

Hybrid LoRa (HyLoRa): Case Study & Limitations

Upgrading with UAV-DTN and Federated Learning

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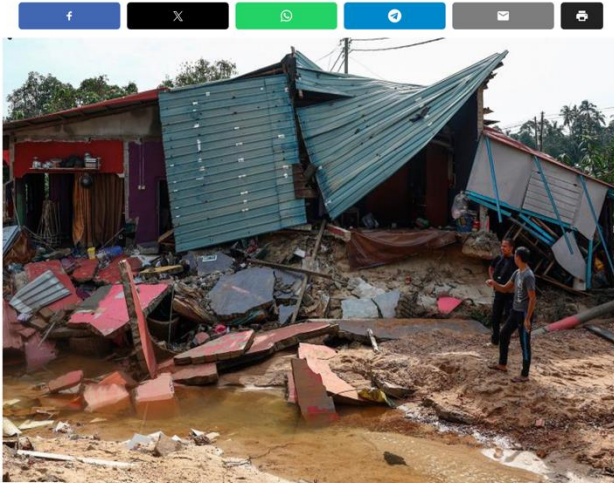
Motivation

- Flood-prone regions in Malaysia → need reliable monitoring & communication
- Some villages often lack mobile coverage
- Goal: Enable resilient, community-based alerting & data collection

Kelantan suffers over RM30m losses due to first wave of floods – Exco

Bernama

2024-12-12 04:04 PM



Malaysia – Floods Displace Over 40,000

20 DECEMBER, 2021 BY RICHARD DAVIES IN ASIA NEWS



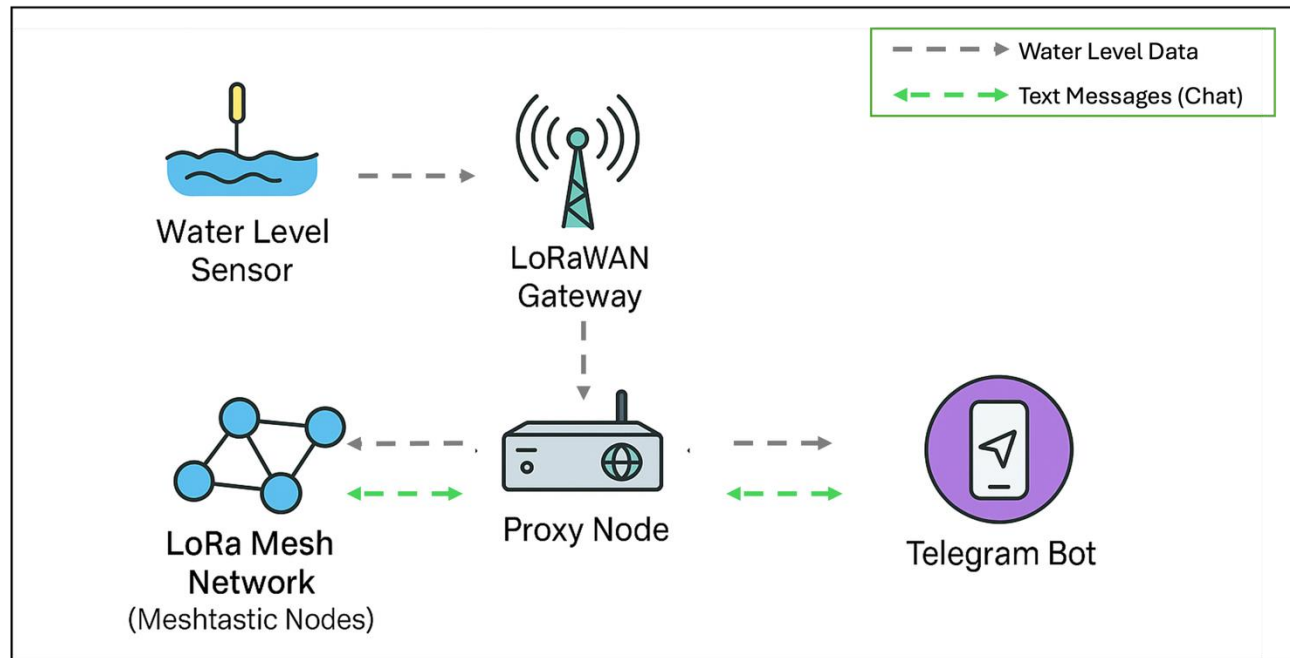
Flooding in **Malaysia** has displaced over 40,000 people according to the country's disaster agency. The Bernama news agency reports at least 1 fatality with 10 people missing.



Flood turns Pahang into an ocean of 'teh tarik'

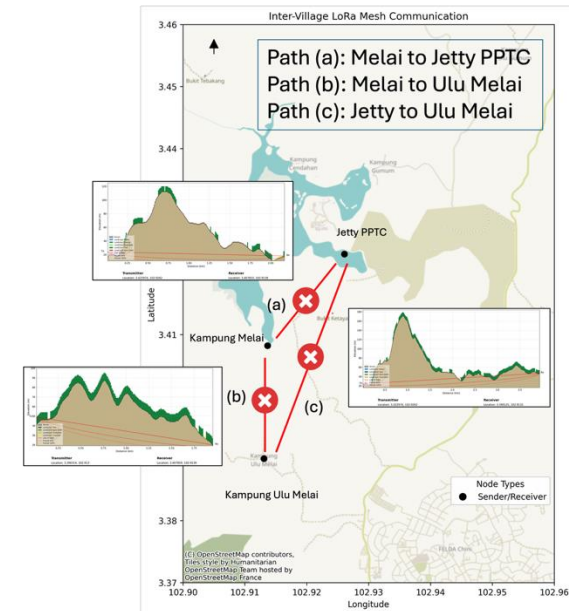
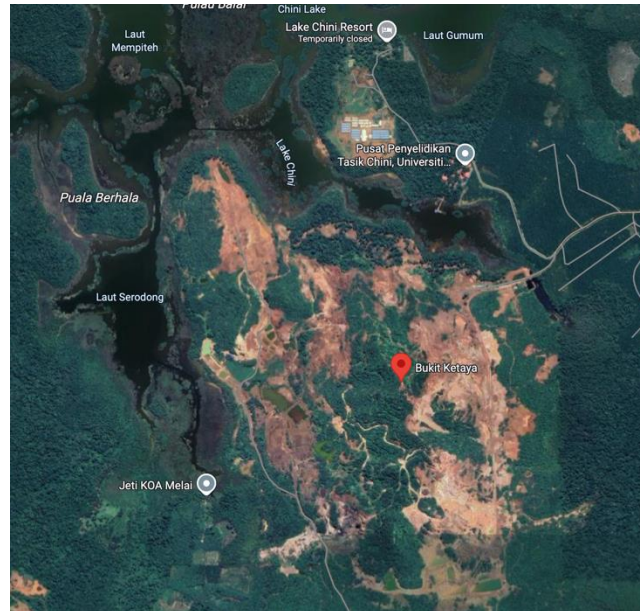
HyLoRa Overview

- It bridge LoRaWAN + LoRa Mesh via proxy node
- Supports both community messaging + water-level monitoring



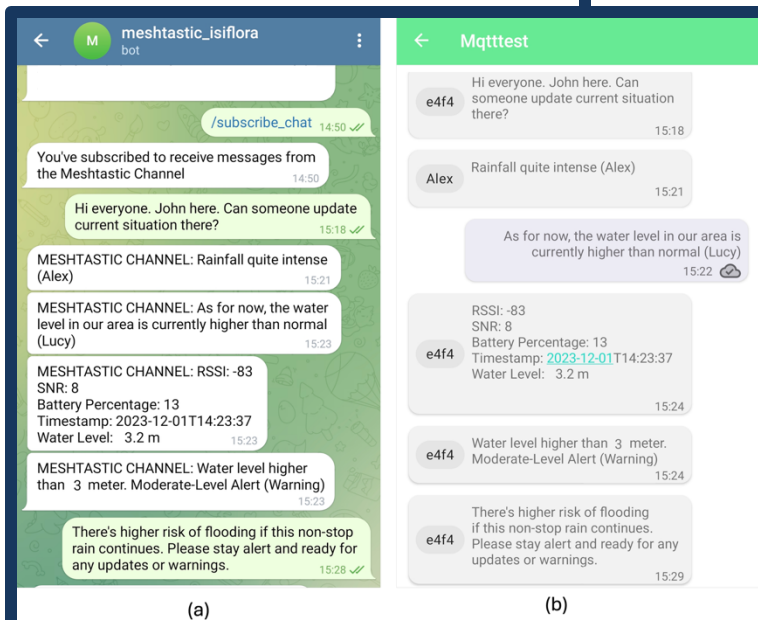
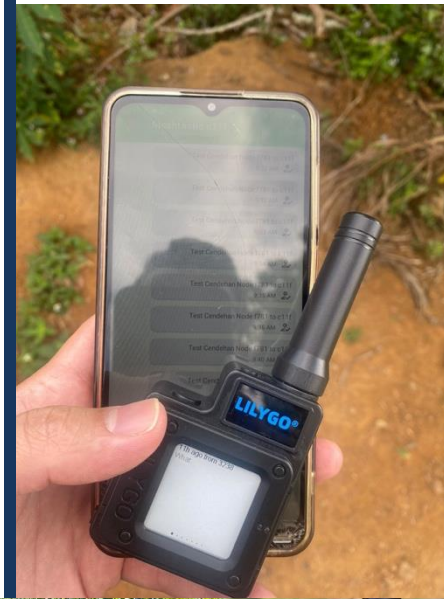
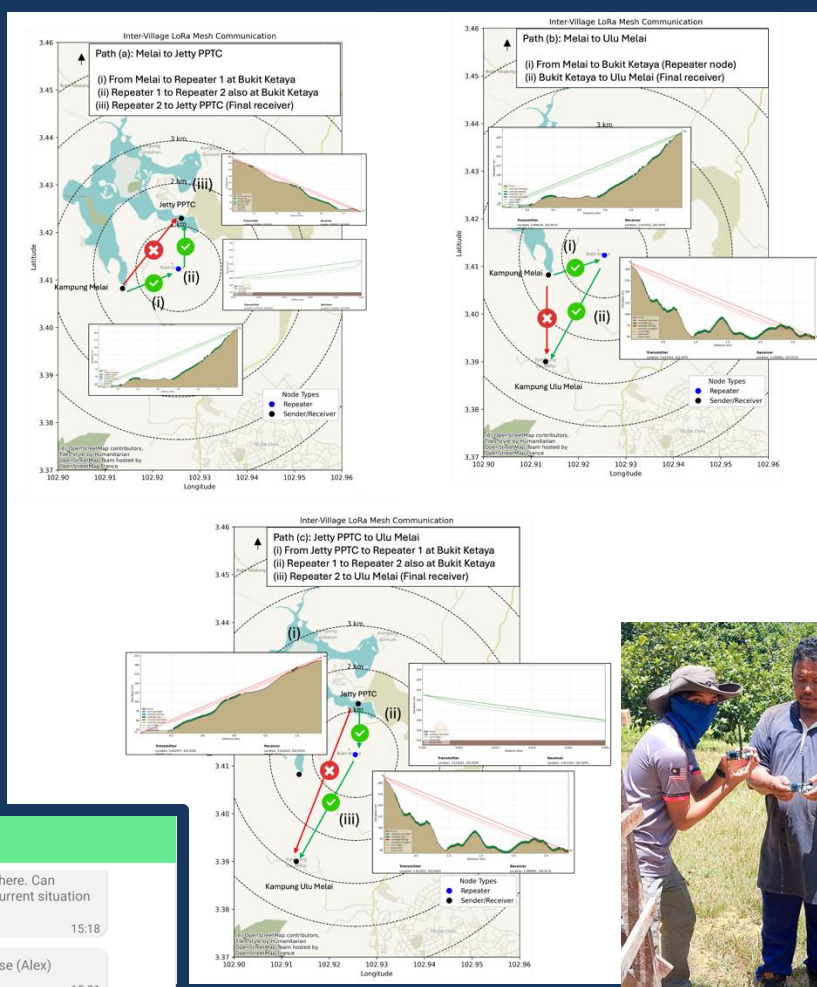
Case Study Deployment

- Water-level stations integrated with LoRaWAN
- To Provide reliable water level monitoring and timely updates to villages around Lake Chini
- To establish communication between Inter-village links: 1.9–3.9 km with terrain challenges.

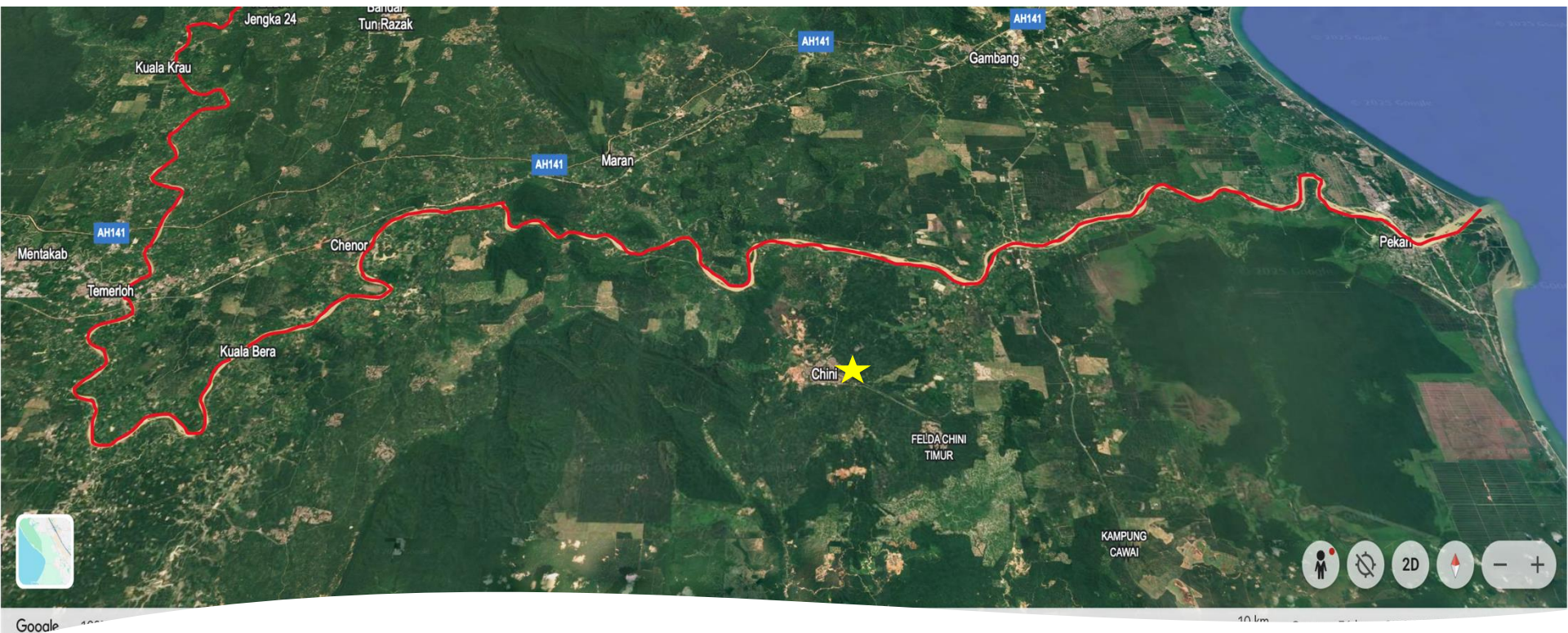




Result



- Achievements: messaging without cell coverage, water level update, LoRa user can messaging with Telegram user.

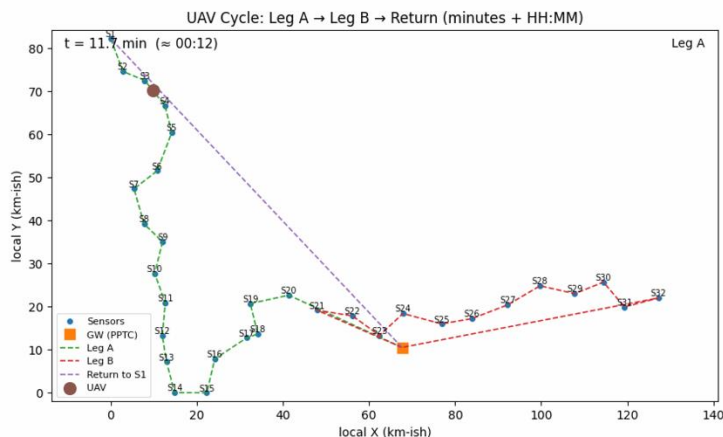


Limitations Observed

- Coverage gaps due to hills/forests
- Reliance on fixed gateways, and fixed proxy node → Difficult to maintain/repair equipment in hilly terrain.
- Delays when nodes can't reach gateway
- Buffer overflows (sensor storage limits)
- Not scalable to 30+ stations, to cover 459 km of Pahang River.

HyloRa+: UAV + DTN

- UAV as data mule (store–carry–forward)
- Extends reach to isolated sensors
- Collects and ferries packets to gateway
- UAV as flying proxy node bridging LoRaWAN
↔ mesh



- UAV starts at **S1** and visits all **32 stations** sequentially
- Performs **mid-route flush at k=20** to gateway
- Flies at **90 km/h**, stops **15 s per node** for data exchange
- Returns to gateway at end of sortie to offload remaining data
- Ensures delivery within **6 h TTL**.

HyLoRa+ Federated Learning — 1 Hour WL Forecast

Concept	Sensors train locally (168h → next 1h) UAV collects model updates Each flush = 1 FL round
Setup	32 stations (S1–S32) UAV 90 km/h, 15s contact/stop Payload 100B, TTL 6H Buffers: sensor 36 pkts, UAV 5000 pkts Policy: drop_oldest + TTL purge
Route	Start S1 → collect Flush 1: S1–S20 → GW Flush 2: S21–S32 → GW
Results	MAE ↓ 0.556 → 0.096 (by round 7) SF10 best; SF12 under-delivers for 15s contact DTN buffering improves delivery
Insights	Every flush = new global model UAV extends coverage & reliability