Innovations in Flash Flood Monitoring and Early Warning System

Insights from Rasuwagadhi and Dharali Flood

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Innovative Engineering Services

- **10+ years experiences in flood monitoring and early warning system**
- **150+ flood monitoring stations and Early warning systems establishment**

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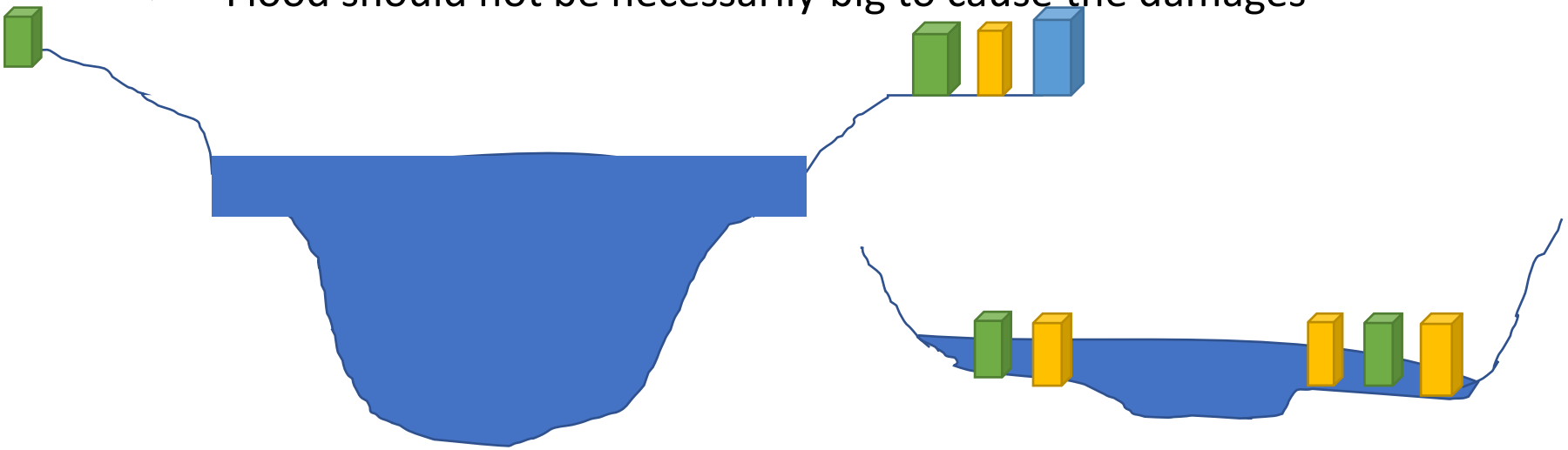
Outline of Presentation

- ✓ Understanding the Flood and Risk
- ✓ Basics of Early Warning System
- ✓ Current practices on Monitoring and Early Warning System (EWS) of normal Flood
- ✓ Innovative approaches for monitoring and EWS of Flash Flood
- ✓ Realtime sediment monitoring
- ✓ Conclusions

Understanding the Flood and Risk

- ✓ The definition of the flood can vary context to context
- ✓ In context of disaster, a flood is the water flow which overflows the normal river channel and poses risk on its exposure such as human lives and infrastructures, livestock, agriculture lands etc…
- ✓ Flood should not be necessarily big to cause the damages



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Risk = Hazard ✘ Exposure ✘ Vulnerability

Understanding Normal Flood Vs Flash Flood

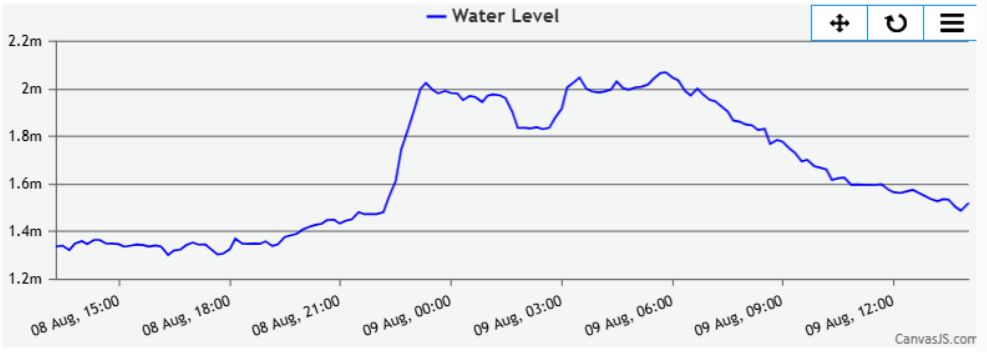
Normal Flood

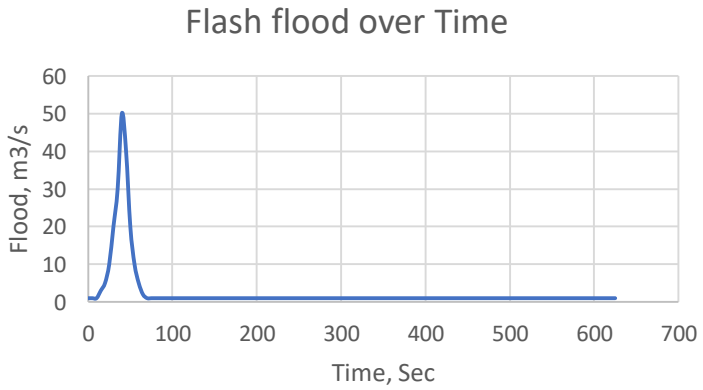
Flash Flood

Aspect	Flood	Flash Flood
Water Level Rise	Gradual rise (typically 30 minutes to 6 hours or more)	Sudden and rapid rise (within seconds to a few minutes)
Catchment Area	Large catchment	Small catchment
River Slope	Low to moderate	Steep slope
Channel Width	Large channel width	Narrow channels or urban drainage systems
Cause	Prolonged rainfall, snowmelt, dam overflow	Glacier Lake Outbrust Flood (GlOF), Cloud Brust, Landslide Dam Outburst Flood (LDOF)

Understanding the Flood Vs Flash Flood

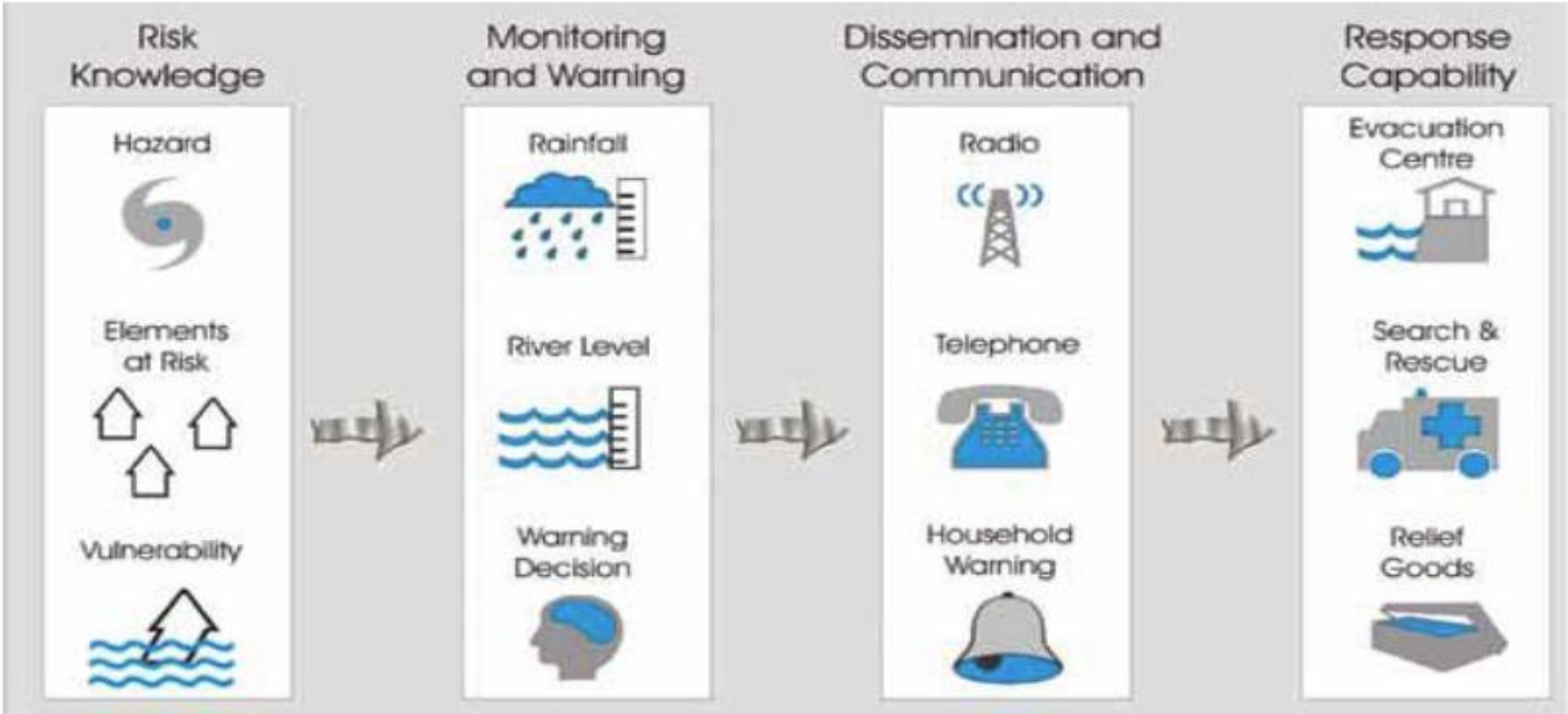
Aspect	Normal Flood	Flash Flood
Debris Content	Low to Moderate	Exceptionally High Debris Flow
Impact Area	Wide area	Localized, often more intense impact
Duration	Can last for days or weeks	Short duration (typically a few hours)
Monitoring & Early Warning System	Easier to monitor; early warning systems more effective	Difficult to monitor; little to no warning time



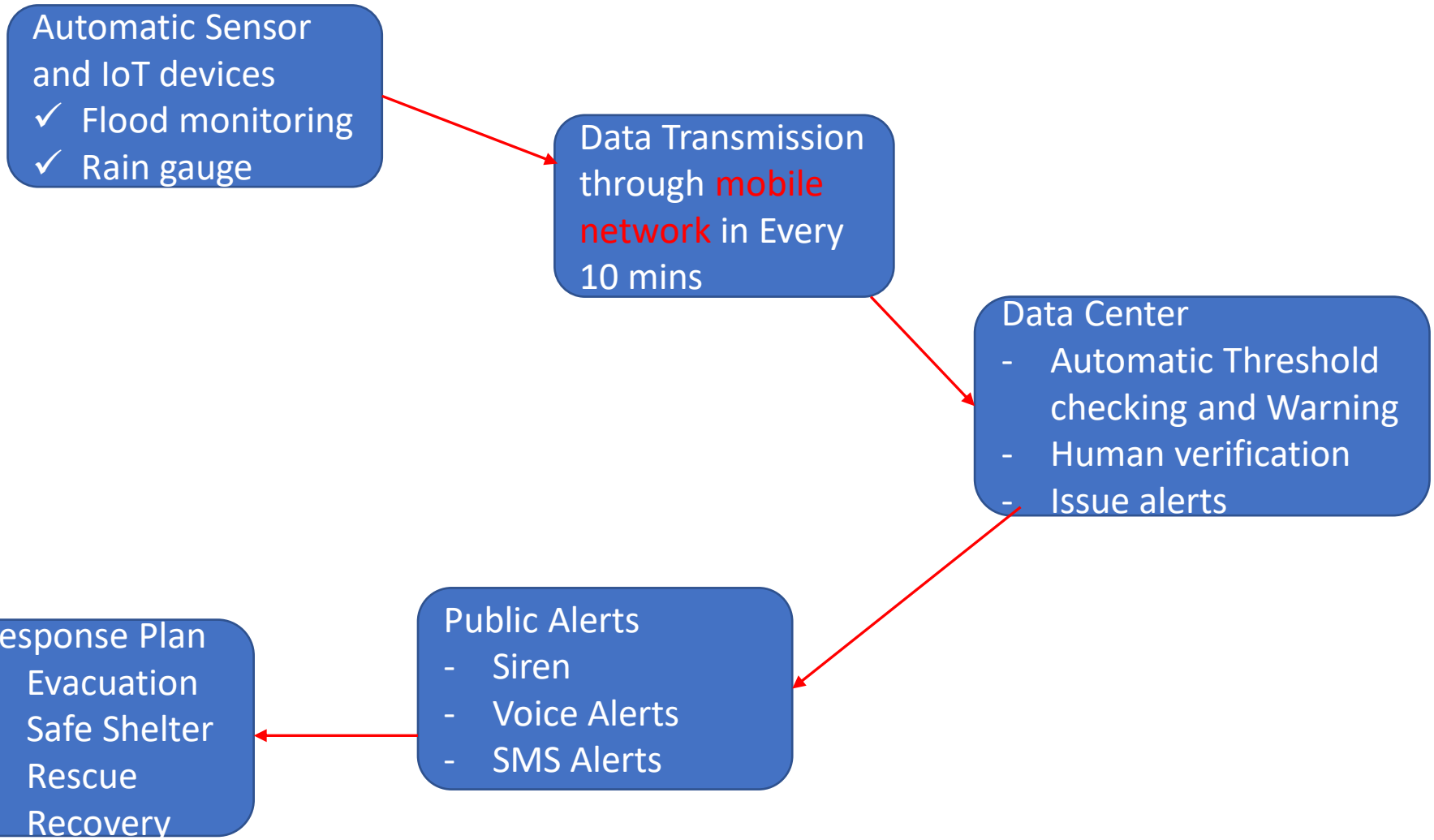


Basics of Early Warning System

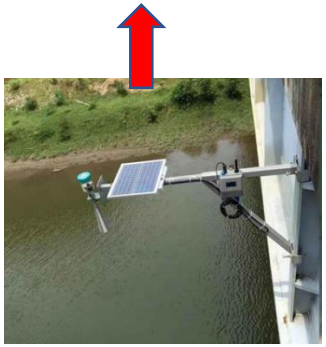
- Early warning for All - set by **UN Secretary-General António Guterres** in **2022**, giving a **five-year timeline** to achieve global early warning coverage against climate-related hazards and disasters
- In **2023**, Nepal was selected as one of the **first 30 countries** to **roll out the EW4All initiative**.
- Four pillars of the Early Warning System



Monitoring and Early Warning System of a normal Flood



Monitoring and Early Warning System of a Normal Flood



Flood Sensor, rain gauge and Datalogger

Telecommunication

Human Verification

Data Center

Siren and Group SMS Alert

Working Principles:

- Flood Level Monitoring by Automatic Sensor in River at 10-20 km upstream
- Data transmission through mobile network to Data Center in every 10 mins
- Checks Warning and Danger Level Threshold in Data Center
- Activates Siren and Issue Group Alerts in Flood Risk Area

Example of SMS ALERT

FLOOD INFO!
Status: Above Warning Level
Project:------Tanahu Seti HPP
Parameter:----Flood Level at Coffer Dam
Current Value:324.4312masl at 2025-07-29 12:14:21

FLOOD INFO!
Status: Normal
Project:------Tanahu Seti HPP
Parameter:----Flood Level at Coffer Dam
Current Value:324.3997masl at 2025-07-29 13:05:02

Question to all

Can we treat Flash Flood in a similar way ??

NO !

Because 10 mins monitoring time is very long time incase of Flash Flood. Flash Flood can occur and settle within few minutes.

Monitoring and Early Warning System of Flash Flood

Flood and Rain Sensor, Datalogger

Wireless Repeater

Wireless Repeater

Human Verification

Data Center

Wireless or GSM Network

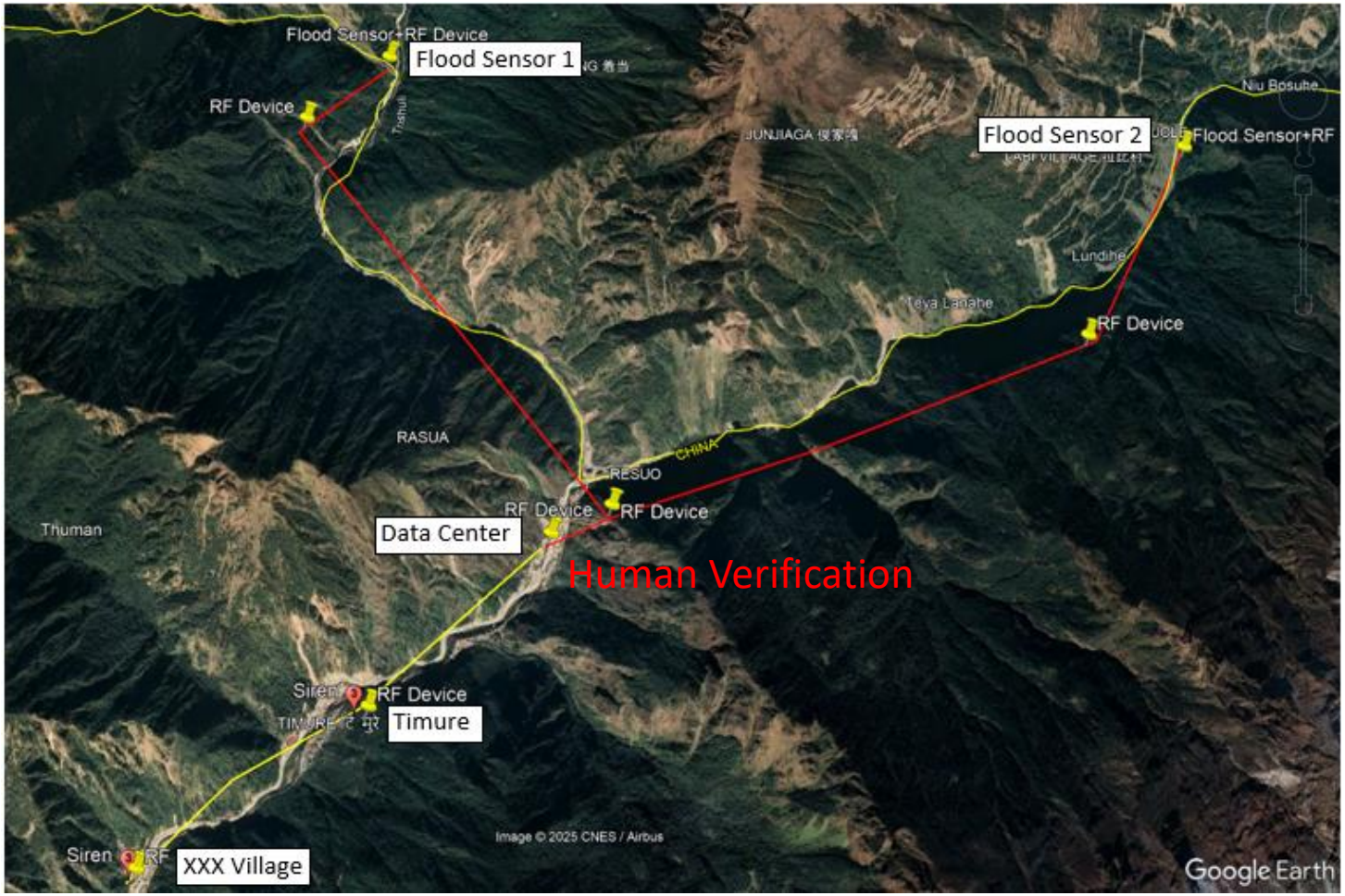
Wireless or GSM Network

Wireless Siren and Group SMS Alert

Working Principles:

- Flood Level Monitoring by Automatic Sensor in River at 8-10 km upstream
- Data transmission through wireless repeaters to Data Center in every second
- Checks Warning and Danger Level Threshold and triggers siren in Data Center
- Activates Sirens in Flood Risk Areas through wireless or mobile network from Data Center

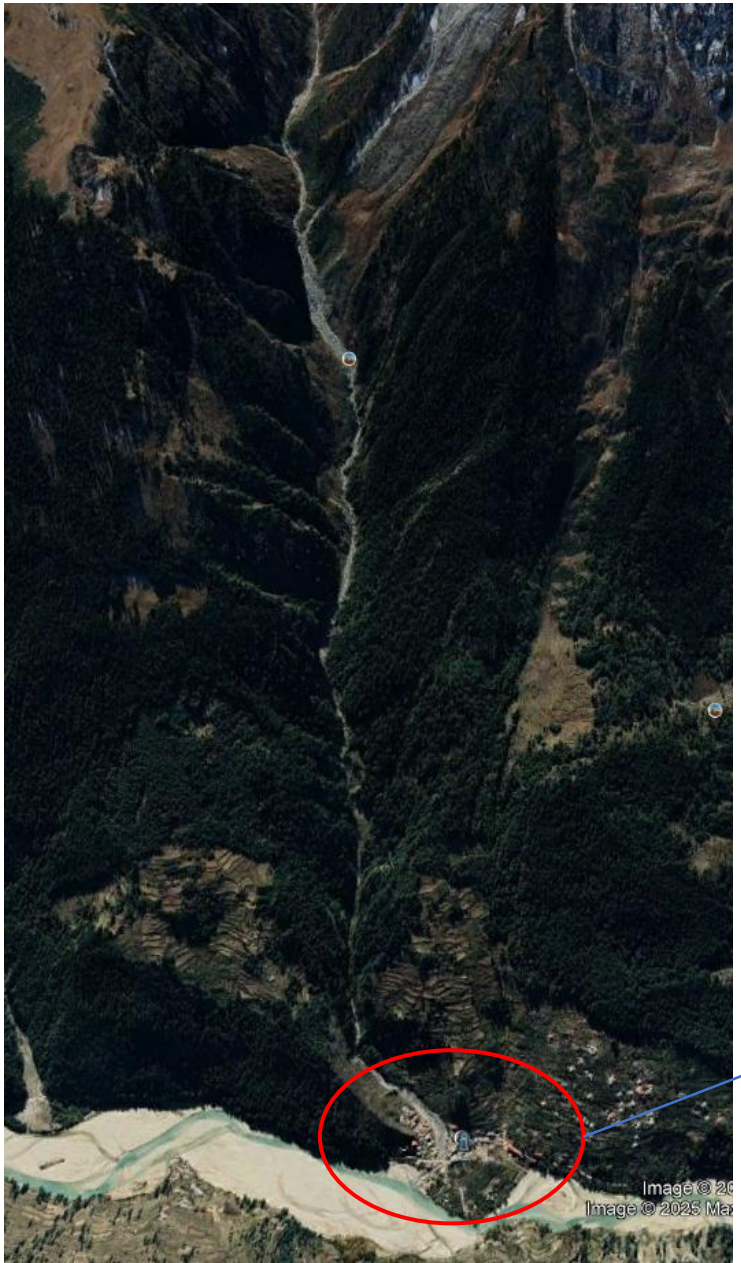
Case Example: Rasuwagadhi Flash Flood, Nepal



Working Principles:

- Automatic Flood Sensor at 6-8 km in both Rivers
- Data transmission through wireless repeaters to Data Center in every second
- Checks Warning and Danger Level Threshold and triggers siren in Data Center
- After confirmation, activates sirens in Flood Risk Areas through wireless or mobile network from Data Center

Case Example: Dharali, Uttarkhand, India



Realtime Sediment Monitoring

- Flash flood transports huge volume of sediment
- Realtime sediment monitoring helps take **timely operational decisions** (e.g., gate closure, intake flushing, diversion), minimizing wear and structural damage of Hydropower Projects

Different type of sediment sensors:

Feature	**OBS (Optical Backscatter Sensor)**	**ABS (Acoustic Backscatter Sensor)**
Principle	Measures light scattered by suspended particles	Measures sound waves reflected by suspended particles
Suitable Particle Range	Fine particles (silt, clay)	Wide range (silt to coarse sand and gravel)
Turbidity Dependency	Affected by water clarity/light	Not affected by turbidity or water color
Calibration	Requires frequent calibration for different sediments	Less frequent calibration; more stable over time
Interference Sensitivity	Affected by biofouling, air bubbles, algae	Less sensitive to optical interference
Installation Flexibility	Must be installed in clear water zones	Can be deployed in harsh, high-sediment environments

Conclusion

- Normal flood can be monitored easily with sufficient lead (evacuation) time
- For flash flood monitoring, special design should be carried out due to its fast occurrence
- Who are at Risk?
  - ✓ Peoples residing on River banks
  - ✓ River dependent peoples such as fishermen
  - ✓ River side hotels and resorts
  - ✓ Construction Workers who are working in River for infrastructure constructions
  - ✓ Water resources infrastructures

Lets ask: is there any Flood Early Warning System in the areas you are living, visiting and working ?

Conclusion

- We Know: Many areas are at Flood Risk
- Now, we Know: We have an effective solution too.

Then what is lacking to implement such early warning system in Nepal?????

- Lack of Risk Knowledge ??
- Inadequate monitoring system ??
- Unreliable communication system ??
- No response plan ??