



Harnessing Satellite Data and AI for Flood Risk Management: Innovative Space-Based Approaches to Emergency Management and Environmental Monitoring

32nd IAF Workshop – Resilient Coasts, Resilient Earth: “Innovative Space Solution for Coastal Resilience and Emergency management”

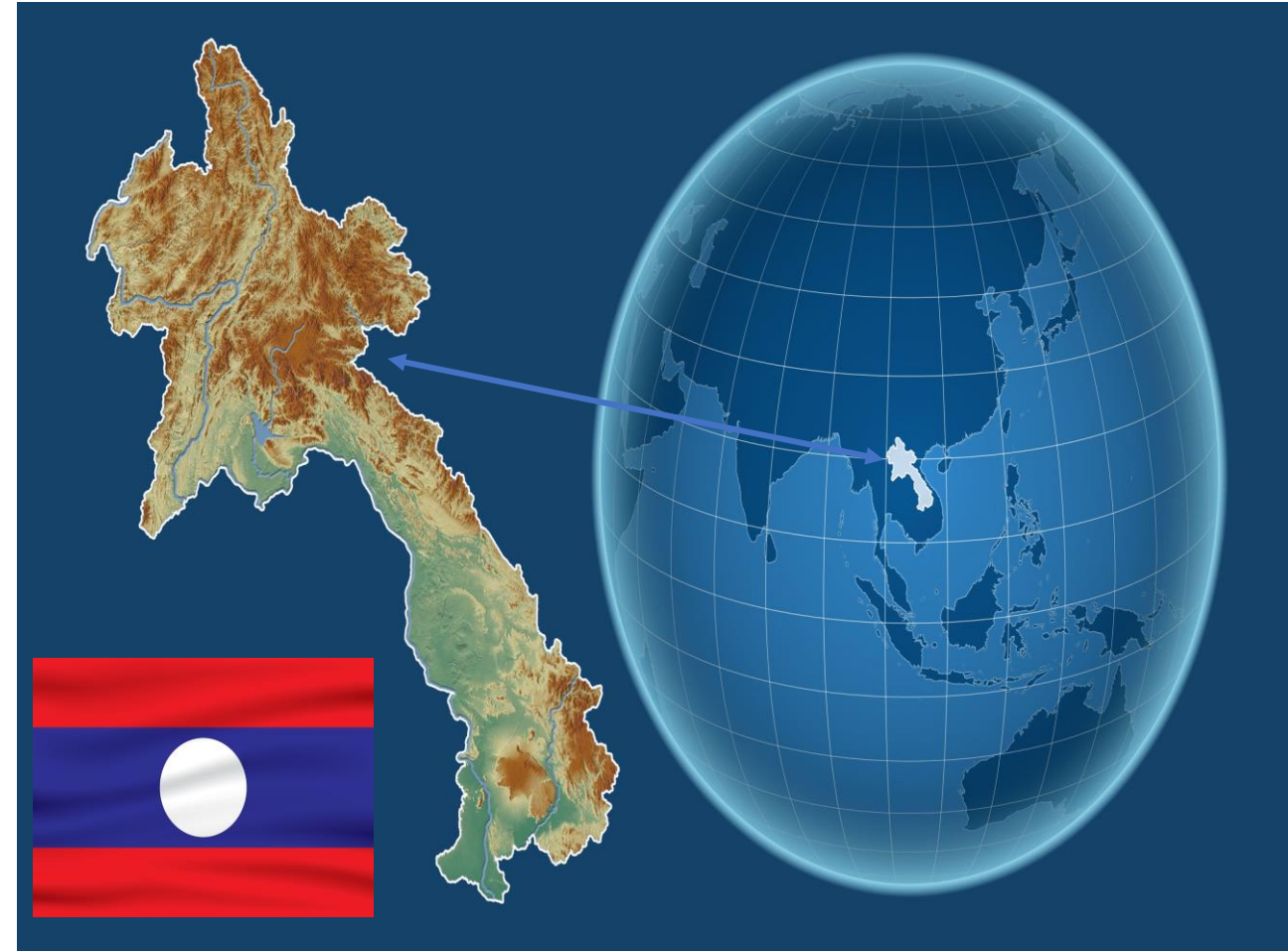
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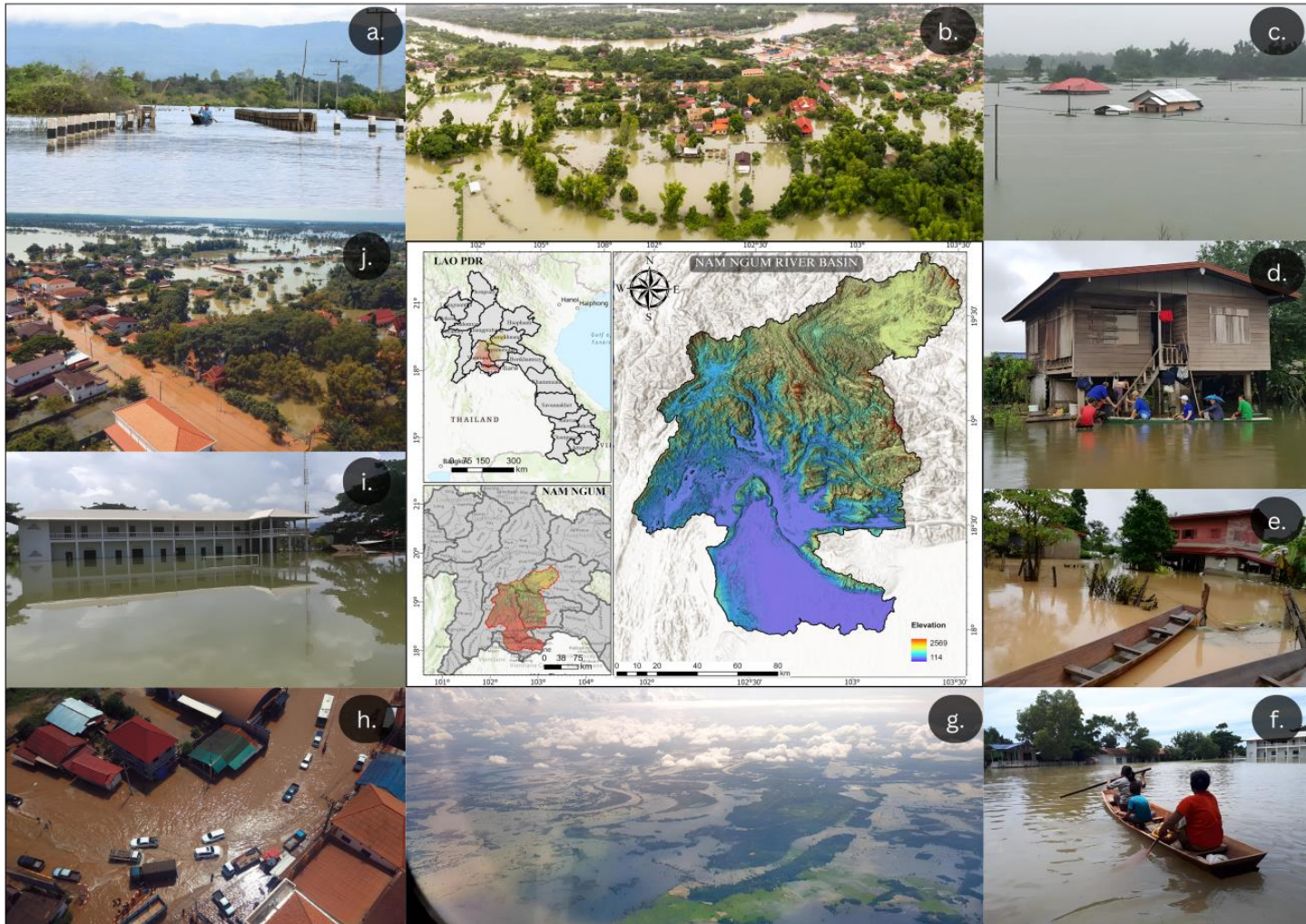
Overview-Water Resources in Lao PDR

- ✓ Lao PDR is located in Southeast Asia with total area of 236,800 km²
- ✓ River and mountain cover 70% of the country
- ✓ 90% of the country's territory is located in the Mekong Basin.
- ✓ The Mekong is a river flow nearly 1,800 km from north to south
- ✓ Water resources per capita is around 55,000 m³ per year
- ✓ 35% of annual flow (or equal 270,000 m³) in Mekong tributaries
- ✓ Monthly river flow follows 80% rainy season and 20% dry season



Source: <https://www.mappr.co/counties/laos-provinces/>

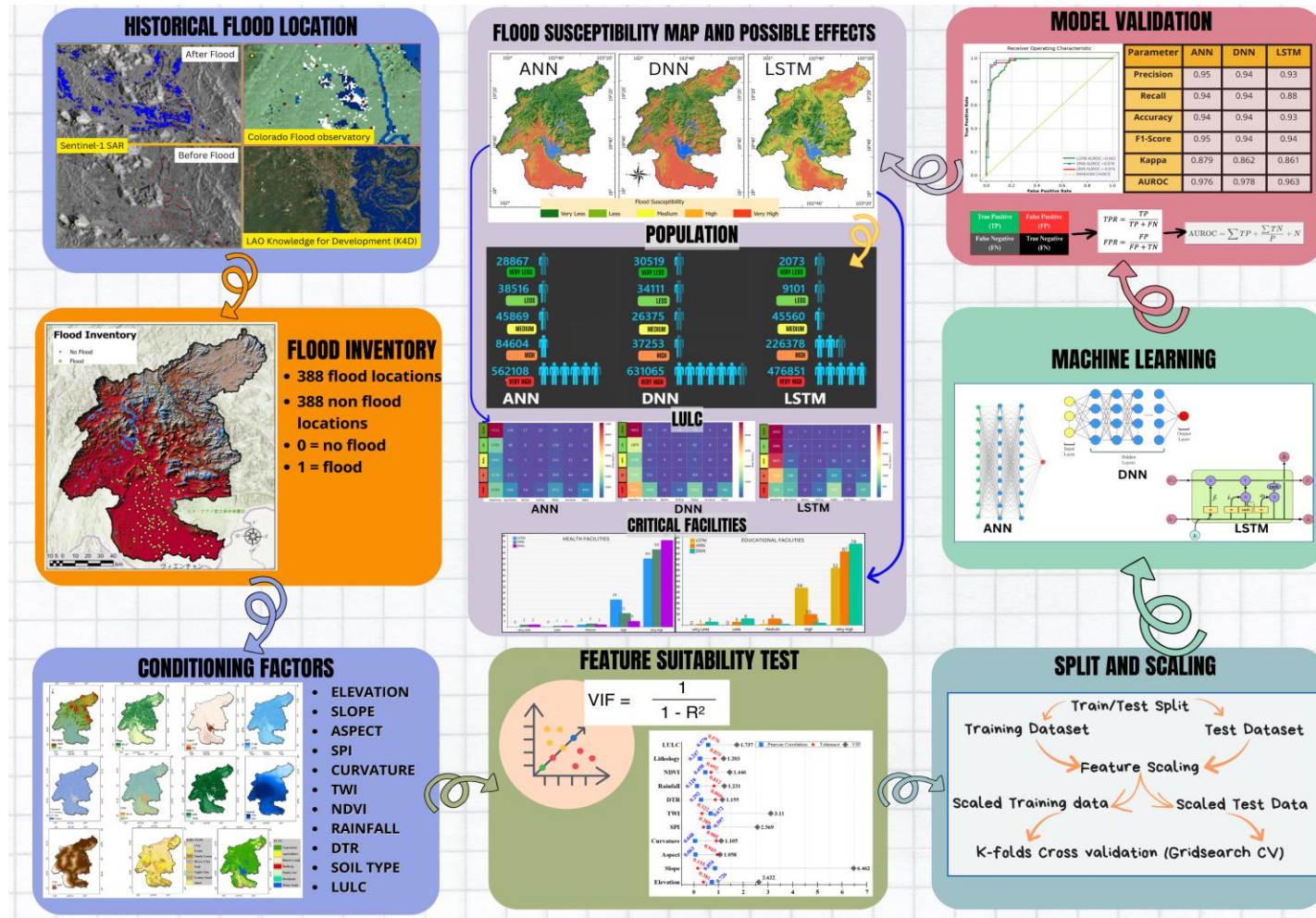
Study area



- Lao PDR, the only **landlocked country** in Southeast Asia, spans 236,800 km², with 90% in the Mekong River Basin. The Nam Ngum River flows from the Xiengkhouang plateau to the Nam Ngum 1 reservoir, through the Vientiane Plain, and joins the Mekong near the capital.
- The Nam Ngum River Basin, spanning 16,800 km², comprises **hilly and mountainous terrain**, with elevations ranging from 2,569 meters to 114 meters above sea level

Figure 1. The Study Area: The Nam Ngum River Basin and Photographs of flooding during 2018

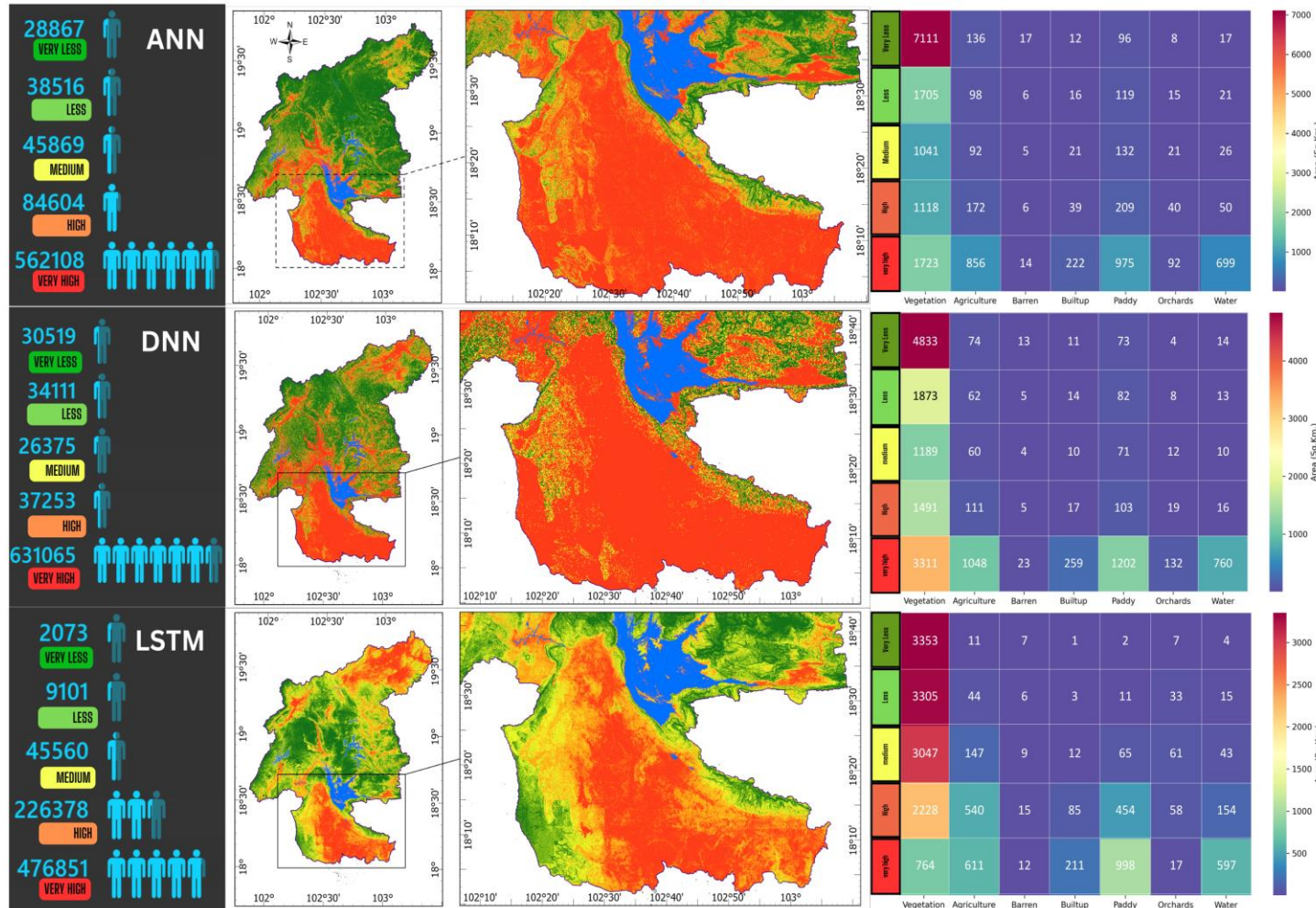
Methodology



- The study collected geospatial data from multiple sources: **ALOS-PALSAR DEM**, ERA5 rainfall data, **NDVI** from Landsat 8, and **LULC** data from Sentinel-2 images.
- Flood locations were identified using **Sentinel-1 SAR** images, the Colorado Flood Observatory, and the Knowledge for Development portal

Figure 2. Schematic diagram of the flood susceptibility mapping in Nam Ngum River Basin

Result



For the "Very High" susceptibility category, the DNN method indicates the highest impact.

In the "High" category, LSTM reports a notably high number of 226,378 affected individuals, compared to 84,604 for ANN and 37,253 for DNN.

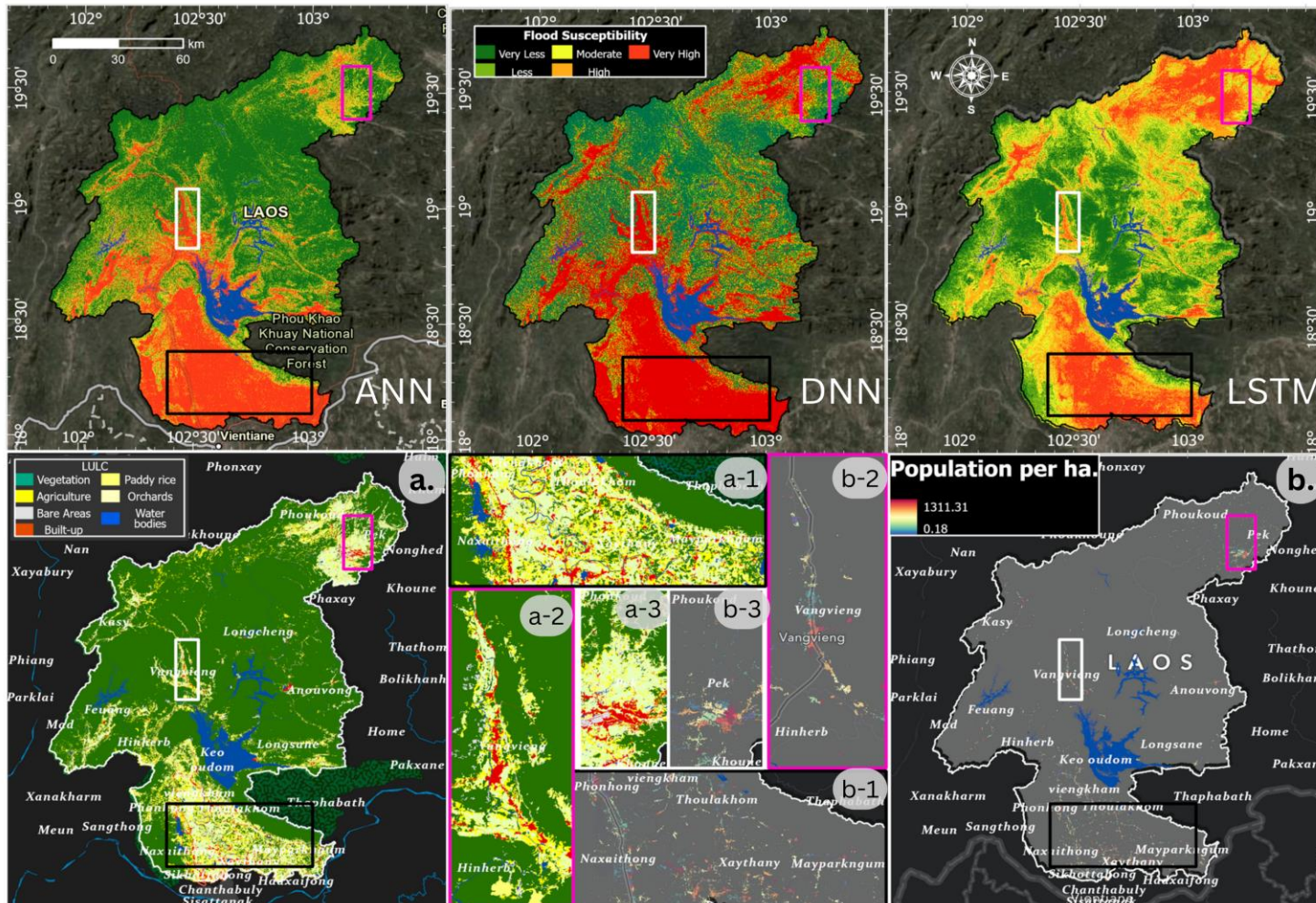
The "Medium" susceptibility shows similar impacts for ANN (45,869) and LSTM (45,560), both higher than DNN (26,375).

The "Less" susceptibility category affects 38,516 individuals for ANN, 34,111 for DNN, and significantly fewer for LSTM (9,101).

Finally, the "Very Less" category sees DNN and ANN affecting 30,519 and 28,867 individuals, respectively, while LSTM affects only 2,073.

Figure 7. Scenarios of the effect of flood susceptibility on Population and Land use / Land Cover

Result



- Most built-up or highly populated areas are in very high flood-risk zones
- Densely populated downstream areas of NNRB are highly vulnerable to flooding.
- Upstream areas of the Nam Ngum Reservoir in Vangveing District and Pek District are highly vulnerable to flooding
- Most less flood-prone areas are vegetated, highlighting vegetation's crucial role in flood control

Figure 8. Flood Susceptibility to a.Land use/Land cover, and b.Population
(a-1. & b-1. Downstream of NNRB (Naxaithong, Xaythany and Thaulakhom area), a-2. & b-2. Vangvieng Area, a-3 & b-3 Upstream of NNRB (Pek Area)
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Result

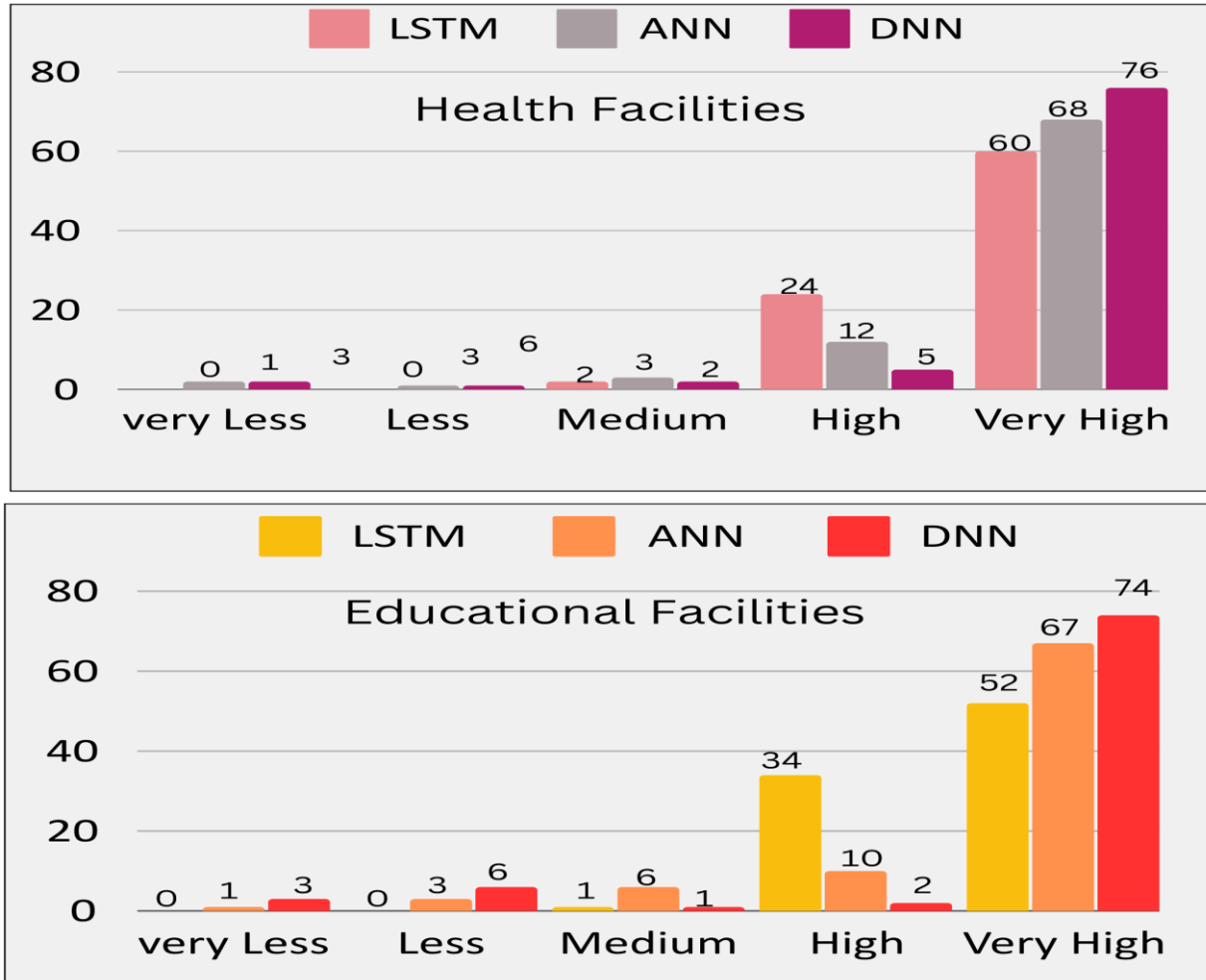


Figure 9. Possible Effects of Flood on the Health and Educational Facilities in NNRB

- For health facilities, **DNN**, **ANN**, and **LSTM** predict 76, 68, and 60 facilities lying in "Very High" susceptible areas.
- Similarly, **LSTM** predicts 24, followed by ANN with 12, and DNN with five facilities in highly susceptible areas.
- For educational facilities, **DNN** predicts 74, ANN predicts 67, and **LSTM** predicts 52, lying in very highly susceptible areas
- In the highly susceptible areas, **LSTM** predicts the most affected facilities with 34, followed by ANN with 10, and **DNN**

Conclusion and Future Work

Conclusion

- ✓ In the case of the Laos river basins, flood susceptibility mapping using deep learning approaches is very **limited or almost not started**.
- ✓ The study **highlights** using **publicly available remote sensing datasets** for **flood prediction and susceptibility mapping**
- ✓ To **support** local authorities, urban planners, policymakers, and stakeholders in **disaster management and climate change mitigation**
- ✓ **DNN** model outperformed in deep learning model based on AUROC

Future work

- ✓ Develop **flood early warning** systems for similar regions.
- ✓ Develop an **automatic flood detection technique** is crucial for timely mapping and real-time hazard analysis
- ✓ Explore a hybrid model combining **hydrodynamic and deep learning techniques** to predict flood-prone areas, velocity, and depth
- ✓ Increase the **conditioning factor, label training data**, and employ advanced **deep-learning models** for enhanced flood modeling.



Thank you for your attention ☺