



Emergency Investigation and Assessment 2022 Pakistan Flood

Investigation Briefing

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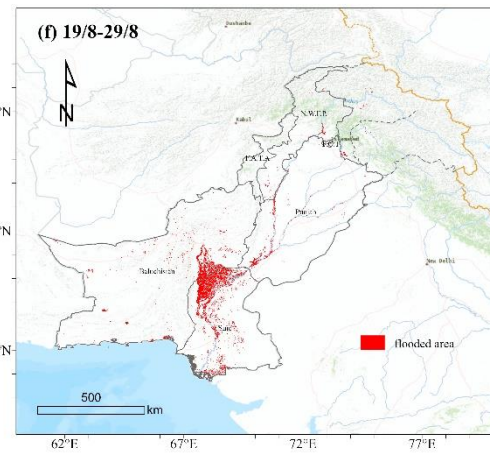
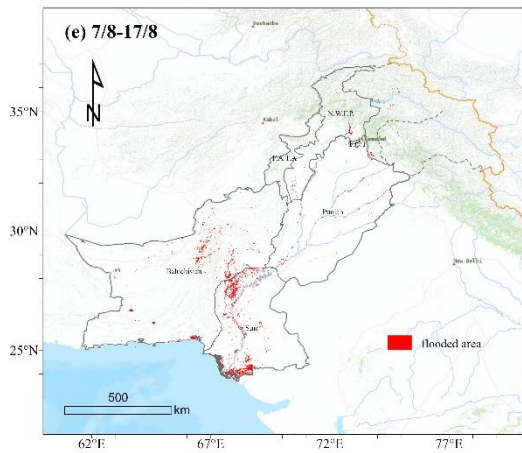
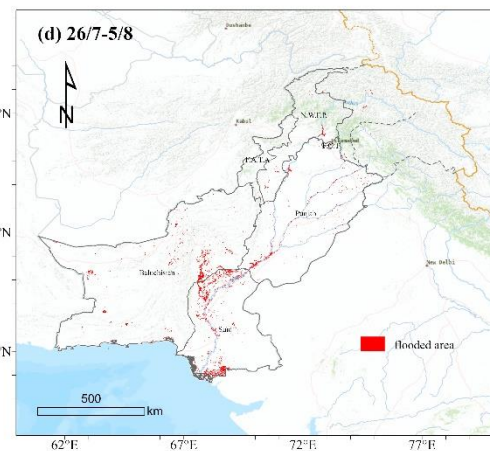
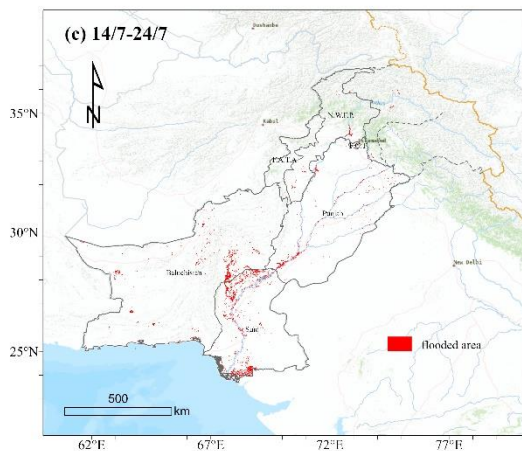
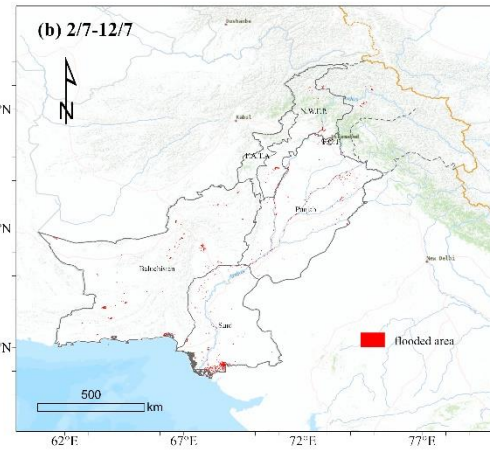
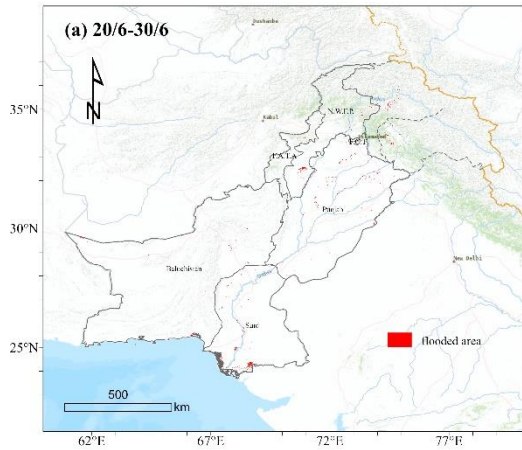
October 15, 2022

Dynamic Monitoring and Risk Assessment of the 2022 Monsoon Flood in Pakistan

As of October 12, this monsoon flood had led to 1717 casualties, 12,867 injuries and affected more than 33.04 million people across Pakistan. By using Sentinel-1A, High-resolution, Google and multi-period SAR images, the time series of flood coverage and inundation depth across the country were traced and the flood impact was analyzed. With those data, the dynamic assessment of the flood risk was carried out.

1. Flood Inundation Area

The growth series of flood inundation area from May to September 2022 (**Fig. 1**) showed that compared with early May, the inundation area growth reached the peak in late August (the growth area exceeded 28,500 km²), and the cumulative inundation area was close to 50,000 km² (**Fig. 2**). In September, the flood began to subside. Compared with that in late August, the inundated area in mid-to-late September was halved. From a regional perspective, the inundation areas were mainly located on the southern plains, both sides of the Indus River and parts of the western mountains. Based on time series analysis (**Fig. 2**), the flood-inundated area increased rapidly, from approximately 3,458 km² of the water area in late June to nearly 16,000 km² in mid-August. Then, the water area increased rapidly within 12 days and peaked at 29,348 km² at the end of August. Moreover, Sindh province is the most severely affected area, with 16,734.61 km² area flooded, accounting for 12 % of the province.



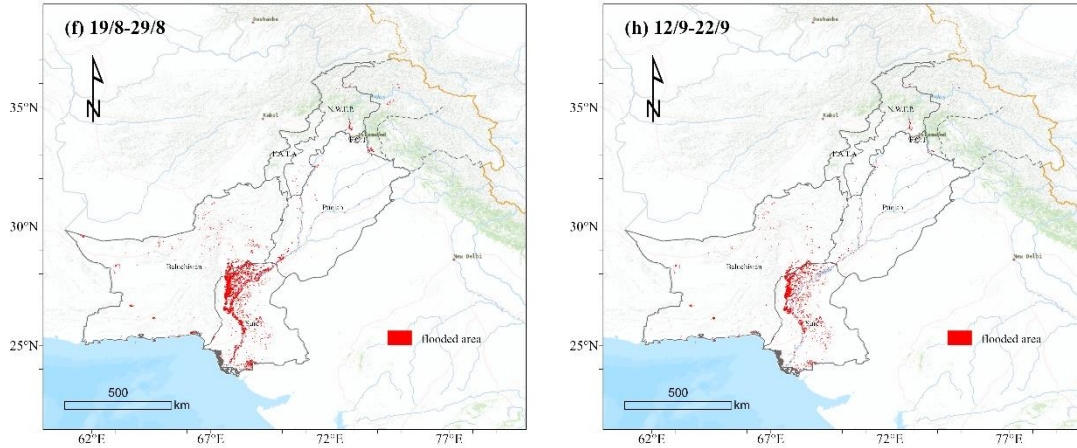


Figure 1. Change of flooded areas across Pakistan from June to September 2022

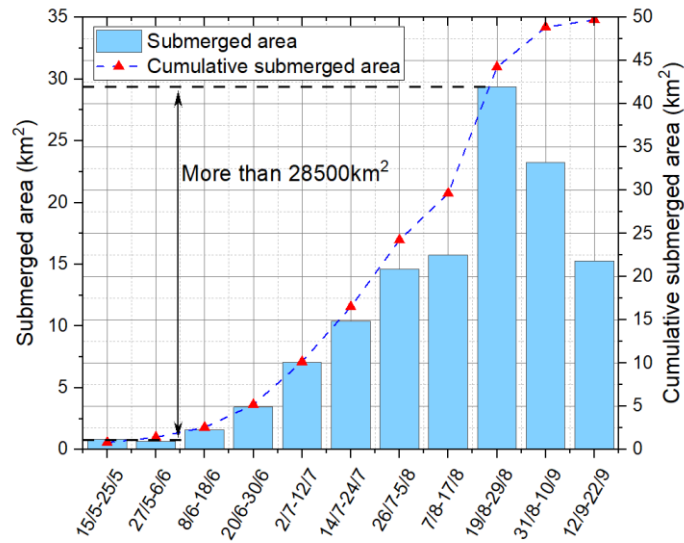


Figure 2. Cumulative flooded area in Pakistan from May to September

2. Flood impact on Buildings and Roads

As of September 22, the cumulative total flood-affected buildings area of Pakistan was 248.28 km², of which Baluchistan and Sindh provinces were most severely affected, with a total area of 97.41 km² and 146.05 km² respectively (**Fig. 3**). In the course of this flood, the flood-affected building area of the whole country showed exponential growth before late August, increasing from 14.43 km² to the peak of 168.50 km² in late August (increased by 154.07 km²) (**Fig. 4**). In September, the flood-affected building area began to decrease, and reduced to 31.11 km² in late September.

The flood has severely affected roads and transportation facilities. A total of 19,165 km of roads have been affected. The total affected roads in Baluchistan province is 1,635.11 km, in Punjab province is 1,627.75 km, and in Sindh province is 15,107.14 km (**Fig. 5**). From June to August, the total length of flood-affected roads across Pakistan showed exponential growth. It increased from 1,018.93 km in June to a peak of 11,383.74 km in late August (increase by 10,364.81 km), and the floods began to recede in September and the flood-affected roads decreased to 4,644.29 km in late September (**Fig. 6**).

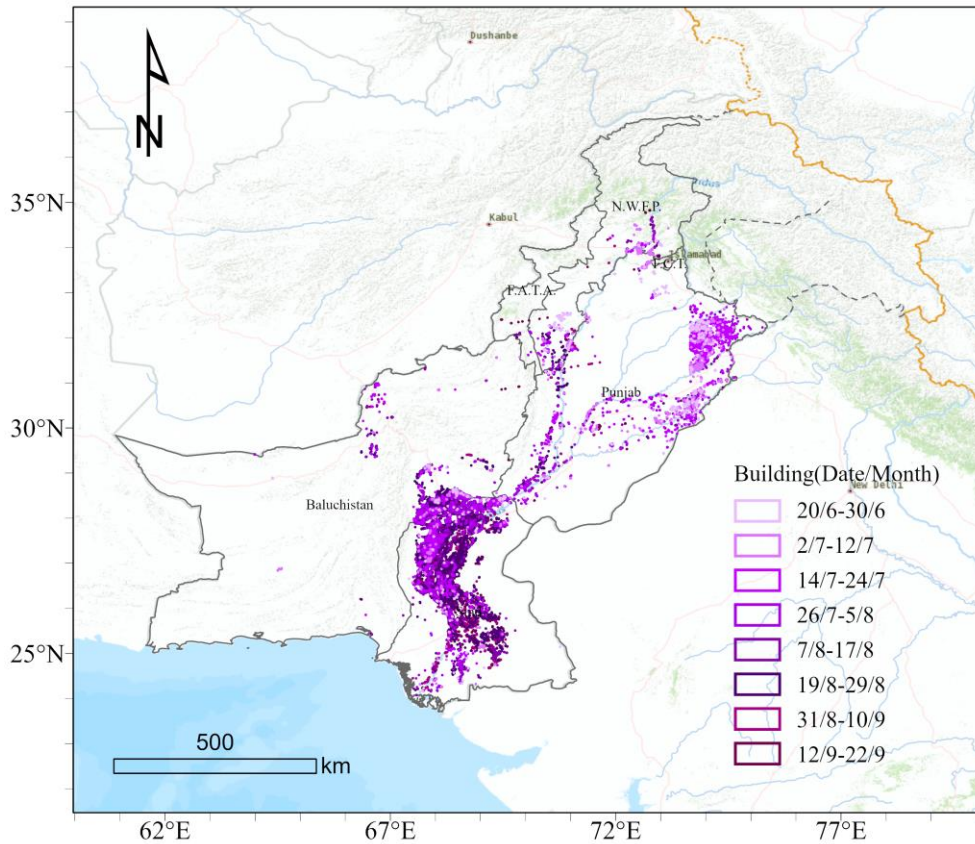


Figure 3. Distribution of flood-affected buildings in Pakistan from June to September

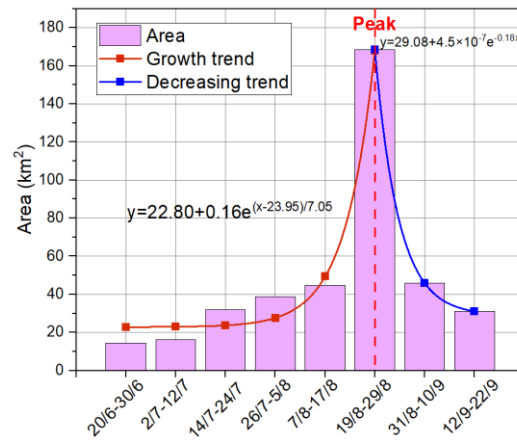


Figure 4. Area of inundated buildings in Pakistan from June to September

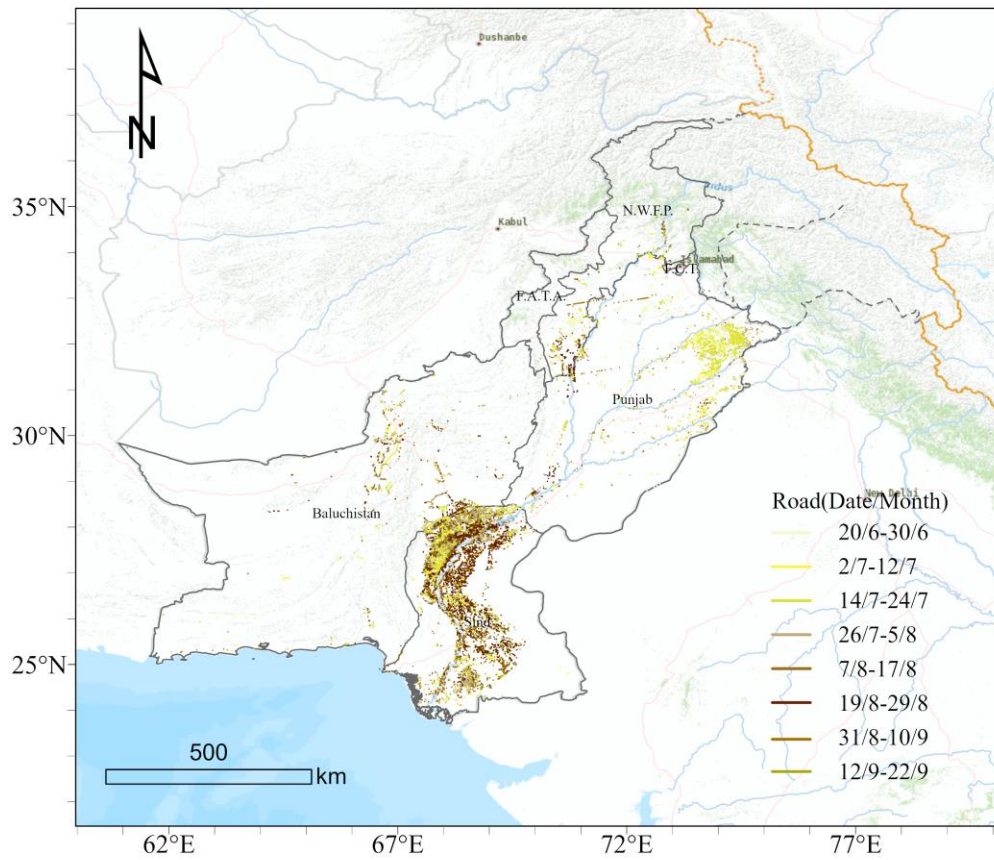


Figure 5. Distribution of flood-affected roads in Pakistan from June to September

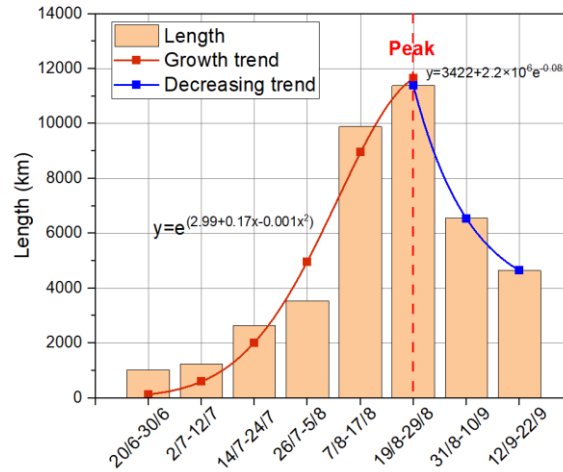
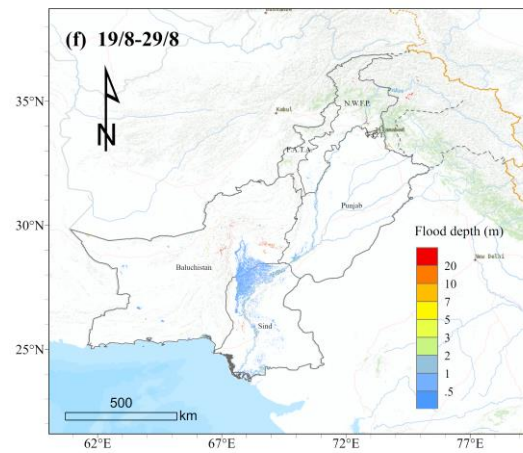
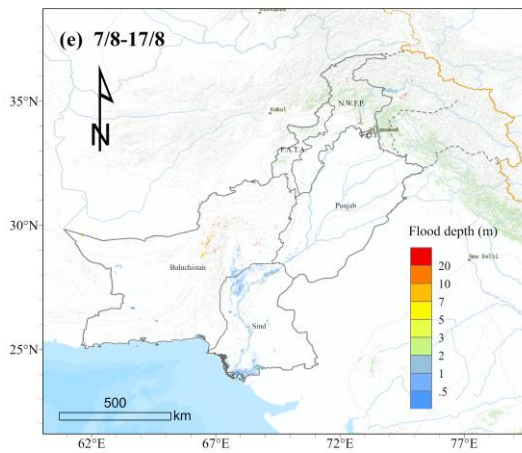
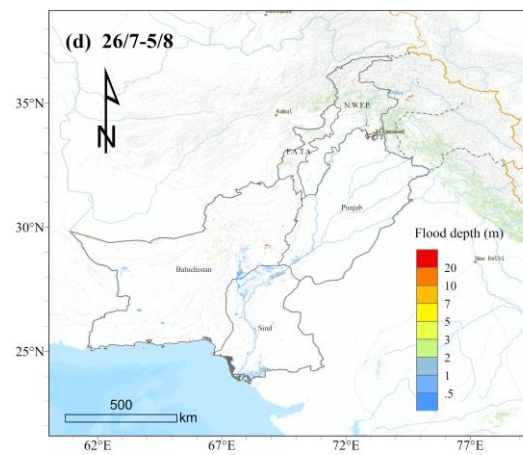
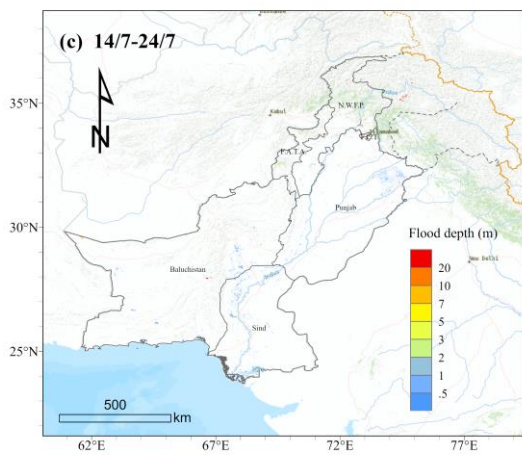
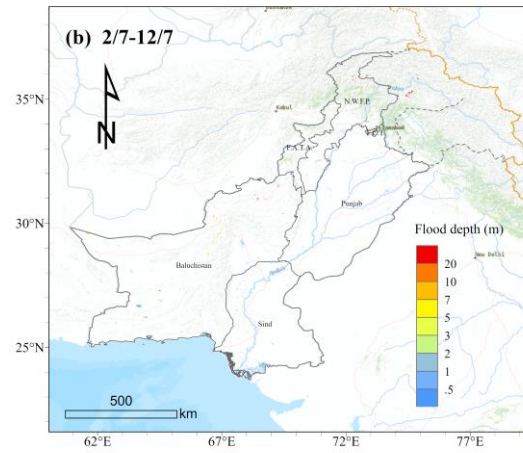
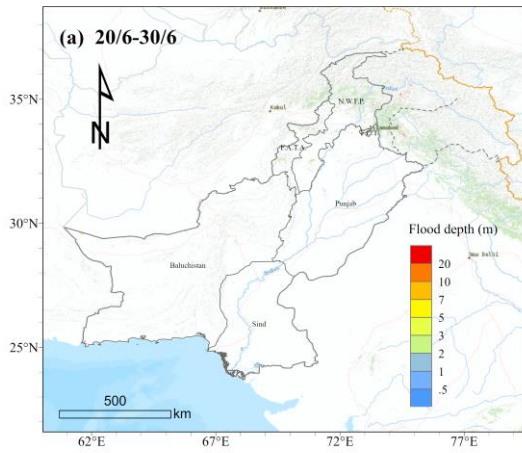


Figure 6. Length of flood-affected roads changes in Pakistan from June to September

3. Flood Depth Monitoring

The time series of flood depth (floodplain inundation depth, hereafter referred to as depth) shows in **Fig. 7**. Since late June, the average depth was 1.93 m, increasing to about 2 m from July to early August. A recorded maximum depth was 3.37 m in mid-August. The flooding began to subside in September, and the depth decreased to 1.90 m in mid to late September. Among them, the most serious flood occurred in late August. The average depth in Pakistan reached 2.20 m, 80% area was covered by 1 m and below of water, and the area of water depth greater than 5 m was 1,752.14 km² (which takes about 6.51% of the whole country area) (**Table 1**). In some areas (such as northern Pakistan and western mountainous Sindh Province), the relative height difference was largely due to narrow river channels, and the water depth can reach over 20 m.



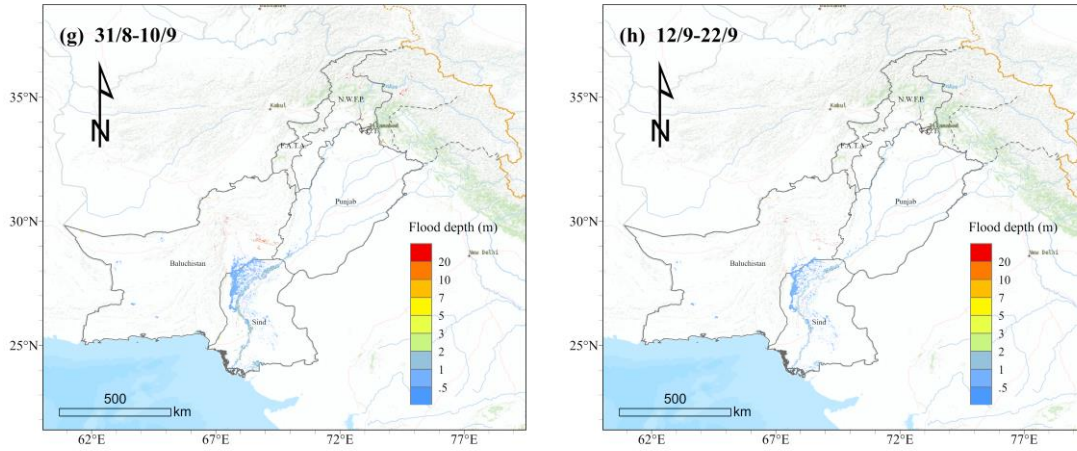


Figure 7. Change of flood depth in Pakistan from June to September

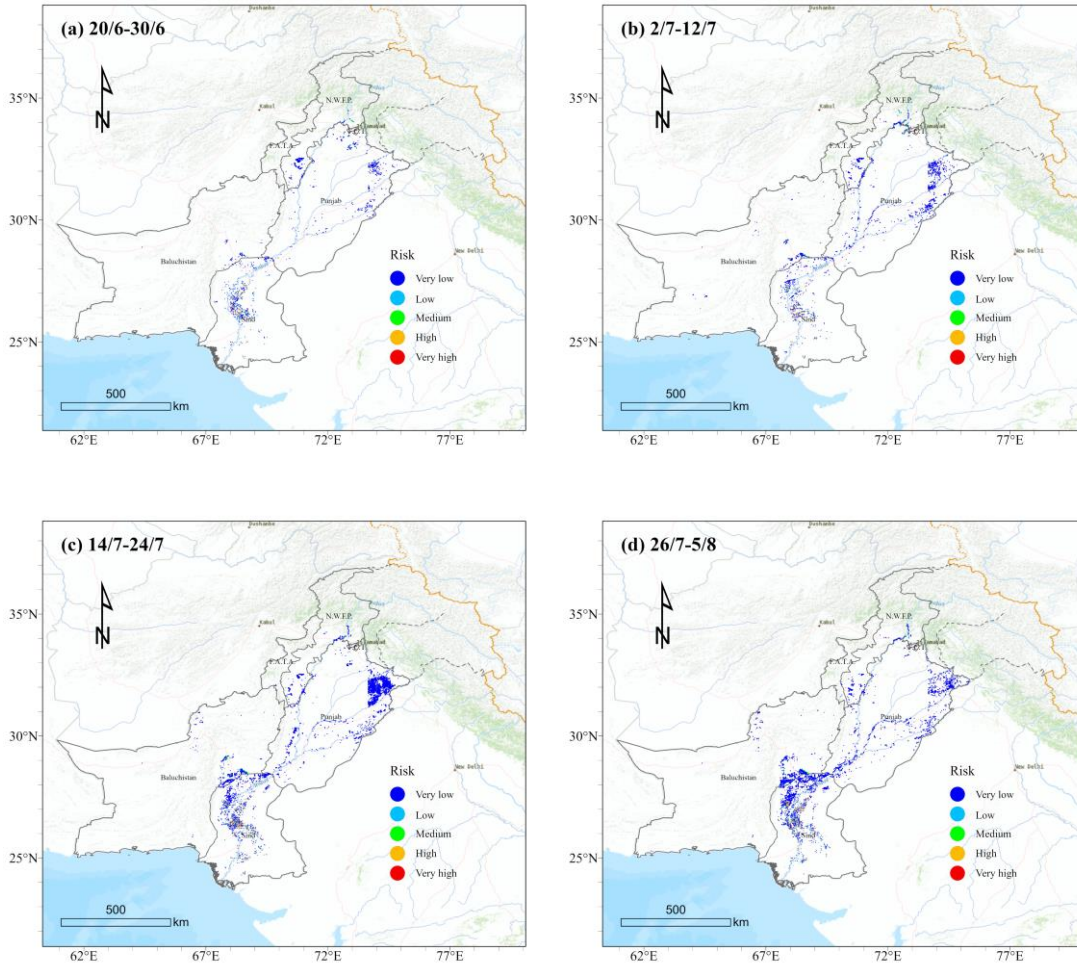
Table 1. Areas and different flood depths in late August

Flood depth (m)	Area (km ²)	Proportions
0~1	21,769.96	80.89%
1~2	1,992.20	7.41 %
2~3	680.73	2.52 %
3~5	717.64	2.67 %
>5	1,752.14	6.51%

4. Flood Risk Assessment

Flood depth was used to quantify the hazard level of flood and flood-inundated building area was used to quantify the flood impact. Thus, those two indicators were used to calculate the flood risk in Pakistan, where 0~0.01 is very low risk; 0.01~0.05 is low risk; 0.05~0.1 is medium risk; 0.1~0.2 is a high risk, and 0.2~1 is very high risk. The assessment results show that the overall flood risk areas increased with flood expansion, from 187.90 km² in late June to 2,000.21 km² in late August (**Fig. 8**). As of August 29, the area of the very low risk zone is 1,775.76 km², and the low risk zone is 142.78 km². The medium risk zone is 47.91 km², the high risk zone is 25.01 km², and the very high risk zone is 8.66 km². The high and very high flood risk area increased from 3.63 km² in

late June to 33.67 km² in late August and began to reduce in September. It decreased to 6.10 km² in late September. Regarding spatial distribution, the high and very high risks are mainly concentrated in the central and western parts of Sindh, along the Indus River, where high flooding depth overlaps with the active anthropogenic environment.



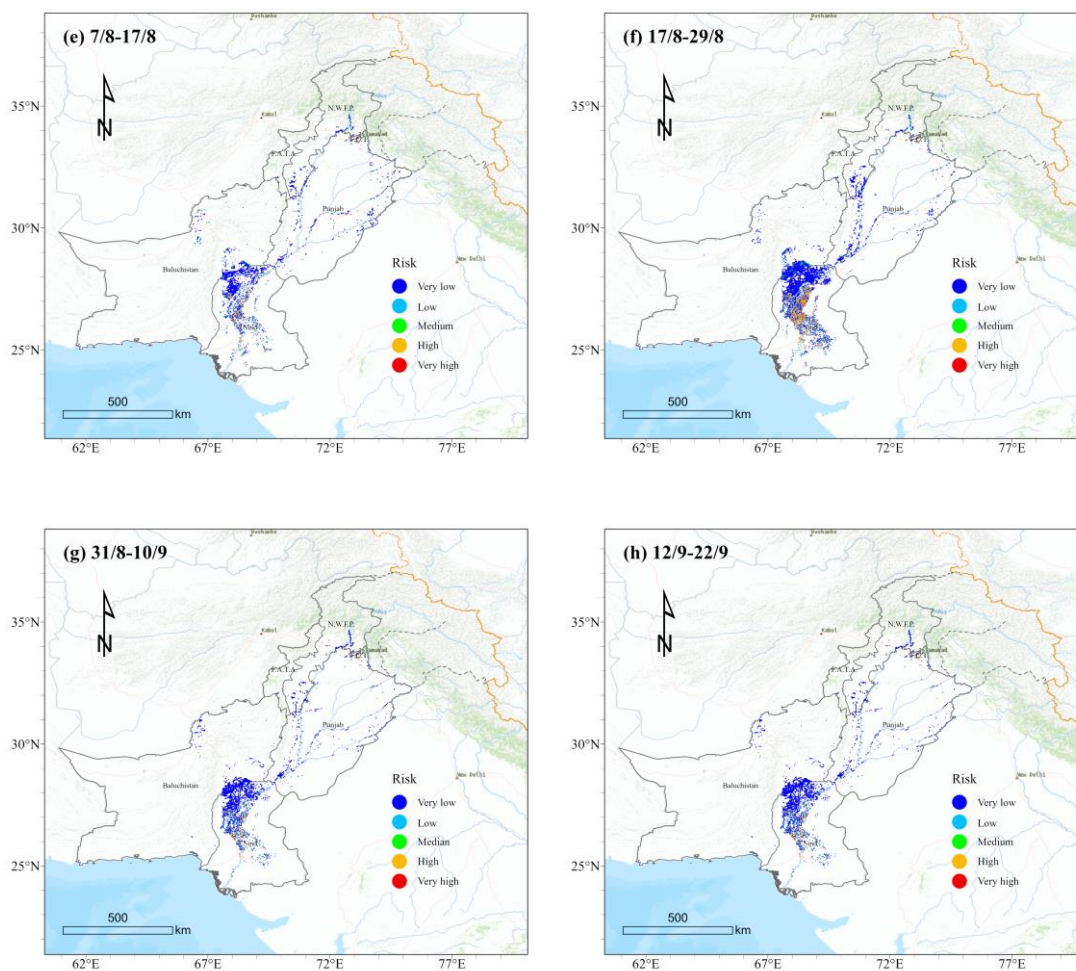


Figure 8. Change of flood risk area and level from June to September

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