

HYDRO-ELECTRIC POWER - ARE WE ON THE RIGHT TRACK?

Presentation by

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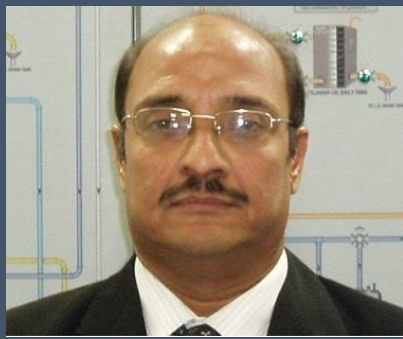
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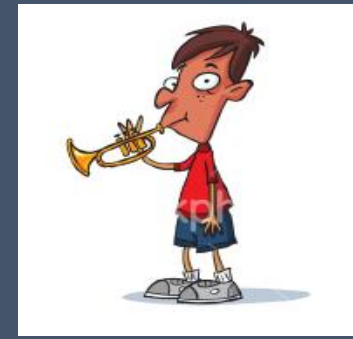
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About the Author



Marine Engineer by profession

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Published two books: 1. CONTAINER REFRIGERATION in 2008 through Witherbys, UK, the first book to be ever published by an Indian author by Witherbys and on the subject and is listed as a reference course material for USCG MARAD's Marine Engineer's Licences on Marine Refrigeration and Air Conditioning.

2. REFRIGERATION AND PERSONAL SAFETY IN 2022 through Bhandarkar Publications

His expertise includes Marine Engineering, Naval Architecture, Refrigeration, Containerisation, Cold Chain, Post Harvest Management and Sustainable Solutions.



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Water Disasters and Consequences

- 90% of natural disasters are water related.
- Half the population of the developing world are exposed to polluted sources of water that increase disease incidence.
- In 1969 Severe famine in China caused deaths of an estimated 20 million of the population.
- The Sahel drought from the late 1960's to early 1980's created a famine that killed a million people and afflicted more than 50 million.
- In 1977, a devastating cyclone in South India caused 20,000 deaths.
- The periodic El Nino and Al Nina continue to create flooding and drought conditions
- In early 2000 a cyclone across southern Africa led to three weeks of severe floods devastating Mozambique.
- In 2005 Hurricane Katrina swept through New Orleans causing severe loss of life and damage to property .
- In 2006 Flash floods killed hundreds of people and left tens of thousands homeless in Ethiopia.

HYDRO-ELECTRIC POWER - ARE WE ON THE RIGHT TRACK?

- Today, there are approximately 850,000 dams located around the world
- As with other man made structures, dams are not eternal, they are not made to last forever.
- Dams are usually built for 50 years, beyond which, they become uneconomical to maintain. Even after 80 years, Hoover and Grand Coolie Dams are still going strong. Chinese Three Gorges Dam is also designed to last for a long time.
- About 5,000 large dams worldwide are now over 50 years old, About 70 percent of 87,000 dams in USA will be more than 50 years old The average age of dams in US is around 40 years needing US\$ 54 billions to repair and maintain.

Some of the oldest Existing dams in the world

- Quatinah Barrage / Lake Homs Dam, Syria - 1319-1304 BC, subsequently expanded between 1934 and 1938.
- Proserpina Dam and Cornalvo Dam, Spain – between late 1st & early 2nd century AD
- Kaerumataike Dam, Japan - 162 AD
- Kallanai Dam / Grand Anicut, India - 2nd century AD
- Sayamaike Dam, Japan – 7th century AD
- Manoike Dam, Japan - 701-704 AD
- Sadd-e Kobar Dam, Iran - 10th century AD
- Tonnur Kere / Moti Talab Dam, India - 12th century AD
- Almansa Dam, Spain – 1384 enlarged during the years 1586, 1736 and 1921

What can go wrong with dams

- **Collapse**
- **Erosion of spillways and pipes**
- **Failure of sluice gates and valves**
- **Wearing out of powerhouse equipment**
- **Silting up of the Reservoir**

Some Recent Dam failures

South Carolina flooding in 2015 resulting in 17 deaths and \$12 billion property damage was failure of 25 supposedly low-hazard dams because of heavy rainfall.

In Northern India, in June 2013, 6000 lives were lost, 110,000 people were evacuated; 37,000 sq miles of area got affected with an estimated overall property loss of US\$ 500 million

In 2015, a sludge-filled dam built for mining industry burst in Brazil, killing 19 people and destroying several villages.

The 1975 Banqiao Reservoir Dam failure due to heavy rainfall in China caused 171,000 deaths and 11 million persons were displaced

The failure of the Buffalo Creek Dam in West Virginia, Canyon Lake Dam in South Dakota, Teton Dam in Idaho, and Kelly Barnes Dam in Georgia, resulted in the loss of 300 lives and hundreds of millions of dollars in damage.

In 1963, A huge rockfall into the reservoir of the towering 860-foot Vajont Dam in Italy sent an enormous splash of water over the top in a wave more than 80 stories high, sweeping downstream and wiping out several villages killing about 2,000, but the structure itself suffered only minor damage.

Some Potential catastrophic dam failures

- If Mosul dam in Iraq fails, the unleashed torrent of water could be 45 feet high putting about 1.47 million Iraqis at risk.
- The \$28.3 billion Three Gorges Dam in China, built in 2003, which is the largest dam in the world is facing significant safety concerns due to the development of 80 worsening cracks, potentially compromising its structural integrity and posing a catastrophic threat to downstream populations.
- If Hoover Dam gets breached, the 9 trillion gallons of water in Lake Mead would rush through and inundate 10 million acres of land (bigger than the state of New Jersey) to about 1 foot high and affect 25 million people.

The Indian context

- In sync with the world's quest for non-coal based energy, in late 1990s, the then Prime Minister Atal Bihari Vajpayee proposed building 162 big hydroelectric power projects totalling 50,000 MW by 2025.
- Almost all of the new projects - 113 dams and power stations capable of generating 40,000 megawatts of electricity - were planned for five Himalayan states of which 33 were targeted for the high mountain valleys in the state of Uttarakhand. Energy sourced from moving water was seen as the most viable alternative.
- By 2003, India's hydropower ambitions magnified: 292 big hydro projects were under construction or planned for India's Himalayan region.

Formation of Himalayas

- One of the Youngest mountain ranges on the planet
- Formed because of a continental collision between the Indo-Australian Plate and the Eurasian Plate
- 70 million years ago (Upper Cretaceous) the north-moving Indo-Australian plate (which has subsequently broken into the Indian Plate and the Australian Plate) was moving at about 15 cm per year.
- Today, it is still moving at 67 mm per year, and over the next 10 million years it will travel about 1,500 km into Asia.
- About 20 mm per year of the India-Asia convergence is absorbed by thrusting along the Himalaya southern front causing Himalayas to rise by about 5 mm per year, making them geologically active.
- The movement of the Indian plate into the Asian plate also makes this region seismically active, leading to earthquakes from time to time.

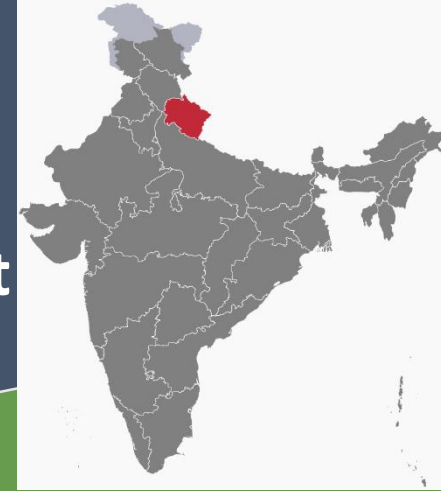


Uttarakhand

- Earlier named Uttaranchal
- Formation- 9th November 2000 - 27th State of India, carved out of northern Uttar Pradesh with Dehradun as capital
- Area -53,566 km² of which 86% is mountainous and 65% is covered by forest.
- Population in 2023 11.64 million
- Source of origin of Ganga at Gangotri and Yamuna at Yamunotri which along with Badrinath and Kedarnath form Char Dham Hindu holy pilgrimage circuit – nicknamed Dev Bhoomi
- 2 regions – 13 districts

Proud Host of

- Jim Corbett National Park
- Forest Research Institute, Dehradun
- IIM, Kashipur
- NIT, Srinagar
- IIPES, Dehradun
- Herbal Research & Development Institute, Gopeshwar
- AIIMS, Rishikesh
- BHEL, Hardwar
- Hero Motors Plant, Hardwar
- IMA, Dehradun
- IIT Roorkee



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June 2013 – What happened?

In June 2013, in five days, 6000 persons had lost their lives; 110,000 people were evacuated; 37,000 sq miles of area got affected with an estimated overall property loss of US\$ 500 million.

1. The early arrival of the annual monsoon accelerated snow melting, produced higher than normal rainfall, and then unleashed a cloudburst that dumped at least 300 millimeters (12 inches) of rain on June 16 on the Himalayan ridges that fed the Alaknanda and Bhagirathi river basins.

2. The second event, a direct result of the cloudburst, was the collapse of the banks that retained the waters of Chorabari Lake, a glacial lake fed by rain and snowmelt that was located at 3,960 meters (13,000 feet) and two kilometers (1.2 miles) upstream of Kedarnath, in the Mandakini River floodplain.

June 2013 – What happened?

3. Chorabari Lake, 400 meters long by 200 meters wide and up to 20 meters deep (1,300 feet long, 660 feet wide and 60 feet deep) about 51.4 million cubic feet released all of its water in 10 minutes.
4. Floodwaters tore down the steep valleys, bounded out of the river channels, and lashed at everything in their path. Kedarnath, Rambara, Gaurikund, much of Sonprayag, and other villages disappeared under the deluge of water, boulders and mud.
5. The rivers clawed at the banks and bluffs, causing over 100 landslides that brought down or damaged more than 1,000 kilometers of highways and caused an unknown number of homes, shops, and government buildings to fall into the torrent.

Why it Happened?

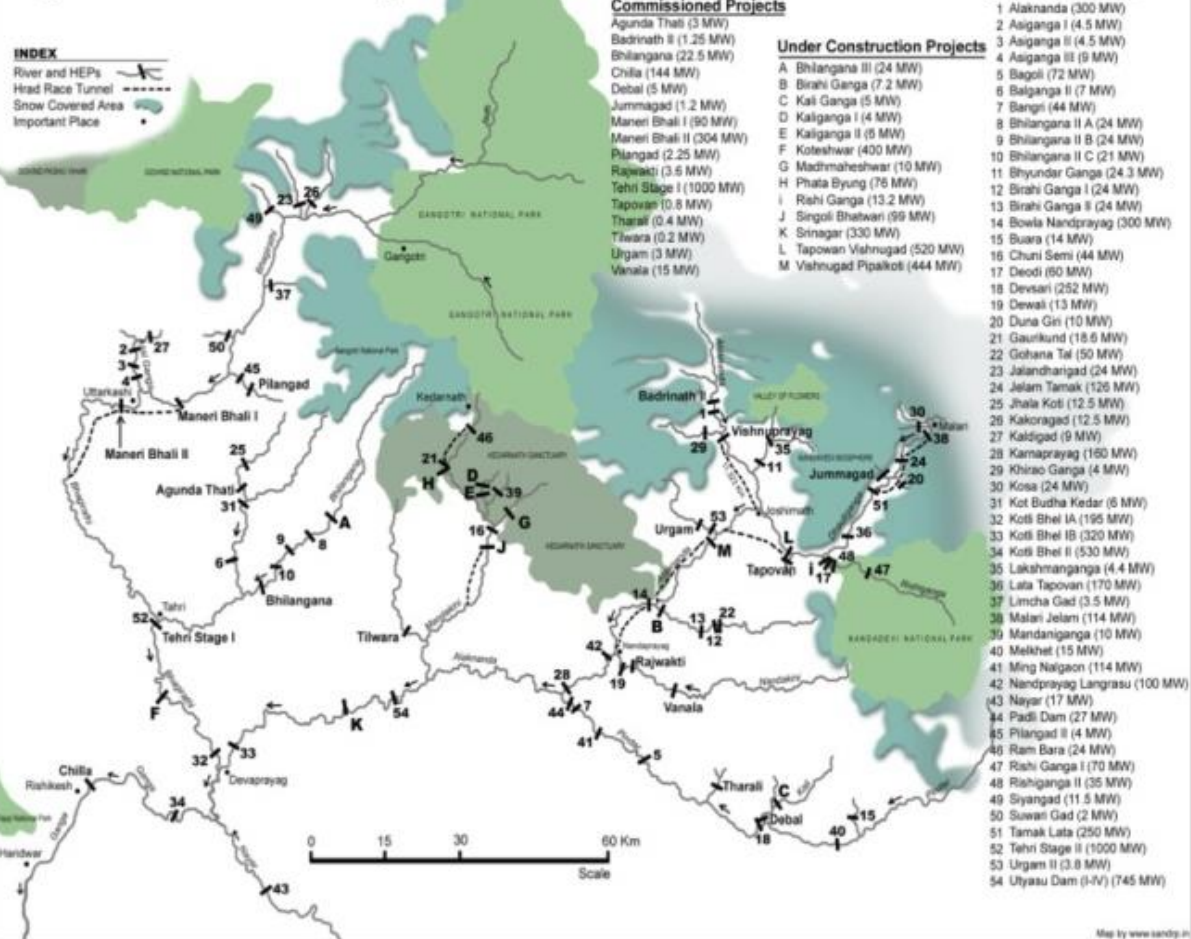
- Indiscriminate setting up of about 70 hydroelectric projects along the tributaries of Ganga without considering the long term consequences.
- While dams are needed to meet energy requirements, building them is a construction intensive activity, involving blasting, excavation, debris dumping, movement of heavy machinery, tunnelling and diversion of forests and rivers and affects environment
- This has cumulatively impacted Himalayan ecology. In Uttarakhand, 45 HPPs of 3,164 MW were operational and 199 big and small projects were under way.
- In Alaknanda-Bhagirathi basin, 69 HPPs of 9,000 MW (most of them less than 25MW), were under way affecting 75% of the basin.
- No proper muck disposal mechanism was followed. The deposition of muck and debris of a dam located upstream on the river banks downstream became a common practice.
- Indiscriminate dumping of muck increases erosive capacity of a river manifold during monsoon and causes extensive destruction downstream.



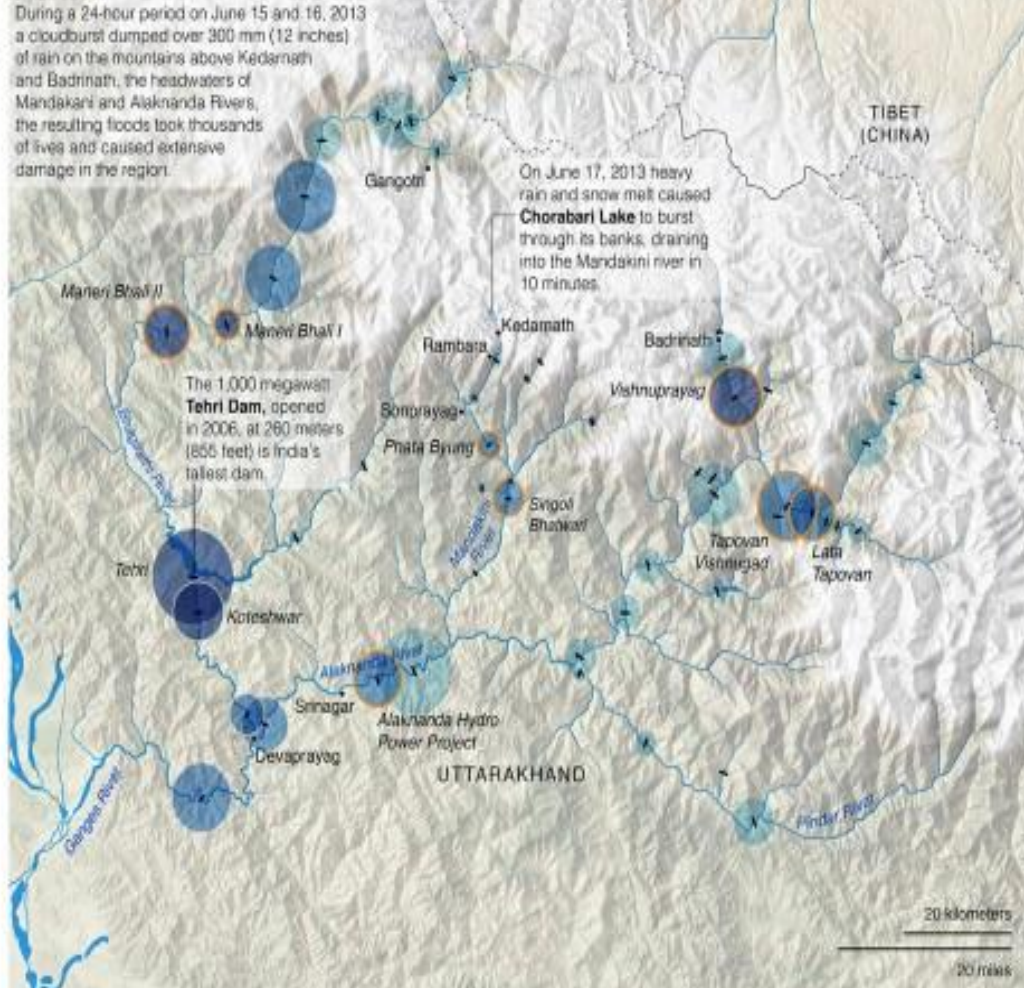
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Why it Happened?

Hydro Electric Projects on River Ganga



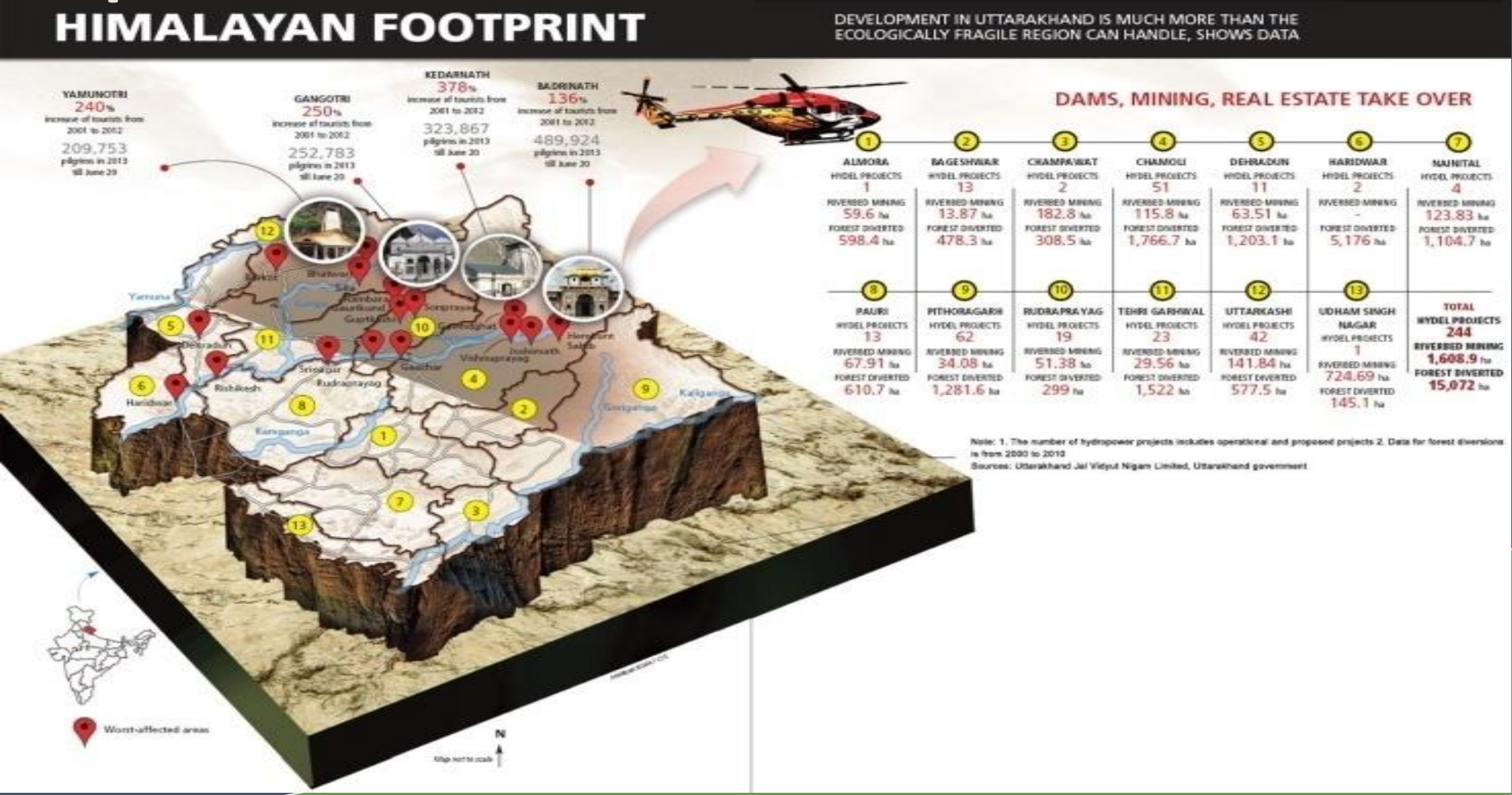
Hydroelectric Power Projects in the Bhagirathi and Alaknanda Basins



Compromises Made

- The recommended 2-3 miles distance from each other was not maintained.
- Smaller plants do not need environmental impact assessment, tending to overlook many safety and environmental issues.
- The recommended ecological flow (30-50% flow in lean season (November to April) and 20-30% flow during other months) which is the minimum quantity of water needed for ecosystem protection and livelihood purposes was not maintained.
- Most of the 69 projects are lesser than 25 MW. But even small run-of-the river projects can cause severe damage to the rivers. They re-route water through tunnels, cutting through mountains to increase the pressure, leaving long stretches of river dry—for instance, the 10 MW Madhya Maheshwar SHP plant in Uttarakhand uses a 4 km-long tunnel to divert water.
- In Kedarnath, the water bodies had dried up and rainfall had been scanty since 2007, when L&T started building a tunnel for a 99 MW hydro power project.

Compromises Made



The Aftermath

- Kedarnath, Rambara, Gaurikund, much of Sonprayag, and other villages disappeared under the deluge of water, boulders and mud.
- The estimated death toll ranged from 6,000 (Government of Uttarakhand) to 30,000 (residents and the Wadia Institute of Himalayan Geology). The Indian Army and emergency and rescue crews transported tens of thousands of stranded people to safety, many by helicopter. Under rolling masses of clouds, it was dangerous work. Twenty rescuers died when one of the choppers crashed.
- The torrent produced consequences that no engineer anticipated and no Uttarakhand resident had ever seen.
- A joint study by the World Bank and the Asian Development Bank estimated that damage to public infrastructure — roads, water transport, buildings — amounted to nearly \$700 million.

Conclusion

- Can there be one more Uttarakhand disaster in the waiting? Have we learnt the lessons?
- The Uttarakhand disaster is wake up call for the world.
- Since the long-term irreversible damage to the atmosphere outweighs the advantages of hydro-electric power projects and dams, there is a strong case for abandoning the concept in favour of other environmentally sustainable power sources like solar power, tidal power, geothermal power, wind power etc.
- Nuclear power has its own drawbacks due to safety concerns
- Thermal power being fossil fuel based is not recommended in the present context.
- Solar power and wind power have their own circular economy problems. After the useful life of 25 years, disposal of solar panels and wind turbine components becomes an issue.
- Thus, a real long-term sustainable solution for power source still eludes us.
- Among the available choices, we have to choose the energy source which causes least harm to the environment in the long run.



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THANK YOU

