Climate-driven cloudbursts and glacial lake outburst floods in Gilgit Baltistan, Pakistan, 2025

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Abstract

Climate change is a global problem driven by rapidly rising greenhouse-gas emissions. In 2024 the planet registered the warmest year in the instrumental record and 2015–2024 was the warmest decade; warming is intensifying heavy precipitation and "fire weather," while reducing snow and ice and accelerating permafrost thaw. Glaciers are losing mass at a globally significant and faster rate—about 273 ± 16 Gt of ice per year from 2000–2023, with ~36% faster loss in 2012–2023 than in 2000–2011—contributing to sea-level rise and altering seasonal water supplies. These signals are expanding glacial lakes, amplifying short-duration downpours, and raising flood and landslide risk. Although Pakistan emits well under 1% of global greenhouse gases, it is highly exposed. In the north, Gilgit-Baltistan (GB) sits in the Hindu Kush–Karakoram–Himalaya, where a warmer, wetter monsoon is heightening cloudburst and glacial-lake outburst flood (GLOF) hazards. In 2025 alone, a 21 July cloudburst along Babusar Road caused at least five deaths, fifteen missing, and four injuries; a late-July flood cut the Danyore–Sultanabad canal; a predawn 11 August landslide killed seven volunteers repairing the channel; Shishper-fed flows damaged protective works and the Karakoram Highway; and on 22–23 August a major slope failure dammed the Ghizer River, forming a ~7 km temporary lake and forcing evacuations.

To match global fairness with local protection, we propose a dual track. Mitigation targets the biggest, fastest levers—coal phase-down, system-wide efficiency, rapid methane and HFC cuts, and black-carbon abatement from diesel, brick kilns, cookstoves, and open burning—to limit further heating that drives cloudbursts and ice loss. Adaptation prioritizes measures communities can run and maintain: finish early-warning coverage with monthly drills and last-mile redundancy (sirens plus mosque/FM alerts); treat canals, bridges, and access roads as critical infrastructure (armoring, debris screens, bypass valves, prepositioned quick-repair kits); enforce no-build flow corridors; and deploy site-specific controls at choke points (controlled lake drawdown via spillways or gravity siphons, debris-flow barriers, bridge-abutment hardening, and culverts sized to 1-hour extremes). GB should maintain an up-to-date glacial-lake inventory, classify potentially dangerous lakes, and proactively lower volumes at critical sites. New operational ideas include valley micro-bund networks optimized with drone/DEM mapping and participatory flow-path walks; a shared Nowcast & Lake-Watch data commons; parametric early-action financing tied to sub-daily rainfall or discharge thresholds; and "bridge-as-spillway" retrofits with safe-to-fail culverts. Provide shelter for impacted people. Together, these actions convert warnings into avoided losses while aligning rapid global emissions cuts with practical, locally maintainable protection for front-line communities.

Keywords: Gilgit-Baltistan, GLOF, cloudburst, early-warning systems

1. Global GHG emissions until 2022

According to the EDGAR 2023 booklet, global greenhouse-gas emissions reached 53.8 Gt CO_2-equivalent in 2022; the six largest emitters—China > United States >India> EU-27 >Russia >Brazil—together accounted for 61.6% of the world total that year. Pakistan's contribution is under 1%, as it does not appear among the countries with shares ≥1% See Figure 1 and figure 2.

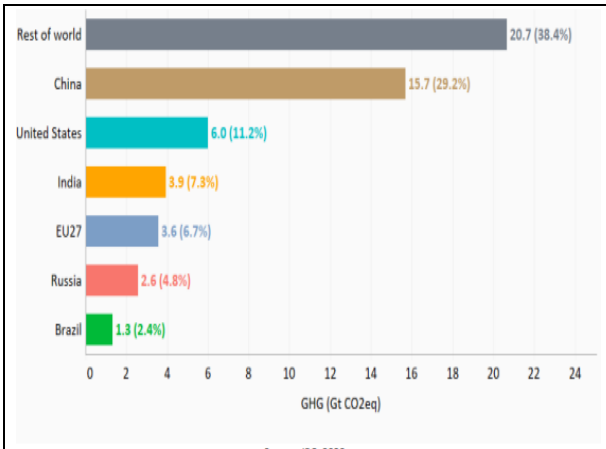

Figure 1. GHG emissions (in Gt CO2eq) and contribution of the major emitting economies and the rest of the world in 2022

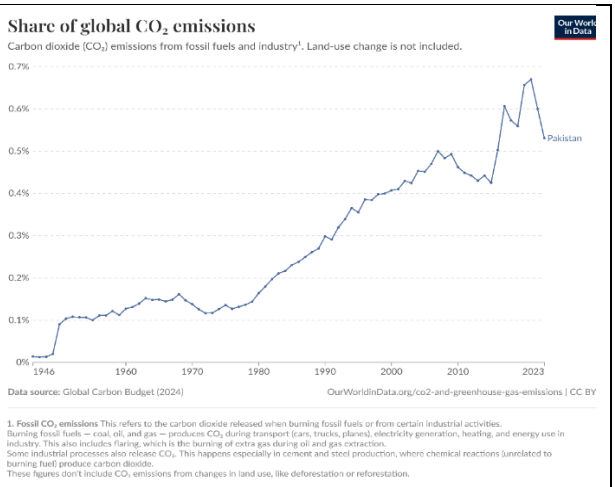

Figure 2: Pakistan's share of global CO_2 emissions

2. Why low-emitting Pakistan is highly vulnerable — key indicators?

Indicator	Pakistan/GB value	Source (short)
Glaciers in Pakistan/GB	≈7,000+ (GB hosts the majority in Pakistan)	Regional syntheses (ICIMOD/press)
Glacial lakes in GB+KP	3,044 lakes; 33 hazardous	UNDP GLOF-II / Climate Promise
2022 Pakistan floods	≈33 million affected; ≈1,700 deaths	International reporting (2022)
2025 GB events (Jul–Aug)	Cloudbursts, GLOFs; Ghizer debris-dam lake ~7–8 km	Reuters & national media (Aug 2025)

3. Loss and Damage due to Flood in Pakistan from June 26 to Aug 23

Table 1. Loss and Damage due to Flood in Pakistan from June 26 to Aug 23

Province	Deaths	injured	Roads (KMs)	Bridges	House Damages	Livestock Perished
Punjab	165	584	0	0	220	121
KP	469	285	431.74	48	3,926	4,904
SINDH	54	71	0	0	90	221

BLN	24	5	1.5	2	144	22
GB	45	42	26.56	87	998	67
AJK	23	28	201.5	94	1,187	213
ICT	8	3	0	3	65	0
Grand Total	788	1,018	661.3	234	6,630	5,548

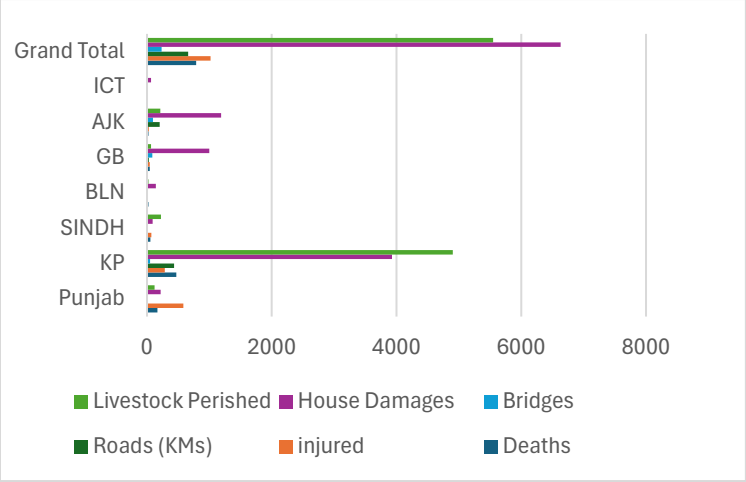

Figure 3: Loss and Damage due to Flood across provinces of Pakistan

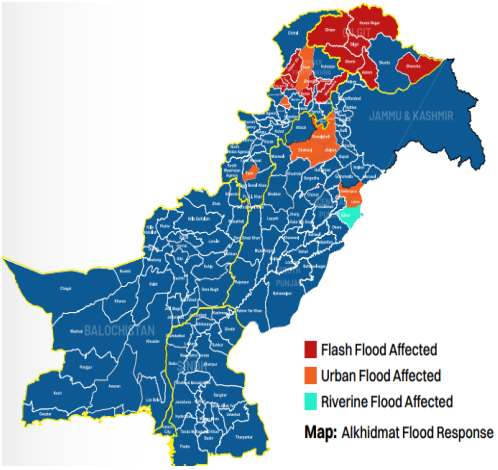

Figure 3: Map of Affected areas of Pakistan

4. Conclusion

Observed 2025 events in Gilgit-Baltistan—including the Babusar cloudburst, the Danyore–Sultanabad canal failure with subsequent fatal landslide, Shishper-fed flooding at Hassanabad, and the Ghizer landslide-dam lake at Raoshan—are consistent with a warming-driven rise in short-duration precipitation extremes and cryosphere instability. Continued greenhouse-gas forcing, compounded by transboundary black-carbon deposition, will increase the probability and severity of cloudbursts, GLOFs, and cascading infrastructure failures in narrow mountain valleys. Rapid mitigation of global GHGs and regional soot, together with targeted adaptation—early-warning systems, engineered and community bunds, lifeline hardening, controlled lake drawdown, and enforceable no-build flow corridors—offers the most direct pathway to lower mortality and economic loss. Prioritized deployment in Raoshan Valley provides an operational template for similarly exposed catchments across High Mountain Asia.