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Conflict and agricultural resilience in Afghanistan's river basins: A remote sensing assessment of irrigated cropland dynamics (2001–2024)

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Abstract

Armed conflict is often assumed to uniformly disrupt agricultural systems, yet empirical evidence on how violence interacts with hydrological variability and institutional conditions to shape irrigated cropland dynamics remains limited. This study examines irrigated cropland change across Afghanistan's major river basins from 2001 to 2024, a period encompassing prolonged insurgency, political transitions, and recurrent drought, to assess how conflict intensity influences agricultural land use.

A multiscale analytical framework is applied at basin and sub-basin levels, integrating geospatial and statistical datasets. Annual irrigated cropland estimates are derived from the USGS FEWS NET eMODIS NDVI irrigated area product (250 m resolution), while long-term cropland dynamics are assessed using the GLAD Landsat-based cropland dataset (30 m resolution). Conflict data from the Uppsala Conflict Data Program (UCDP) Georeferenced Event Dataset are aggregated annually at basin and sub-basin scales through GIS-based spatial overlay analysis. Spatial processing is conducted in QGIS, and statistical analysis in R.

Results reveal substantial spatial heterogeneity in the conflict–cropland relationship, with no uniform national pattern. The Helmand and Kabul basins experienced the largest reductions in irrigated area, linked to high-intensity conflict and declining surface-water availability during drought periods. In contrast, parts of the Helmand sub-basins show increases in irrigated cropland during peak violence years, likely reflecting adaptive groundwater use and locally embedded water governance. The Northern Basin exhibits a positive association between conflict intensity and irrigated area, supported by relatively stable surface-water resources, while the Amu Darya basin shows partial recovery after 2021, indicating localised post-conflict resilience.

Overall, the findings demonstrate that agricultural resilience under conflict is associated not just with conflict intensity alone but also by basin-specific hydrological conditions, institutional arrangements, and strategic responses taken by local governments. The study highlights the value of integrating multi-source remote sensing and conflict datasets in monitoring agricultural land-use change in data-scarce, fragile environments. This example of multi-source data analysis provides evidence for context-specific resilient agricultural planning.

Keywords: Agricultural resilience, irrigated cropland, land-use change, military conflict, remote sensing

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