FORECASTING FLOODS IN MALAYSIA

SOPHISTICATED NEW MODELLING TECHNIQUES ARE ENABLING IMPROVEMENTS IN FLOOD RISK ANALYSIS. **PAUL DRURY** EXPLAINS HOW GEOSPATIAL DATA AND SYSTEMS HAVE BEEN HELPING THE MALAYSIAN GOVERNMENT TO RESPOND MORE EFFECTIVELY TO FLOODS

Flooding is a natural hazard that poses a major threat to life and property. With increasing land development pressure and a rise in the frequency and severity of floods globally, there is a growing urgency for governments to adopt new solutions for reducing the impacts of flooding. Whilst it is often impossible to prevent floods, there is much that can be done to lessen the severity of their impacts. From a geospatial perspective, this means investing in quality data to help understand flooding processes and integrated systems to visualise and interpret flood information.

Ambiental Risk Analytics has developed modelling techniques that take multiple spatial datasets to simulate real world processes. Digital terrain models are central to this process and ideally LiDAR of 5m grid resolution or better is used for achieving the highest precision. Coupled with this are multiple geospatial layers describing soils, geology, hydrological features and land use – which all influence the rates of water flow and infiltration within the model.

Another critical model component is data that describes how much water to put into the model, whether that be river flows, rainfall intensities or sea levels. Historic records from rainfall, river flow and sea level gauges enable hydrologists to form a statistical view of the past and determine the probability of flood occurrence based on the frequency of historic events. Additionally, by incorporating rainfall forecasts into a model, it is possible to predict where and when a future flood event will strike.

These technologies have been helping the government of Malaysia to prepare for and respond to the severe floods that regularly affect the country, especially during monsoon seasons.

Introducing EASOS

The Earth and Sea Observation System (EASOS) is a pioneering solution first launched in Malaysia but with a worldwide capability. EASOS provides actionable intelligence technologies for environmental risk management and emergency response coordination. It has a simple goal of making the availability and interpretation of environmental data as easy as possible. The system achieves this by automating modelling processes and using a user-centred intuitive design that makes insights easily shareable and speeds up decision-making.

Flood alerts from the EASOS Flood Watch browser-based application can be configured to specific user requirements and issue flood warnings up to seven days in advance. Advanced warnings can enable emergency responders to tactically deploy rescue forces and flood defence measures more effectively. Warning people where and when a flood will strike can save lives and prevent damage. Integrated telemetry sensors in the field are also fed into the dashboard to provide real-time measurements of river levels and rainfall patterns, which provide greater situational awareness and useful information with which to validate and calibrate the system.

The Malaysia flood risk project was led by Ambiental Risk Analytics, which developed a full catchment, two-dimensional, coupled hydraulic and hydrological modelling engine called Flowroute-Hydro. This was deployed into a cloud platform and a front-end, online GIS developed by Satellite Applications Catapult. This can model flood forecast predictions anywhere within a hydrological catchment, which is essential for predicting rapid onset flash flooding – traditional one-dimensional linear modelling approaches can only predict flood hazard along river corridors. EASOS displays flood maps and – uniquely amongst flood forecasting systems – it outputs dynamic live risk quantifications. This rapidly informs system operators of predicted impacts to critical infrastructure, the number of people likely to be affected and quantifications of expected financial impacts.

Risk quantifications are achieved through taking data layers of built assets and infrastructure locations and intersecting these with flood hazard predictions to calculate the time at which they flood and to quantify the severity of the impact. Techniques acquired through Ambiental's work in catastrophe modelling are used, with the degree to which a receptor of risk is affected by flooding is determined using vulnerability curves. These describe the relationship of increasing flood depth relative to increases in damage.

Some types of buildings are more vulnerable to floods. For example, a wooden building is highly susceptible to structural damage from flooding and will be more severely affected than a concrete structure when exposed to flood waters. Therefore, hypothetically, if both buildings have equivalent value then the wooden structure will generate higher financial losses relative to the concrete structure, which is more resistant to water ingress.

Similar principles of vulnerability assessment apply when considering flood impacts to people where population distribution and demographics data are used to form the live impact analysis. The risk quantification algorithms used by the system will consider that very young or elderly people inhabitants are more susceptible to floods. The reasoning is that they are less capable of rescuing themselves from a flood, so are more likely to drown, and are more susceptible to injury and infection from pathogens in the flood water.

EASOS in action

The live command and control dashboard system has already provided benefits to the Malaysian government. In November 2017, the time and location of significant floods in the eastern states of Kelantan and Terengganu were accurately predicted. This provided the government with spatial data to coordinate response efforts.

Synthetic aperture radar (SAR) data was captured by EASOS consortium partner Telespazio Vega to extract flood footprints and monitor the flood disaster. Data from the Sentinel-1 constellation of satellites at 5m x 20m swath resolution was used for wide area flood detection in rural areas.

Higher resolution data was required to increase data precision in urban areas, and COSMO-SkyMed satellites provided between 3m and 5m metre, which Telespazio Vega commercially sourced. These satellites also have much more frequent revisit times, typically of around once per day. To overcome gaps in the SAR data from urban crowding and back scatter effects, Ambiental applied its FloodSat flood inference algorithms to infill the model outputs to produce continuous realistic flood extents.

To help the Malaysian disaster response teams to prepare for flood incidents, Ambiental used its Flowroute-Hydro forecasting technology to produce a time series of realistic synthetic flood extents. These were used in emergency training to plan military response drills.

Conclusion

Flooding can take many forms, whether it be from rivers, storm surge from the sea or flash flooding from rainstorms. Each can be modelled using a range of techniques that use geospatial data to achieve informative outcomes. With the growth of remotely sensed data inputs from live telemetry and earth observation technology, there is an opportunity to provide better systems for monitoring natural hazards. With the threat of climate change and the challenges of ever-growing populations, it is the responsibility of the geospatial community to provide solutions that make best use of new technology, in ensuring nations can become more resilient to hazards and better informed about potential risks.

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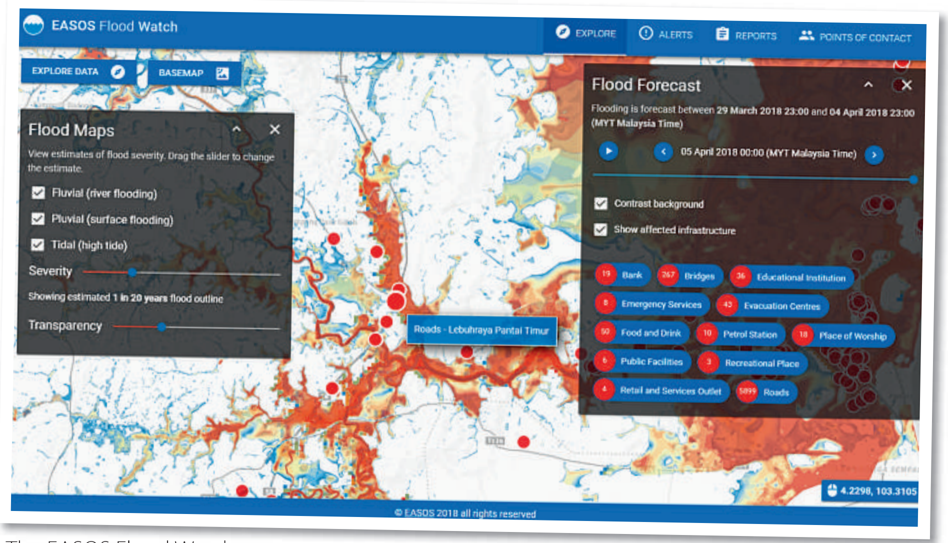

The EASOS Flood Watch system