CLIMATE-RESILIENT DAMS AND HYDROPOWER INFRASTRUCTURE INTEGRATING ENVIRONMENTAL SUSTAINABILITY IN PLANNING AND DEVELOPMENT

Climate impact on hydrology and systems leading to more frequent and severe extreme weather events like floods and droughts

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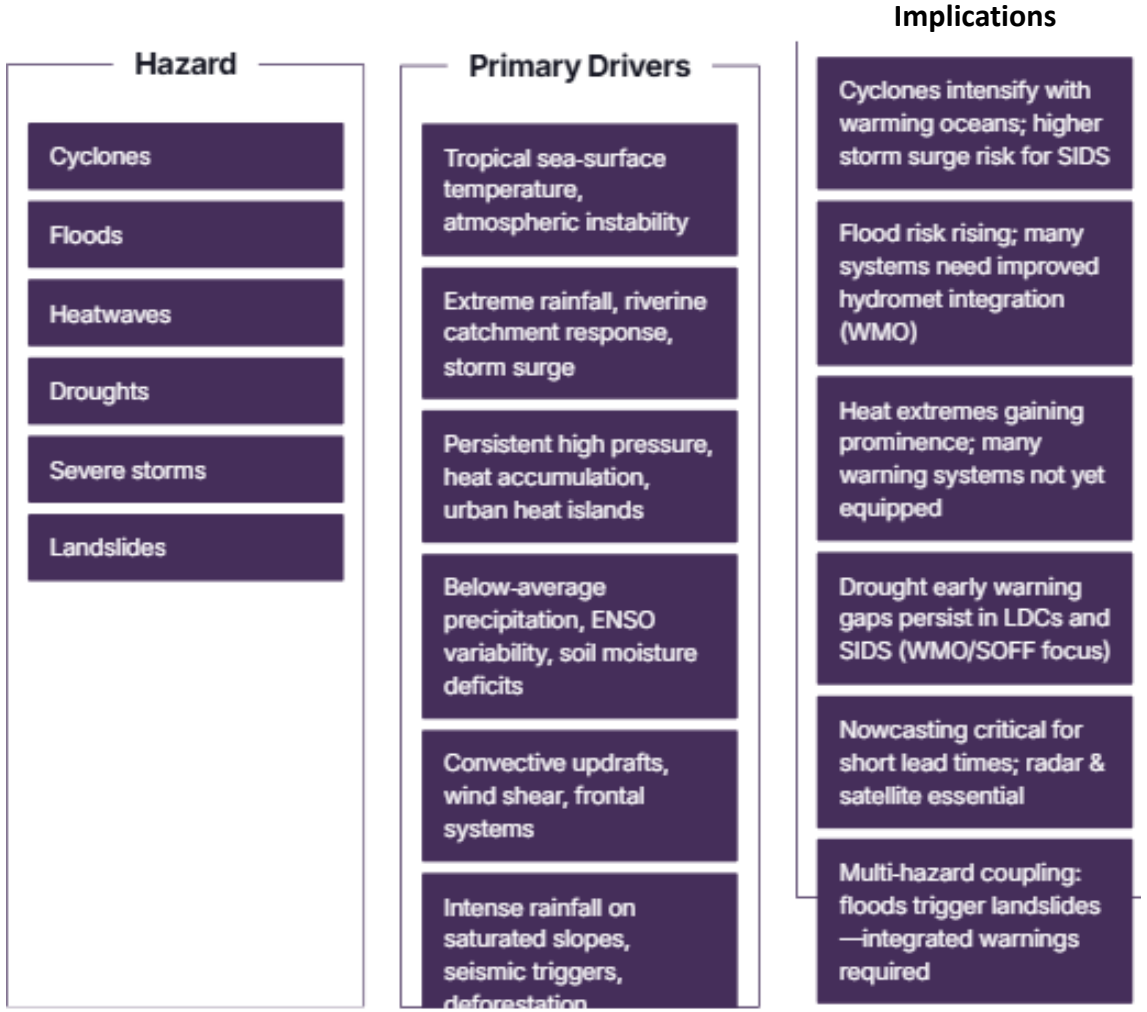
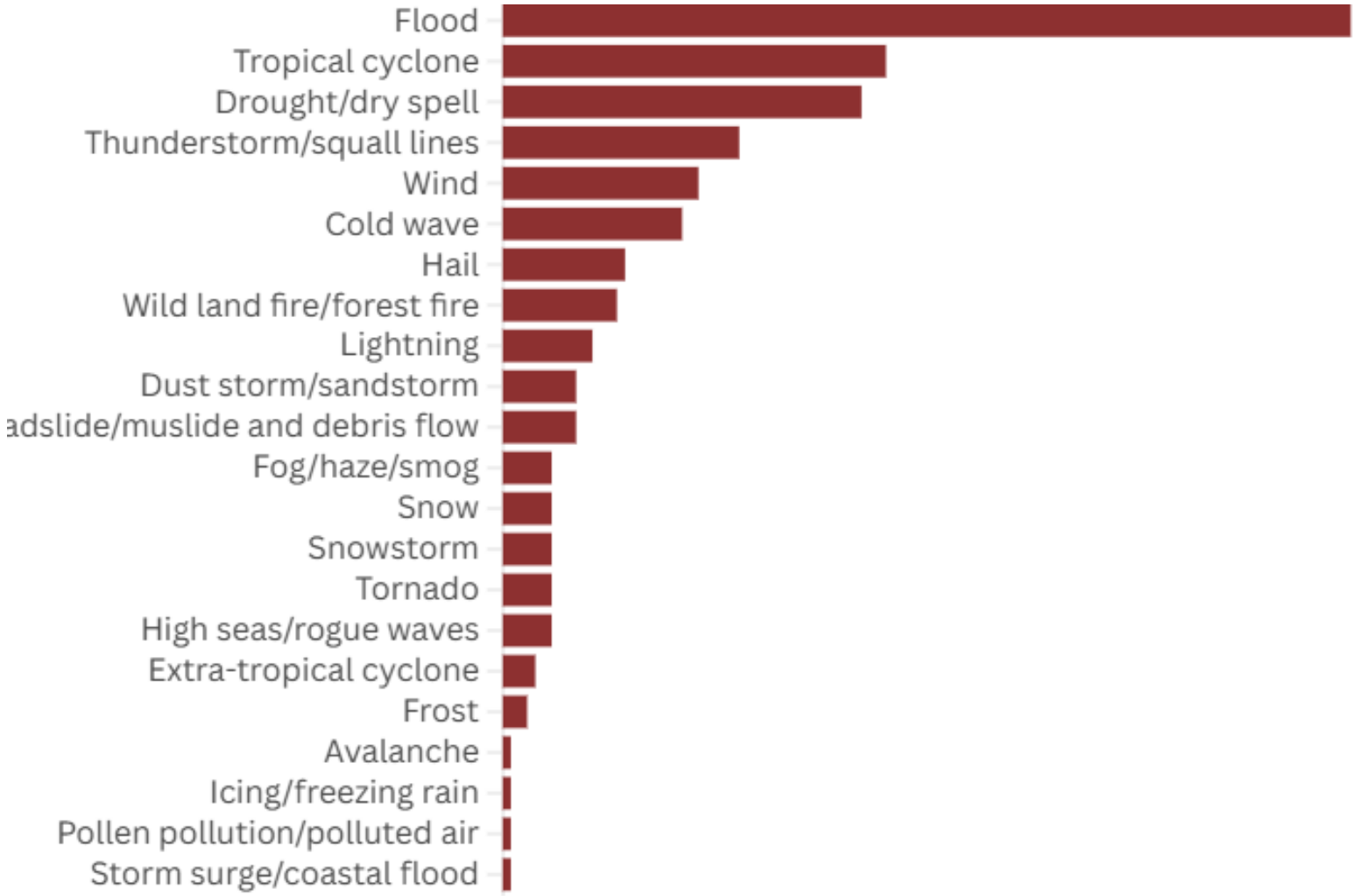
Extreme Weather Events

India Meteorological Department (IMD) defines extreme weather events as rare occurrences for a particular place and time and threshold.

More than 600 reported extreme weather events, including 148 classified as "unprecedented", displaced 824,000 and killed 1,700 people in 2024 Globally



Climatic Impact : Extreme Weather Events in 2024



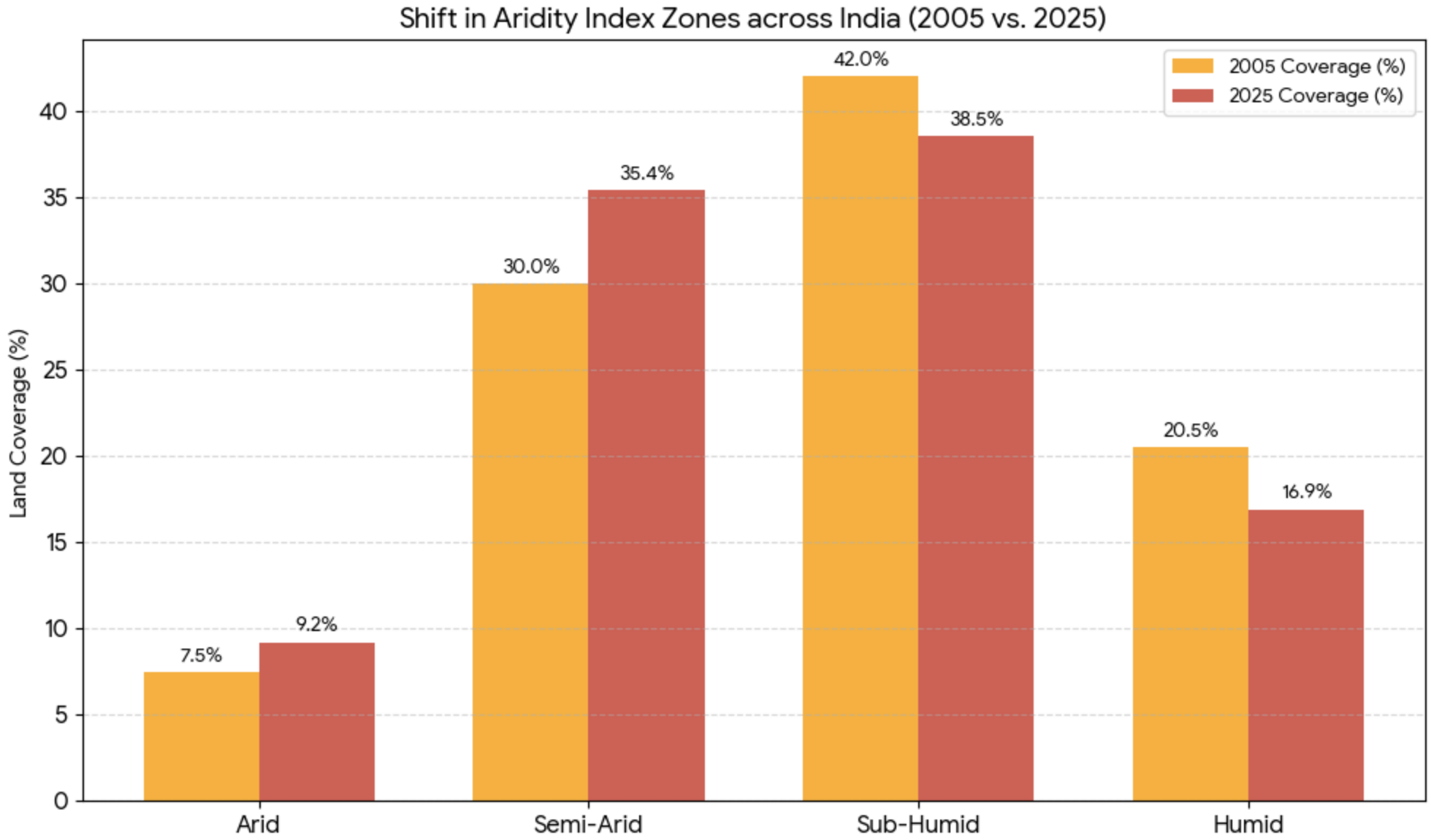
Floods & Droughts are amongst the top 3 most frequently occurring extreme Weather Events

Trends

- Global surface temperatures have risen at an average rate of **0.20°C per decade** since 1975.
- Year 2024 was the warmest year on record. **It was the first calendar year of temperatures surpassing the key 1.5 °C warming limit .**
- 10 warmest years in history have all occurred since 2015.

Impacts
Changing Precipitation Patterns:

- For every **1°C** of warming, the atmosphere can hold approximately **7% more water vapor.**
- An "acceleration" of the hydrological cycle—faster evaporation and more intense precipitation.
- A shift toward fewer, more intense rain events rather than frequent light rain.
- Total seasonal rainfall in India remains relatively stable, but it now falls in shorter, more intense bursts (leading to floods), followed by prolonged dry spells (leading to droughts).
- Flooding is no longer restricted to the Indo-Gangetic plains; traditionally dry states like **Rajasthan and Gujarat** now report frequent extreme rainfall events.
- **Soil Moisture**: Higher temperatures increases evapotranspiration, stripping moisture from the soil even in areas with "normal" rainfall, leading to agricultural drought.


Shift in Aridity Index Zones across India (2005 vs. 2025)
2005 Coverage (%)
2025 Coverage (%)
Land Coverage (%)
0
5
10
15
20
25
30
35
40
7.5%
9.2%
30.0%
35.4%
42.0%
38.5%
20.5%
16.9%
Arid
Semi-Arid
Sub-Humid
Humid

Conclusions :

Expansion of Drylands: The most significant trend is the expansion of the **Semi-Arid** zone, which has grown from covering 30.0% of India's land area in 2005 to an estimated 35.4% in 2025.

Shrinking Water-Abundant Zones: Both **Sub-Humid** and **Humid** regions are in retreat. Humid zones, historically found in the Western Ghats and North-East, have shrunk from 20.5% to 16.9% as rising temperatures increase potential evapotranspiration.

State	Primary Regions Affected	Change in Hydrological Profile
Maharashtra	Vidarbha, and Central Plateau	**Sub-Humid → Semi Arid**
Telangana	Northern and Eastern Districts	**Sub-Humid → Semi-Arid**
Odisha	Western Districts (e.g., Kalahandi, Bolangir)	**Sub-Humid → Semi-Arid**
Madhya Pradesh	Western Malwa Plateau	**Sub-Humid → Semi-Arid**
Karnataka	Northern Plains (Belagavi, Bagalkote)	**Dry Sub-Humid → Semi-Arid**
Andhra Pradesh	Rayalaseema & Coastal Hinterlands	**Sub-Humid → Semi-Arid**

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