Geospatial and IoT Solutions for Smart Lake Monitoring in India

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Water is crucial for human survival, but its excess can lead to floods, while its scarcity can cause droughts. Monitoring water levels in both urban water bodies and remote glacial lakes is essential to prevent disasters like urban flooding and Glacier Lake Outburst Floods (GLOFs). Traditional water level sensors deteriorate over time due to exposure to moisture, temperature, and humidity, while satellite and airborne data suffer from delays in processing. To address this, a real-time monitoring system is necessary. The proposed buoy system, housed in an airtight container, overcomes physical constraints and data latency issues by leveraging LoRa WAN for communication and Apache Flink for Complex Event Processing (CEP).

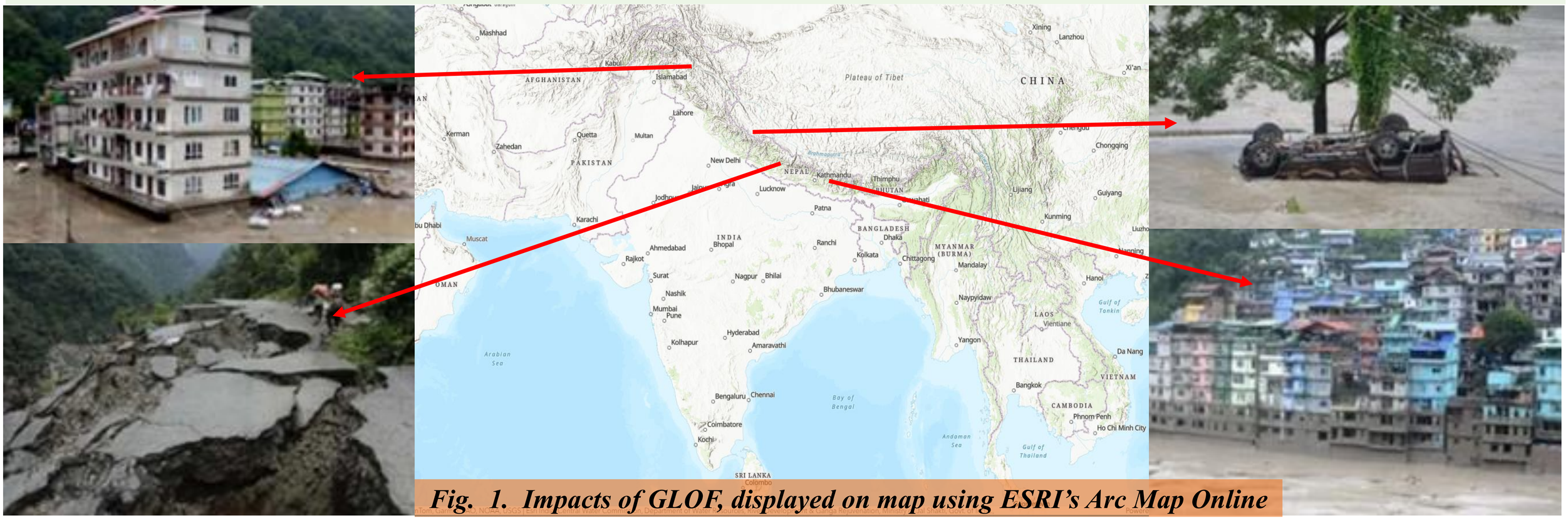


Fig. 1. Impacts of GLOF, displayed on map using ESRI's Arc Map Online

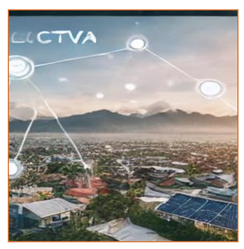
Need of the study

Hazard Risks from Rising Water Levels – Excessive lake water levels can cause floods, infrastructure damage, financial losses, and even fatalities, as seen in the 2023 GLOF event in Sikkim's South Lhonak Lake.

Need for Early Warning Systems – Densely populated regions, especially in High Mountain Asia, require real-time monitoring due to the increasing frequency of GLOFs, landslides, and other disasters.

IoT for Real-Time Monitoring – IoT-based sensors enable instant data transmission, allowing authorities to respond quickly and reduce casualties and property damage.

Limitations of Existing Methods – Satellite imagery has high latency and costs, CCTV cameras require illumination, and traditional water level sensors face accuracy and reliability issues.



LoRaWAN for Remote Sensing – The system uses LoRaWAN for long-range data transmission, enabling real-time analytics, nowcasting, and forecasting, making it ideal for remote and inaccessible regions.

Methodology

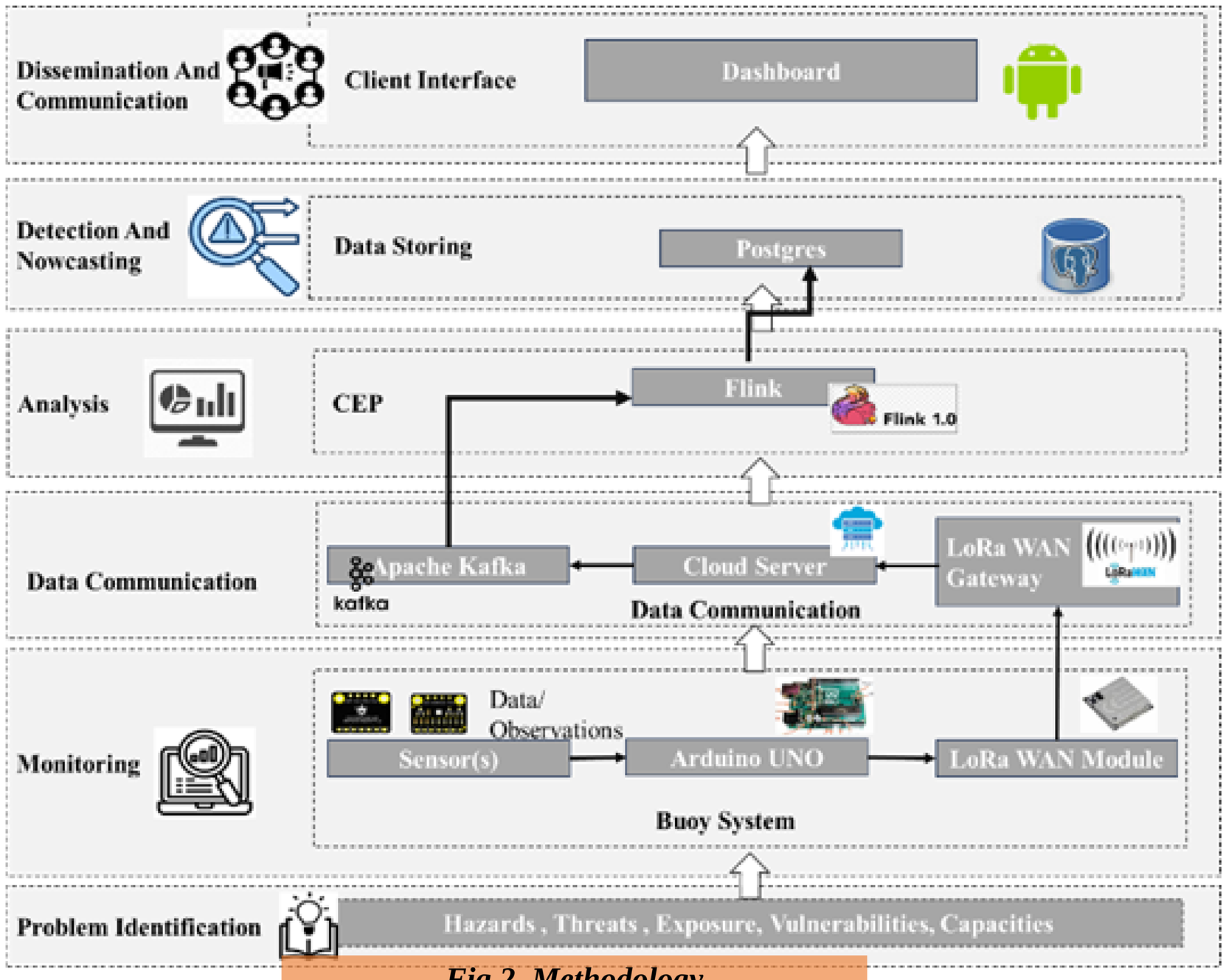
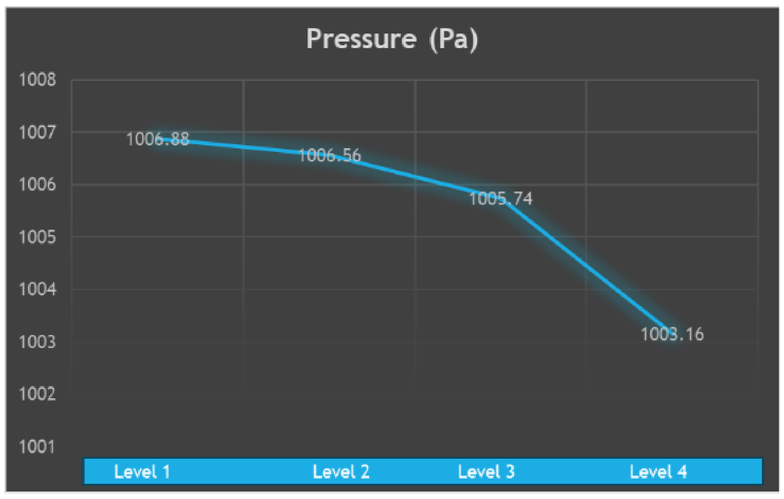


Fig.2. Methodology

Preliminary Work



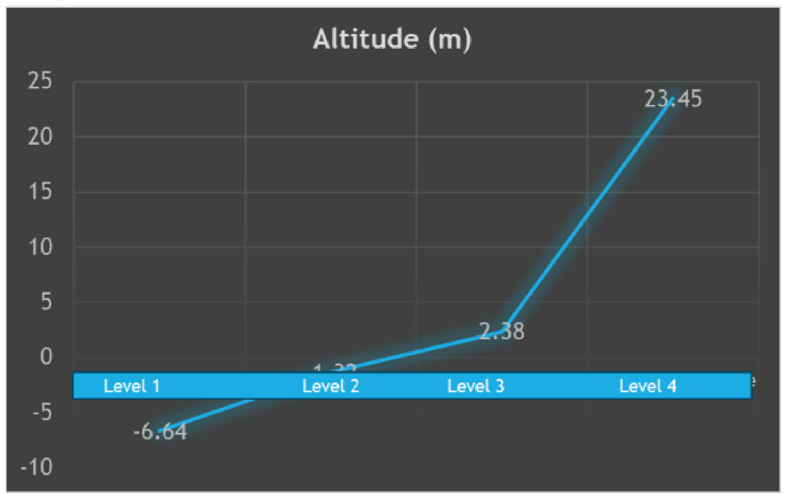


Fig. 3. Experimental readings

The setup was taken with a microcontroller and measurements were taken at four levels level 1, level 2, level 3, and level 4. the results are shown and visually represented using the graph as above.

Conclusion

The increasing frequency of natural disasters, particularly Glacial Lake Outburst Floods (GLOFs), has underscored the urgent need for effective and real-time monitoring systems to mitigate such risks. The proposed buoy-based water-level monitoring system addresses these challenges by utilizing IoT and advanced data processing, to provide cost-effective, scalable, and reliable approach to monitor GLOFs, offering invaluable support for geospatial monitoring and disaster management in glacial regions by combining IoT technologies.