

# Multi-Region SAR-Based Assessment of Monsoon Flood Vulnerability in Layyah, Dadu & Nowshera

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## I. Rationale for Selecting Layyah, Dadu & Nowshera for Flood Mapping

These three districts were selected due to their **historical flood exposure**, **strategic geographic spread**, and **clear flood signatures visible in satellite data**. Each lies in a different province; Punjab, Sindh, and Khyber Pakhtunkhwa, offering a diverse yet representative snapshot of monsoon-driven flood vulnerability in Pakistan.

- **Layyah:** Located along the Indus River, it is frequently cited in NDMA reports for flood risk from river overflow and irrigation canal breaches.
- **Dadu:** Severely impacted by the 2022 super floods, with over 70% of its landmass submerged at the peak.
- **Nowshera:** Situated near the Kabul River, it experiences recurring riverine flooding, compounded by urban expansion and deforestation in surrounding hills.

### Sources:

NDMA Hazard Profile Maps (2023):

<https://www.ndma.gov.pk/public/storage/plans/July2024/VdJWG822N7jzkEXKUyh.pdf>

- UNDP Flood Reports 2022: <https://www.undp.org/pakistan/publications/pakistan-floods-2022-post-disaster-needs-assessment-pdna#:~:text=October%2028%2C%202022&text=The%20assessment%20estimates%20total%20damages,reach%20about%20USD%2015.2%20billion.>
- Food and Agriculture of the United Nations: <https://openknowledge.fao.org/items/06212376-f2cb-474f-8eb9-f8d44710d956>

## II. July 2022 Flood Risk Mapping Insights (Based on Sentinel-1 Imagery)

### Layyah (Punjab)

Moderate-to-high reflectance zones in satellite imagery indicate **riverine flooding** along the Indus belt. The NDMA classifies Layyah as a high-risk flood district. Poor canal maintenance and heavy monsoon runoff aggravate flood intensity.

#### Vulnerability Factors:

- Close proximity to the Indus River.
- Poorly managed irrigation infrastructure.

#### Citation:

- Flood Vulnerability in Layyah – Research Study 2024: [https://www.researchgate.net/figure/Flood-risk-management-in-district-Layyah\\_fig5\\_351831050](https://www.researchgate.net/figure/Flood-risk-management-in-district-Layyah_fig5_351831050)

### Dadu (Sindh)

Deep blue tones in satellite imagery reveal extensive **standing water** and **permanent inundation patterns**. This aligns with reports from 2022 floods, where millions were displaced and infrastructure collapsed.

#### Vulnerability Factors:

- Flat terrain with low drainage gradient.
- Lack of embankments and emergency drainage.

#### Citations:

- NDMA – August 2022: <https://ndma.gov.pk/storage/sitreps/August2022/aXFevH00srm2F8xM9LHL.pdf>

- Relief web:

<https://reliefweb.int/map/pakistan/flood-waters-between-cities-dadu-hyderabad-sindh-province-pakistan-19-aug-2010>

### **Nowshera (Khyber Pakhtunkhwa)**

Water extent imagery shows high reflectance along the **Kabul River floodplain**. Flooding extended into both urban and peri-urban zones. Flash floods from hilly areas add to the riverine flood burden.

### **Vulnerability Factors:**

- Dual flood exposure from Kabul and Swat rivers. Poor early warning and drainage infrastructure.

### **Citation:**

- Relief Web 2022 KPK Flood Report:  
<https://reliefweb.int/report/pakistan/revised-pakistan-2022-floods-response-plan-final-report-issued-15-dec-2023>

## **III. Flood Change Detection Analysis (2014–2025)**

Using Sentinel-1 SAR-based flood change detection, long-term trends of flood extent were assessed. The maps compare **2014 vs 2025** surface water presence, offering insight into flood evolution patterns, persistent risks, and emerging flood-prone zones.

### **Layyah**

**Change Observed:** Moderate increase in surface water coverage in southern Layyah.

**Interpretation:** Likely due to changing rainfall patterns, irrigation-induced breaches, and intensified monsoon cycles.

### **Backed By:**

- PIDE Monsoon Impact Analysis 2023: <https://file.pide.org.pk/pdfpdr/2023/605-616.pdf>
- NDMA Annual Monsoon Report: [https://www.ndma.gov.pk/publication\\_by\\_category/2](https://www.ndma.gov.pk/publication_by_category/2)

### **Dadu**

**Change Observed:** Significant surface water increase between 2014 and 2025. Persistently flooded zones in 2022 remain prominent in 2025.

**Interpretation:** Indicates poor post-flood drainage rehabilitation and rising groundwater table due to prolonged standing water.

**Backed By:** Sindh Flood Resilience Assessment: <https://sferp.gos.pk/>

ReliefWeb Satellite Analytics: <https://reliefweb.int/report/pakistan/pakistan-emergency-situation-analysis-district-dadu-february-2015>

## Nowshera

**Change Observed:** Expanded floodplain activity over the years; visible lateral spread along Kabul River basin.

**Interpretation:** Suggests increased upstream rainfall and higher frequency of flash floods in hilly catchments.

**Backed By:**

- KPK River Basin Risk Report: [https://pcrwr.gov.pk/wp-content/uploads/2023/08/Final-Report-Groundwater-Study-in-Khyber-Pakhtunkhwa-Peshawar-Valley\\_2019.pdf](https://pcrwr.gov.pk/wp-content/uploads/2023/08/Final-Report-Groundwater-Study-in-Khyber-Pakhtunkhwa-Peshawar-Valley_2019.pdf)
- WWA Pakistan Flood Attribution: <https://www.worldweatherattribution.org/wp-content/uploads/Pakistan-floods-scientific-report.pdf>

## Final Takeaways

- **Layyah:** Shows increasing vulnerability with consistent monsoon flooding patterns.
- **Dadu:** Remains the most critical zone, with severe change detection signals and high humanitarian risk.
- **Nowshera:** Reflects growing riverine pressure and urban flood exposure.

## IV. Visual Appendix

- July 2022 Flood Risk Mapping Insights (Based on Sentinel-1 Imagery)  
[https://drive.google.com/file/d/1aPcsT4ADIkSwwHuKXRb\\_Xnl325S9ErVh/view?usp=sharing](https://drive.google.com/file/d/1aPcsT4ADIkSwwHuKXRb_Xnl325S9ErVh/view?usp=sharing)

- Flood Change Detection Analysis (2014–2025)  
[https://drive.google.com/file/d/1djpQBSpImuYsh942S\\_HkZgAVgMMoTTtq/view?usp=sharing](https://drive.google.com/file/d/1djpQBSpImuYsh942S_HkZgAVgMMoTTtq/view?usp=sharing)