

Background

Social vulnerability is characterized by social, political, and economic factors that make certain populations more vulnerable to hazards than others (Burton, Rufat, and Tate 2019). Reducing vulnerability requires understanding the socioeconomic and political perspectives prior to addressing risk and vulnerability (Chen et al. 2013). Floods are a recurring phenomenon in Pakistan, driven by heavy precipitation during the monsoon season. The flood of August 2022 submerged one-third of the country and disproportionately impacted the southern provinces (Nanditha et al. 2023).



Figure 1. Map of Pakistan

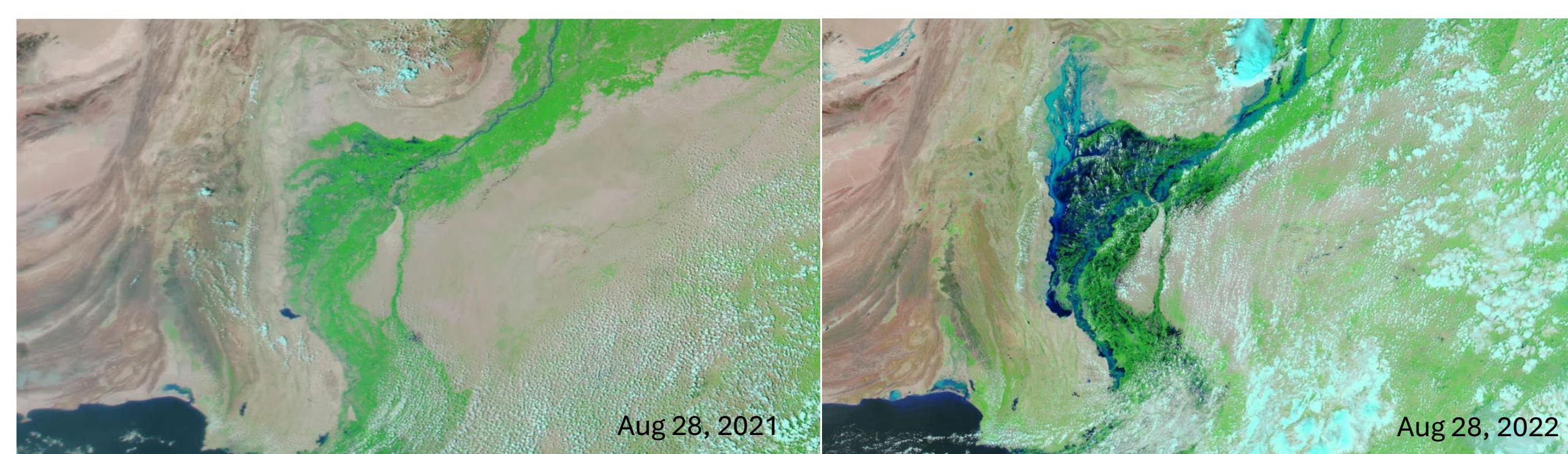


Figure 2. Sindh province, taken from NASA's MODIS satellite sensor. Source: NASA worldview

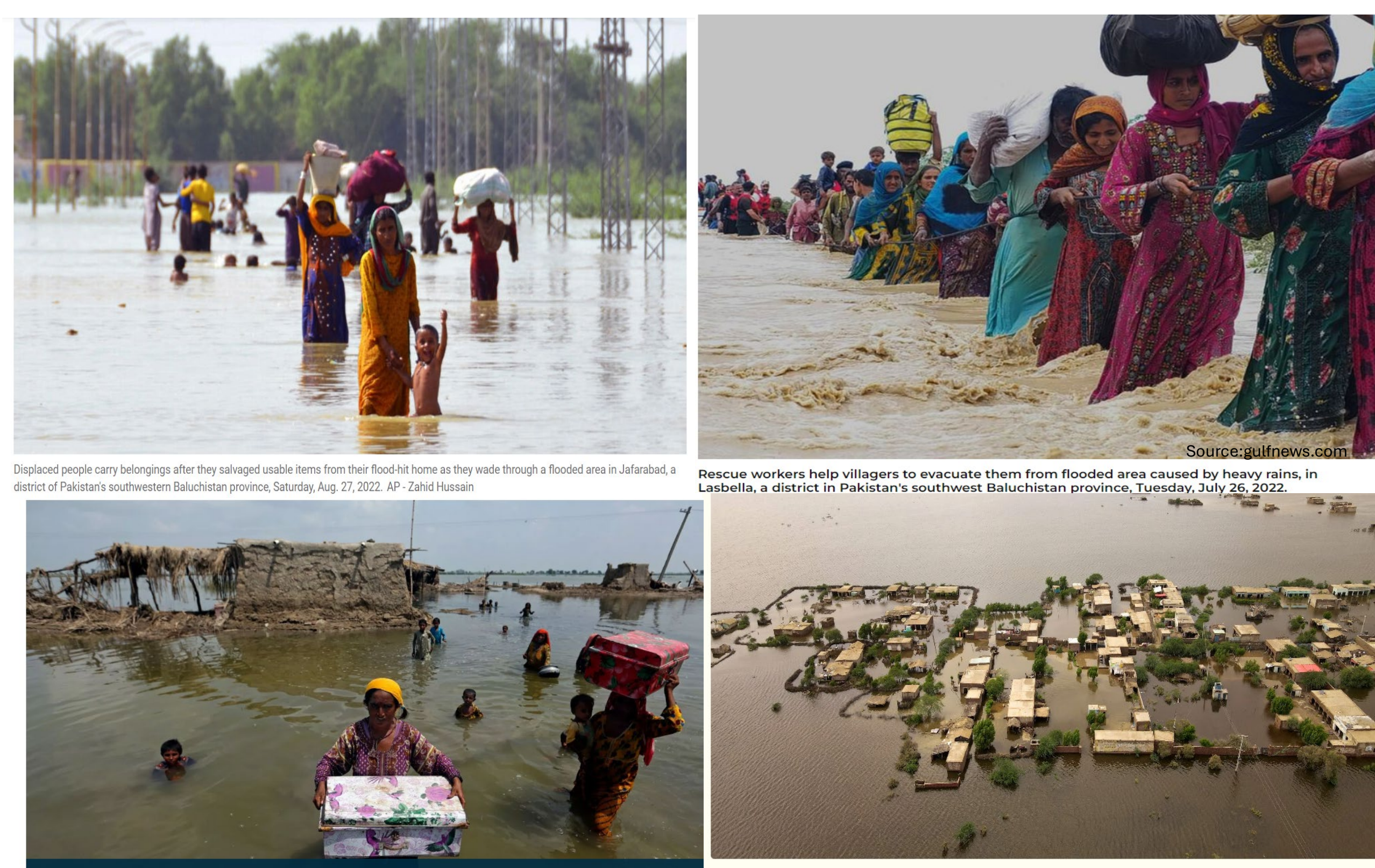


Figure 3. Pakistan floods 2022

Research questions

- How does social vulnerability vary across different districts in Pakistan?
- which districts are both highly exposed to flood risk and have a high level of social vulnerability?

Data and methods

Table 1. Selected indicators of social vulnerability

Indicator	Variable name
Population < 5 years (%)	QPOPUN5
Population ≥ 65 years (%)	QPOPAB65
Population density	POPDEN
Female (%)	QFEMALE
Female participation in the labor force (%)	QUNEMPLYD_F
Widowed & divorced female (%)	FEMALE WD
Illiterate people aged 15 & above (%)	QILLAB10
Minority population (%)	QMINORITY
Household with one person	QHHIP
Average household size	HHSIZE
Renters (%)	RENTEDH
Population unemployed (%)	QUNEMPLYD
Female unemployed (domestic workers) (%)	QUNEMPLYD_F
Disabled person (%)	QPOPDSB
Homeless	QHOMELSS
Households without piped water connection (%)	QDRNKWTR
Households without electricity (%)	QLIGHT
Population living in houses without gas fuel (%)	QFUEL
Population living in houses with low-quality external walls (%)	QWALLHOUS

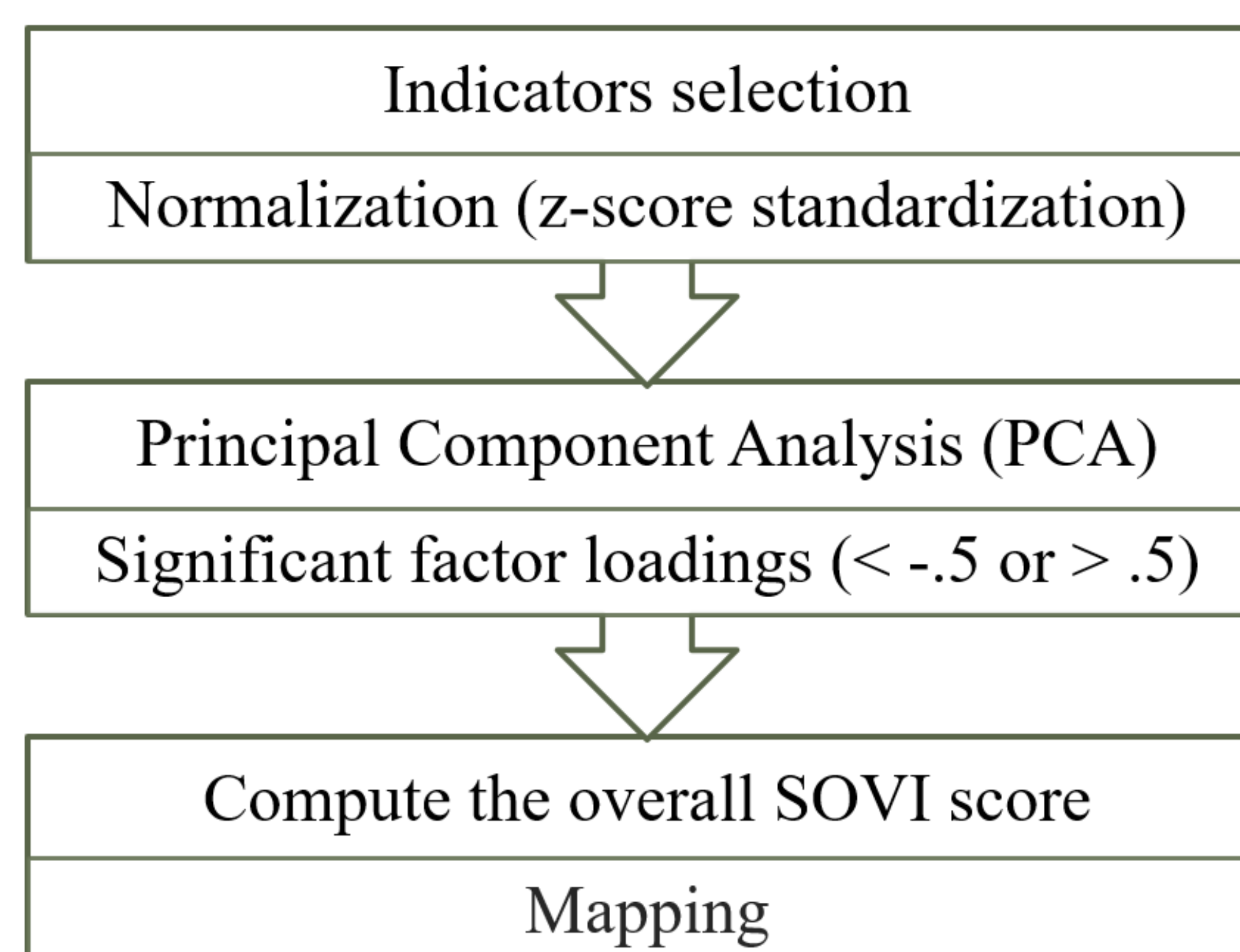


Figure 4. Flow chart of the methods

Results

Table 2. Social vulnerability component summary of Pakistan at the district level

Component	Name	Directionality	% Variance Explained	Dominant Variables	Component Loading
1	Socioeconomic Status	+	39.409	QPOPUN5	0.527
				POPDEN	-0.696
				QILLAB10	0.591
				QRENTEDH	-0.866
				QUNEMPLYD	0.527
				QUNEMPLYD_F	0.714
				QLIGHT	0.521
				QFUEL	0.831
				QPOPUN5	0.685
				QPOPAB65	-0.850
2	Employment and education	+	15.992	QFEMALE	-0.806
				FEMALE WD	-0.646
				QILLAB10	0.680
				QUNEMPLYD	0.595
				QPOPDSB	-0.709
				QLIGHT	0.607
				QWALLHOUS	0.719
				FEMALE WD	0.591
				QMINORITY	0.657
				HHSIZE	-0.871
3	Minority and Household Composition	+	10.778	QHHIP	0.819
				QHOMELSS	-0.866
4	Housing Conditions	+	5.981	QDRNKWTR	0.568
	Total Variance Explained		72.161		

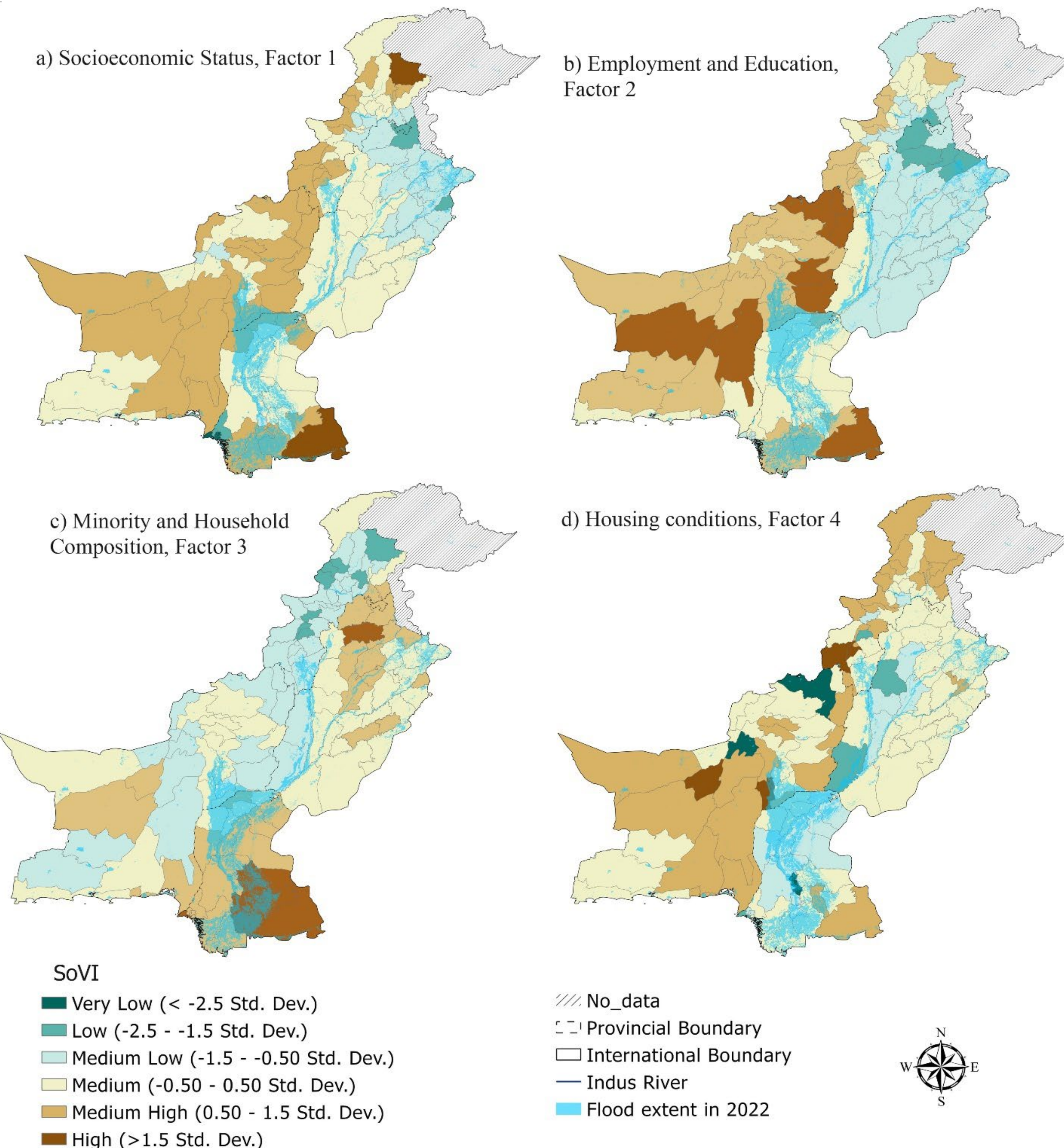


Figure 5. Maps of four principal components of social vulnerability and flood extent

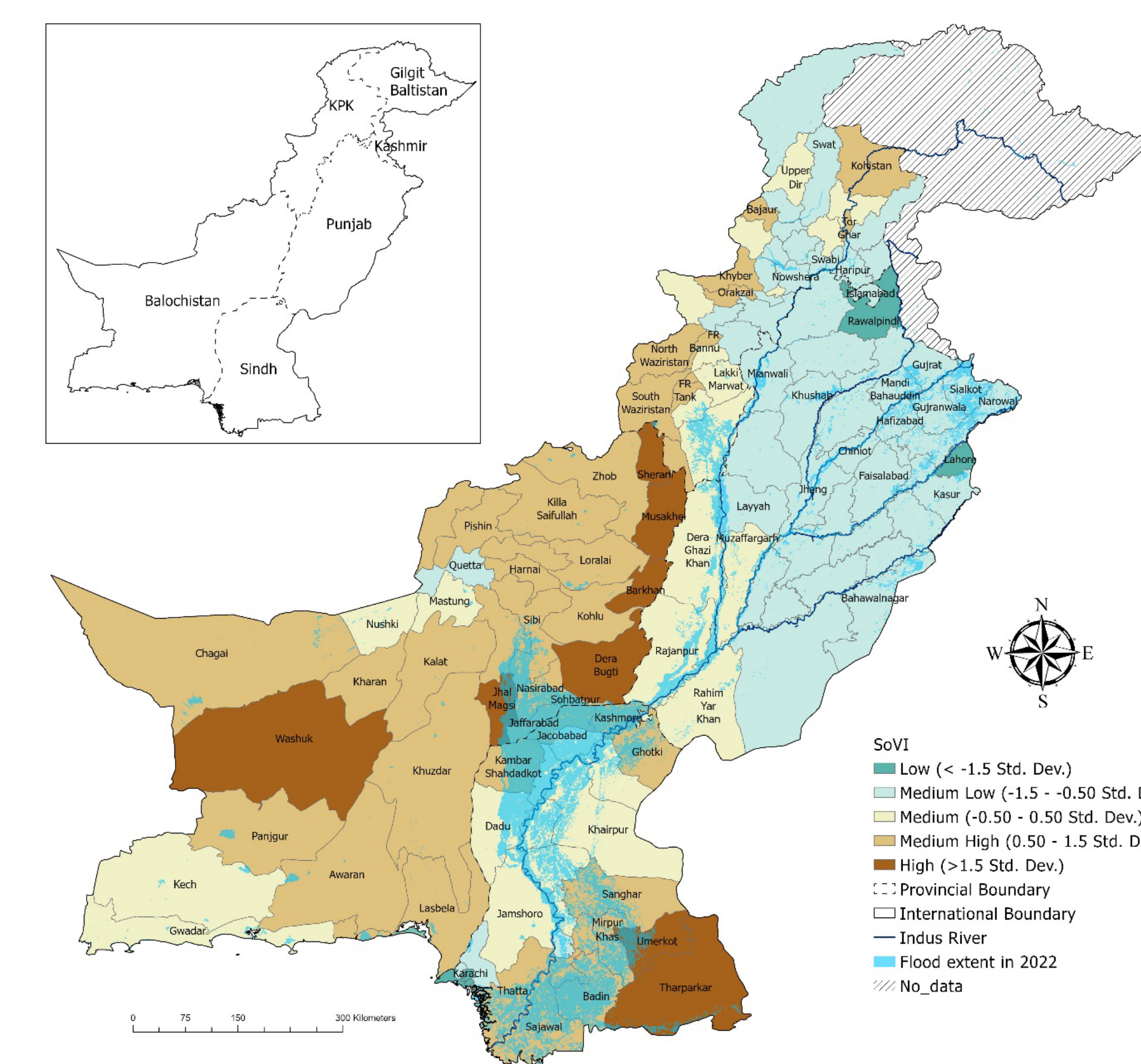


Figure 6. Spatial distribution of SoVI and flood extent map

Conclusion

Overall, the most vulnerable study units are located in the Southern region, in the Sindh and Baluchistan provinces. Our analysis also suggests the underlying causes of overall vulnerability in Pakistan are rooted in socio-economic disparities and housing conditions, providing a baseline for policymakers.

References

- Burton, Christopher G, Samuel Rufat, and Eric Tate. 2019. "Social Vulnerability: Conceptual Foundations and Geospatial Modeling." <https://doi.org/10.1017/9781316651148f>.
- Chen, Wenfang, Susan L. Cutter, Christopher T. Emrich, and Peijun Shi. 2013. "Measuring Social Vulnerability to Natural Hazards in the Yangtze River Delta Region, China." *International Journal of Disaster Risk Science* 4 (4): 169–81. <https://doi.org/10.1007/s13753-013-0018>
- Nanditha, J. S., Anuj Prakash Kushwaha, Rajesh Singh, Iqura Malik, Hiren Solanki, Divesh Singh Chuphal, Swarup Dangar, Shanti Shwarup Mahto, Urmin Vegad, and Vimal Mishra. 2023. "The Pakistan Flood of August 2022: Causes and Implications." *Earth's Future* 11 (3). <https://doi.org/10.1029/2022EF003230>.