Improving free topography data for more reliable flood modelling in data-scarce regions

Michael Meadows,[1] Prof Simon Jones[1] and Assoc Prof Karin Reinke[1]

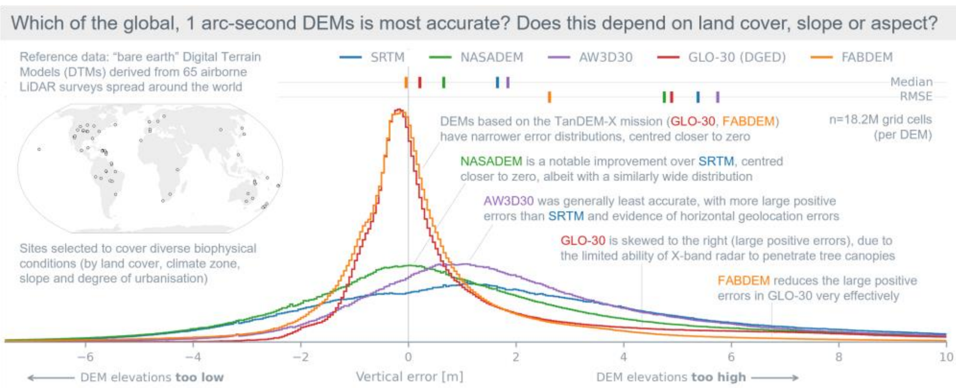
[1] Faculty of Geospatial Science, School of Science, RMIT University, VIC

Correcting vertical errors in a global Digital Elevation Model, to derive a “bare earth” terrain surface for flood modelling in data-scarce regions

Flood modelling relies on accurate topography data but in much of the world the only options are the free global Digital Elevation Models (DEMs), known to suffer from significant vertical errors. My research explores ways to correct these errors, to enable more reliable flood hazard and risk modelling where it’s needed most.

Flood modelling is increasingly important

Flood impacts are rising globally, driven by increasing human exposure and the higher hydro-meteorological variability associated with climate change. Especially given these changing drivers (which mean that past events are less reliable guides to future risk), flood modelling is an important tool in understanding and reducing flood risk, enabling emergency managers and planners to prepare for possible future flood events.



Topography accuracy is crucial

Accurate topography data is a critical requirement for flood models, given their sensitivity to even minor vertical errors. Ideally, these data are derived from airborne LiDAR surveys, which penetrate vegetation canopies and filter out buildings to map the “bare earth” surface. These are increasingly common in high-income countries but remain rare elsewhere, where the risk to lives and livelihoods is often higher.

For this reason, many flood models rely instead on free global DEMs, despite well-known vertical errors associated in part with the inability of spaceborne sensors to fully penetrate vegetation canopies to record the ground surface beneath. When used in a flood model, these vertical errors act as artificial obstructions that block or divert simulated flows, often resulting in misleading flood assessments.

Can we predict (and remove) vertical errors in DEMs?

However, since at least some of these errors relate to vegetation and buildings, it is possible to reduce them using complementary remote-sensing data products (e.g. canopy heights and building footprints).

Machine learning (ML) algorithms are well suited to predicting the correction patterns involved, given their capacity for handling large input datasets and complex, non-linear relationships. My research is exploring the predictor variables and ML models/architectures most useful for predicting these vertical errors, with a focus on global applications that use only free, open-access datasets and tools, to maximise real-world impact.

Model explainability, dependencies & uncertainty

Past studies on DEM correction have generally focused on predictive performance without interrogating the model itself – what are the patterns learned (do they make physical sense?), in what ways are models dependent on their training data, and can we quantify residual uncertainty and how it varies? However, these are essential questions if these models are to be used in real-world applications potentially affecting people’s lives and livelihoods. My research addresses these questions using state-of-the-art explainable AI (XAI) techniques, such as Shapley Additive exPlanation (SHAP) values.

Further information

For additional information scan the QR code or contact:
Michael Meadows, PhD Candidate, RMIT University
michael.meadows@student.rmit.edu.au

Australian Government

RMIT UNIVERSITY