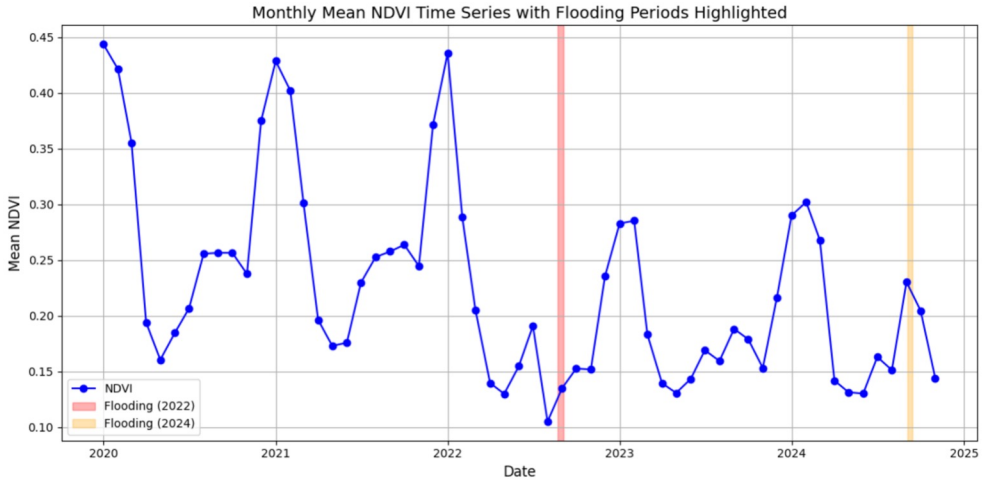
NDVI legend:

Red = Negative Delta NDVI

Green = Flooded area

Discussion

- 2022 more severe in terms of flooding and crop damage
- Damaged crop area because of flooding?
- Increase in mean NDVI for summer and decrease for winter since 2022
- Plant adaptation, climate change, change in vegetation species…



Conclusion

- SAR and optical satellite data are useful for flooding observations
- 2024 flood had less impact than 2022
  - Flood extent
  - Damaged crops
  - Crops damaged by floods
- Increase in biomass greenness means less crop losses

- Future scope:
  - Continuous studying of the region
  - Compare with rainfall data
  - Study base on another index such as NDWI (Normalized Difference Water Index)
  - Impact on population analysis

SAR Flooded zone (UN method)

2022

Legend

- potentially flooded areas
- affected cropland
- affected urban

Results

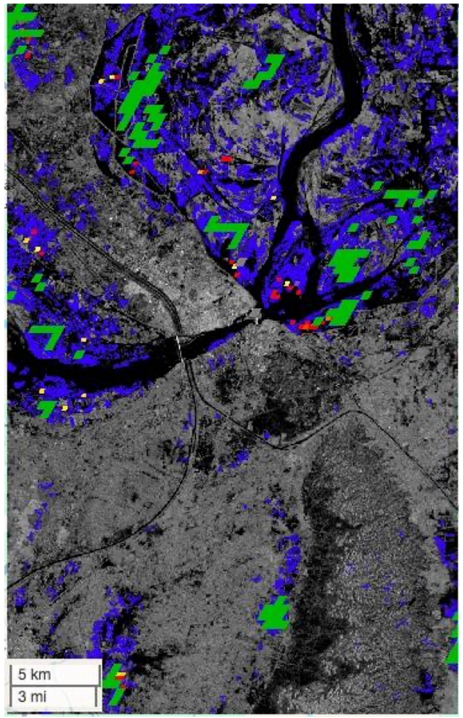
Flood status between:
2022-08-22 and 2022-09-03

Estimated flood extent:
based on Senintel-1 imagery from 2022-08-25 to 2022-08-30
12573 hectares

Estimated number of exposed people:
based on GHSL 2015 (250m)
33633

Estimated affected cropland:
based on MODIS Land Cover 2020 (500m)
2667 hectares

Estimated affected urban areas:
based on MODIS Land Cover 2020 (500m)
324 hectares



Exposed population density

> 200

0

2024

Results

Flood status between:
2024-08-22 and 2024-09-03

Estimated flood extent:
based on Senintel-1 imagery from 2024-08-26 to 2024-08-31
8826 hectares

Estimated number of exposed people:
based on GHSL 2015 (250m)
19527

Estimated affected cropland:
based on MODIS Land Cover 2020 (500m)
75 hectares

Estimated affected urban areas:
based on MODIS Land Cover 2020 (500m)
0 hectares