FROM SPECULATION, TO UNDERSTANDING, TO DEVELOPMENT: THE EVOLUTION OF THE NSW FLOOD DATABASE PROJECT

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Abstract

Monitoring of effective flood risk management from a state-wide perspective requires a strategic overview of flood risk management across local and state government levels. Whilst there is significant information on flood risk generated through floodplain risk management studies, this is not always easy to find or to aggregate across local and state levels due to wide ranging variations in reporting mechanisms, and data formats. Additionally there are methods to spatially analyse this information to improve our understanding and monitoring of risk exposure, yet these methods have not been utilised.

Over the past two years, the Office of Environment and Heritage in partnership with the NSW State Emergency Service (SES), local government, other agencies, and support of Cardno Pty Ltd have examined how to address these issues under a NSW Flood Database project funded through the Natural Disaster Resilience Program and Natural Disaster Resilience Grants Scheme.

The trial database phase of the project is nearing completion. It provides a database design, data standards, and draft specifications of requirements and format for future floodplain risk management studies. The framework is based on the NSW SESs GIS Hazards Library which has been revised to enable the storage of the data collected in the next stage of the project. Work has now commenced on data collection.

This paper aims to (a) outline the background of the project to date, and (b) discuss the work currently underway and future work planned. This includes the database design, the spatial analysis tools that will be developed to accompany the database, the steps behind the system implementation and database population, and the intended governance framework. In addition, the paper will also highlight what this project can bring to the various stakeholders in state and local government and the floodplain risk management industry more broadly.

Introduction

Effective flood risk management is a modern conundrum in NSW and in a broader sense at the Commonwealth level. It is a problem driven by changes in technology, and the evolution of management and standards in the Floodplain Risk Management (FPRM) process over a period in excess of 25 years. The end result being the lack of a strategic and common picture of flood risk across NSW that is easily accessible at the State or Local Government levels. This has led to an inability to effectively monitor and implement the State's Flood Prone Land Policy. In other words there is no longer an effective means to understand, assess, and respond to the risk of floods in the State.

However, the NSW Flood Database project aims to fix this problem by providing a living strategic overview of flood risk in NSW that informs the understanding and management of flood risk at all levels of government and also provides input into whole of government initiatives. To be successful, the database will (a) assist with the monitoring, evaluation and reporting on the implementation of the NSW Flood Prone Land Policy; (b) enable more informed flood risk decision-making across the land use planning, mitigation and emergency management; and (c) remove duplication in data collection across government. This also has to be done across different geographic scales (e.g. Local Government Area, State Government, and River Basin).

The project, in its third stage of four, is a key deliverable in the NSW 2021 Plan under the target to increase support for emergency management planning. The current stage, as well as the former stages, is externally funded as a State significant project under the Natural Disaster Resilience Program managed by the Ministry of Police and Emergency Services (MPES). It is a joint project between the Office of Environment and Heritage (OEH) and the NSW State Emergency Service (SES).

This paper will (a) outline the current floodplain risk management process and how it has evolved (b) discuss the NSW Flood Database project history including the work to date, and (c) what is happening from here.

Background

Effective flood risk management requires an understanding of flood behaviour and related hazards. The FPRM process was designed to facilitate a strategic approach to flood risk management. The process is a framework for the development of studies and plans which (a) define and evaluate flood behaviour and consequences, (b) consultatively examine effective flood risk management options in the context of numerous factors (e.g. social, economic, ecological, etc…), and (c) implement strategies to maximise overall benefit of flood risk management while minimising ad-hoc decision making.

The plans and studies generated from the process contain proposed mitigation works, or options, which attempt to limit or contain degrees of flood risk. Such options include modifications to existing properties (e.g. house raising or razing, land use planning controls), enhancing community resilience through education and awareness initiatives, or by modifying the behaviour of the flood itself (e.g. levees, floodgates, etc…).

The primary responsibility of the FPRM process resides at the Local Government level as outlined in the State's Flood Prone Land Policy. The State Government provides technical and financial assistance through the OEH and the NSW SES. However, both Local and State Government require a holistic understanding of the prevailing flood risk, its associated severity, and what is proposed and being implemented in terms of mitigation options to handle that risk.

Each stage of the FPRM process, including implementation of plans through works projects, planning controls and emergency response planning results in the collection of vast amounts of data which can be either inherently spatial (i.e. already geographically related), or spatially capable (i.e. has the potential to be geographically related). Flood extents are an example of inherently spatial information whereas spatially capable would be information such as the number of properties at risk from a design flood extent. All of this information is necessary to understand risk and how to manage it. In particular the consolidation of inherently spatial and spatially capable information helps build this holistic picture.

Holistic issues

Yet there are numerous roadblocks to consolidating inherently spatial and spatially capable information, and also in linking them together, to produce a holistic and strategic picture. To begin the accepted method for information dissemination from a study or plan is the development of a report and associated outputs (e.g. appendices containing static maps or spatially capable tabular data). These reports are invaluable tools for information dissemination, but in their current form act as information silos. This is most evident when one tries to aggregate reports together to produce a seamless picture of flood risk at geographies beyond the inherent extents of the reports (i.e. a Local Government Area, River Basin, or State geography).

The ability to consolidate the spatial and spatially capable data together is further compounded by the following issues:

- Distribution - Reports can be either analog (paper-based) or digital (electronic). If they are digital they can be in any number of formats (e.g. PDF, word processor, spreadsheet, databases, etc…).

- Content - There is no single standard of required outputs from a floodplain risk management study or plan. For instance, one study may assess two design flood extents as opposed to another with six. Another study may assess hazard and hydraulic categories of a 1 in 100 year Average Recurrence Interval design flood extent while another does not.

- Location - The reports could be physically or electronically located in a centralised place or located throughout any number of organisations involved in the floodplain risk management process – local government, flood study consultants, or State Government. Currently, there is no single repository.

- Spatial Data - In addition to a report being either analog or digital, the spatial data (inherent or spatially capable) may be in either analog or digital form as well. If in digital form, they can also be in any number of file formats (e.g. ESRI Shapefile, MapInfo MID/MIF, AutoCAD, etc).

- Change in technology over time - Advancements in computing power including processing speed, memory, and storage have enabled more sophisticated modeling programs and improved outputs to become viable. More modern studies often take advantage of more complex 2D and coupled 1D and 2D modeling techniques as opposed to simple 1D modeling. In addition, survey data collection methods (particularly the advent of airbourne laser survey) have improved the availability of broad and reliable survey data for use in modeling techniques.

- Change in standards over time - The FPRM process was initially aimed at dealing with existing flood problems and providing basic information for development controls. Outputs of the process focused on supporting the assessment of the benefits of mitigation options and on determining peak flood levels. The outputs of the management process today also attempt to address additional requirements such as strategic and development scale land use planning, emergency response planning requirements, consideration of climate change through defined sea level rise and rainfall intensity adjustment scenarios, and assisting infrastructure providers better understand their flood risk.

As outlined, there are vast quantities of inherently spatial and spatially capable data waiting to be consolidated and linked. The information is varied in quantity, quality, type, and age across NSW but can be brought together to create that single strategic, multi-geographical view.

Project history

Stage one of the NSW Flood Database project began in 2008 with the development of a pre-feasibility study to assess the concept of a flood database, scope the potential benefits, and examine the potential technologies that the database could utilise. The pre-feasibility study resulted in a report and an associated paper presented to the NSW Floodplain Management Association Conference in 2008. A range of technical issues were flagged for further exploration, but overall the concept was well received

Stage two took place from 2009 to 2011. This involved a more detailed project scoping to assess the minimum information requirements from the floodplain risk management process, examine what could be captured, and develop a set of draft standards and templates for data sharing and reporting, and examined the capture of the inherently spatial and spatially capable data and its linkage. This stage of the project was overseen by an inter-agency working comprised of OEH, NSW SES, MPES, the Department of Planning and Infrastructure, the Floodplain Management Association, and representatives from various Local Governments.

From Stages one and two, the following key resolutions were adopted:

- The database was feasible and should be a spatial database supported by textual information.
- It was best built around the NSW SES Flood Hazards Library which already contained a portion of the necessary data, and also contained an associated set of metadata standards.
- Inherent tools and linkages to other key datasets would provide the ability to share this data across and within government, allow analysis for strategic purposes, and support business continuity at various government levels.

Potential benefits

There are numerous potential benefits to be realised for all stakeholders involved in the floodplain risk management process. By stakeholder, they are:

Community:

- Improve availability of reliable and timely information for flood emergency response planning.
- Generate a clearer understanding of the risks to key and cultural infrastructure.
- Improve the availability of consistent information through Local Government.

State and Local Government:

- Facilitate data sharing and collaboration between the State and Local Governments.
- Improve flood risk knowledge management (i.e. currency, availability, and security).
- Enhance support for business continuity and knowledge loss from staff turnover and retirement
- Create a greater holistic understand of flood risk and its impacts.
- Improve information for land use planning and Local Environment Plans (LEPs) and Development Control Plans (DCPs).
- Improve forward planning capability.

Local Government Specific:

- Assist with information sharing and control.
- Enhance management strategy selection, prioritisation, and monitoring the implementation of identified management options and their benefits.
- Provide baseline information to support funding applications.

State Government Specific:

- Assist with gap identification of knowledge on FPRM and the status of management strategies.
- Provide more information to assist with emergency planning and response.
- Assist with grant assessments.

Industry:

- Provision of a consistent standard for floodplain risk management information.

Development of the flood database

Stage three involves the expansion and finalisation of the trial database and draft standards proposed in Stage two. This is a joint project between the NSW SES and OEH, with key inputs from MPES, the Department of Planning and Infrastructure, the Floodplain Management Association, and Local Government. It is fully funded as a State significant project under the Natural Disaster Resilience Program (NDRP) and recognised as a key deliverable in the NSW 2021 Plan. This stage of the project is expected to be completed by the end of October 2012. The following are the key deliverables:

- Consistent data format and model to store and maintain floodplain risk management information.
- Finalised set of standards for the collection and storage of flood information.

- Populated database containing all Government sponsored flood studies.
- Finalised framework for the monitoring of the State's Flood Prone Land Policy.
- Database custodianship arrangements confirmed.
- Maintenance system and regime implemented including the establishment of agreements with LGAs for data updates and provision of non-government funded flood studies.

Database design

One of the key outputs from stage two was the design of a trial database and population of that database with FPRM information obtained from numerous councils and the consultant involved in the study. The trial database was not intended to provide a complete design framework, but more to (a) test the capability of floodplain risk management information being placed into a GIS database, (b) to test how the inherently spatial and spatially capable information could be linked, (c) to road test this format with various stakeholders, and (d) to pilot draft reporting templates. A key recommendation from this stage was that any database should be built around the NSW SES Flood Hazards Library.

As part of stage three a complete redesign of the database architecture was undertaken. The revision took the initial design elements proposed in the stage two trial database, and combined it with the mature NSW SES Flood Hazards Library (database). From this combination, the design was systematically revised based on the requirements set out by the inter-departmental project steering committee, and internal working groups from OEH and the NSW SES. The schema was designed using the Computer-Aided Software Engineering (CASE) tools available in Microsoft Visio 2010 and ESRI ArcGIS version 10.

There are four core components to the database design: base, mitigation, rural, and external components. The base component provides the framework for the storage of all data (inherently spatial and spatially capable) from a FPRM study, or plan. This includes mitigation options, hydrological model limits, hydrological catchment areas, the footprint of a study area, and any variety of flood layers that may be present in a study or plan (i.e. climate change extents, historical flood extents, flood plan levels, design flood extents, etc…). The mitigation component provides the framework for capturing mitigation options that have been completed (i.e. no longer held in base components), and in particular any levee alignments and associated information that is available. The rural component provides the framework for capturing information from rural floodplain risk management studies and plans. The information differs slightly from standard FPRM studies and plans, and includes the capture of designated floodplains, rural floodway networks, and rural mitigation options. The external component is the current proposed framework for providing a linkage with data from external sources (such as the Emergency Services Spatial Information Library – ESSIL – or specialised layers from LEPs and DCPs. This component may be replaced as the database evolves.

Gap analysis

A gap analysis was undertaken to provide the basis for database population. Initially, there was no single, central, accurate, and informative list of floodplain risk management studies for NSW. From the State Floodplain Management Program, in excess of 25 years of studies and reports have become available in digital form. This collection of studies and plans was collated from various digital libraries located disparately through-out the State, and centralised at the NSW SES. Using a combination of semi-automated and manual procedures an accurate and reliable central list was developed which highlighted a total of 1344 studies and plans available.

To prepare for data capture and subsequent database population all entries in the list were thoroughly examined to identify what spatial data existed, in what format (digital vs. analog), and what was already available from the internal NSW SES Flood Hazards Library. The aim being to reduce data capture replication and to take advantage of any existing spatial data. As part of the process, LGAs were contacted indicating what studies and plans were available, and asked to supply all floodplain risk management data they could.

Database population

Spatial data capture is being undertaken by the NSW SES while non-spatial (spatially capable) data capture is managed by the OEH. The spatial data capture process began in January and is an ongoing process anticipated to run for 9 months. The task of capturing and transforming all data into the database design is being performed on a LGA basis. Those LGAs identified as having a high flood risk will be captured first.

Data will be stored in an interim ESRI file geodatabase while a more robust ESRI ArcSDE SQL Server data is built. Linking the inherently spatially data to the spatially capable data captured by OEH is ongoing. It is a manually intensive process linking the two data sets based on the common name, author, and date of a study.

Anticipated analytical abilities

Key analytical abilities are being further developed as part of the stage. They are based on internal and external stakeholder consultation and initial draft reporting tools developed in stage two. The analytics are possible as a result of combining the inherently spatial and spatially capable data from the various FPRM studies and plans together and also linking this information to other State datasets.

It is anticipated that the answers to the following questions will be possible:

- An understanding of areas covered by studies relative to urban areas;
- An understanding of gaps in studies relative to existing urban areas;
- The number of properties affected by different flood events and scenarios and also within key areas such as floodways, flood storage areas, and flood islands;
- The number of buildings at risk from different flood events and scenarios and also within key areas such as floodways, flood storage areas, and flood islands;
- New development areas at risk from flooding;
- An understanding of completed management projects and their benefits;
- An understanding of future management projects and their benefits;

- Properties benefiting from completed and proposed mitigation works;
- Benefits achieved by mitigation works (i.e. damages reduced);
- Key and cultural infrastructure and facilities at risk from different flood events and scenarios;
- Flood damages for different flood events and average annual damages where available;
- Identification of areas which have been assessed with climate change scenario;
- The number of councils engaging with the FPRM process and the stage they are at (e.g. those with management plans, implementing management plans, etc…);
- Number of properties purchased or raised versus those in agreed voluntary schemes; and
- Progress on the State's Flood Prone Land Policy implementation.

Governance

The NSW SES anticipates becoming the custodian of the NSW Flood Database and thus assuming overall accountability and responsibility. As part of these arrangements the NSW SES will (a) assign a point of contact for customer enquiries in relation to the database, (b) provide advice on the proper use and interpretation of the data contained within the database, (c) create and maintain a register of nominated organisations that conduct different roles and responsibilities under the Draft NSW Spatial Custodianship Policy, and (d) create and maintain metadata relevant to the database.

A distribution and maintenance regime is also in development for the NSW Flood Database. When all available data is processed, the likely distribution regime will be quarterly database replicates to OEH. Post stage three, all LGAs will receive a yearly replicate of data limited to their LGA and relevant river basins. This will enable councils to quality assure their data, provide feedback if necessary, and enable them to incorporate relevant data back into their systems for the purposes of floodplain risk management. Those LGAs without sufficient GIS resources will be provided with additional resources to visualise and query their floodplain risk management information. Updates from LGAs and new FPRM studies and plans will be incorporated into the database on a quarterly basis.

Future Work

It is anticipated that from stage three another stage will be required to refine the database schema developed, and further enhance data sharing tools. It is envisaged that this work includes the development of a web-based interface to enhance Local and State Government reporting capabilities and to assist with monitoring the implementation of the State's Flood Prone Land Policy. The scoping of this stage is continuing and will be progressed through the first half of 2012 with funding sought to finalise development of the database as a State significant project under the NDRP. The NSW SES is currently developing an enhancement bid to maintain the database once it is fully developed. Other potential funding sources are being examined.

Conclusion

To date, much work has occurred on the NSW Flood Database project. In its third stage the results of the ongoing project are beginning to become evident. A robust and flexible database design for the State's floodplain risk management information is now available, and database population is underway. Analytical tools, a maintenance regime, and agreements from relevant stakeholders for data supply are being developed.

It is anticipated that a partial database will be available at the conference for attendees to view and comment upon. The NSW SES and OEH would like to invite people to examine the database and provide their thoughts on its usefulness, content, and structure. These comments can be directed to Austen Pepper via E-mail (austen.pepper@ses.nsw.gov.au) or by phone (02 4251 6471).

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