PORT ADELAIDE SEAWATER & STORMWATER FLOOD RISK TREATMENT

Russell King, Civil Engineer, City of Port Adelaide Enfield

Drew Jacobi, Director, Tonkin Consulting

Abstract

Portions of land within the City of Port Adelaide Enfield are low lying to the extent that some areas are below very high tide levels. For the past five years in conjunction with the Federal Government's Natural Disaster Mitigation Program funding and State Government Agency funding (such as the Coast Protection Board) the Council has undertaken a seawater flood risk assessment and is currently working towards developing risk treatment options.

Catchments located on the LeFevre Peninsula, within the Port Adelaide City Centre and the ponding basins in Gillman have been selected for detailed analysis to assess the flood risks associated with high tides and locally generated stormwater runoff. In addition to the consideration of a combined flood risk due to seawater and stormwater influences, future protection strategies are also being developed to account for future global sea level rise, and ongoing land subsidence which occurs in the region.

The analysis has required the development of a TUFLOW 2D hydraulic model to provide greater understanding of the tidal behaviour of the Port River and to model the impact of extreme tides on inland areas. The analysis has been used to facilitate damage estimate calculations based on flood inundation depths, and to assess the effectiveness of flood protection works such as seawalls, flood levees and stormwater pump stations.

As large parts of the study area are yet to be developed there are a number of measures currently being assessed including planning restrictions for floor levels (being applied to the current Port Waterfront residential development) through to seawalls and tide barrier gates.

Key Words: Port Adelaide, seawater, stormwater, protection strategy

Introduction

Port Adelaide, Gillman, and the LeFevre Peninsula is located approximately 15 km north-west of the Adelaide CBD and comprises a diverse mix of dense residential, commercial, and major industrial land uses.

Nearly all of the stormwater from the north west of Adelaide flows into the Gillman wetlands which then discharge out into the Port River.

Figure 1: Location Plan

Large portions of this land are low-lying to the extent that some areas are below recorded high tide levels. The City of Port Adelaide Enfield along with a number of project partners commissioned the Study to determine the extent and consequences of the risk of seawater flooding due to a number of sea level rise scenarios and one in one hundred year storm tide.

Catchments within the area and the wetland ponding basins in Gillman that discharge via gravity to the Port River have been analysed in detail to assess the flooding risk in these areas associated with sea level rise and high tide events.

In addition to the consideration of a combined flood risk due to seawater and stormwater influences, future protection strategies have also developed to account for future global sea level rise, and ongoing land subsidence which occurs in the local region.

Study Funding Process

In 2001 the Federal Government made funding available to Local Government to undertake risk assessment studies for natural disasters under its "Natural Disasters Mitigation Program". The City of Port Adelaide Enfield was successful in securing funding with the condition that Council contribute 1/3 of the total project cost, State Government contribute 1/3, and the NDMP program would contribute the remaining 1/3.

Council was successful in gaining funding from the following State Government Agencies;

- Coast Protection Board
- Ports Corporation (major land owner on Port River)
- Transport SA (now the Department of Transport, Infrastructure and Energy, who were developing the Port River Expressway)
- Land Management Corporation (also a major land owner on Port River)
- Catchment Water Management Board

The Study has been separated into a number of Phases, with Phase 1 (assessment of flood risk and identification of mitigation concepts) completed by a Consultant Team lead by Tonkin Consulting and WBM.

Sea Level Rise Scenarios

At the time of the investigation, global mean sea level was predicted to rise by 0.09 to 0.88 metres between 1990 and 2100, for a range of future global scenarios (IPCC, 2002). The summary of this scenario modelling outcomes suggested that greatest confidence in sea level rise is in the range between 0.30 and 0.50 metres. The Coast Protection Board (South Australian Government Agency) development policy currently requires coastal development to cater for a mean sea level rise of 0.30 metres.

The Study assessed the risks associated with sea level rises of 0.10m, 0.30m, 0.50m and 0.88m.

Land Subsidence

Land subsidence was first identified as potentially occurring in Port Adelaide and the surrounding coastal regions as part of a Beach Erosion Assessment Study (Culver, 1970). This Study identified a trend in the change of Engineering and Water Supply Department bench mark levels across metropolitan Adelaide during the period of 1872 to 1969, relative to a reference bench mark associated with the Hope Valley reservoir that was assumed to be 'stable'. A spatial variation across the 42 bench marks was observed, with calculated land subsidence rates increasing from nil in the Adelaide CBD to 0.6 ft/century (1.8 mm/yr) in the Port Adelaide and Semaphore area.

In order to provide greater certainty to the suggested land subsidence rates described above, particularly with respect to the stability of the reference bench mark, the then South Australian Coastal Management Branch performed a precise levelling survey. A network of deep benchmarks isolated from movement of the surface sediments were linked to ‘stable’ rock pin benchmarks in the foothills by levelling to a high precision standard. Since the benchmarks were established in 1982, precise levelling surveys have been repeated in 1985, 1987 and 1994. The results from the relatively short time period over which measurements have been taken are in general agreement with the findings of the study carried out by Culver.

A single land subsidence rate of 2.1 mm/yr was been adopted over the Port Adelaide Area for the purpose of this Study.

Greater rates of subsidence, up to 10 mm/yr, have been reported in the Gillman region, based on geological evidence including radiocarbon dated palaeosea level indicators (Belperio, 1993). The major causes of the subsidence were concluded to be surficial compaction associated with wetland reclamation and groundwater withdrawal from the upper Tertiary aquifer. Significantly, this work provides the only documented land subsidence rates for Gillman.

Port River Seawater Flooding

Analysis of storm tide propagation from the sea into the estuary and across the Study Area was undertaken using a detailed two-dimensional hydrodynamic model covering all of the potentially inundated areas. This model was established using the TUFLOW software system.

The extent of this broad-scale 2D model covers the outer harbour area, the Port River and the low lying areas of the study area. This 2D model has approximately 150,000 cells, approximately 30m x 30m in size.

The low lying areas include potentially inundated urban areas, however, this broad-scale 2D model does not specifically model individual flowpaths in the urban areas, but rather simulates the storage areas beyond the seawater protection. The model has its offshore boundary along the nearshore zone seaward of the estuary allowing the storm tide to be defined there as time series of water levels consistent with the statistical design criteria.

The TUFLOW model has been calibrated to recorded data, video animations displaying the propagation of the tide into the Port River and breaking out into the inland low-lying areas were generated. Below is an example snapshot showing the peak of the 100 year ARI tide event, including 500 mm sea level rise.

Figure 2: Seawater Inundation during a 100 year ARI tide event (500 mm sea level rise)

Floodplain mapping was executed for a range for future sea level rise scenarios, with the information used to facilitate estimation of flood damage costs. These predict that the damages associated with a 100 year ARI tide event will increase from existing conditions ($8m-28m) to future scenarios associated with 500-880mm of sea level rise ($180m-$310m).

A sea defence upgrade concept design has been developed to protect development for this flood risk. Initial cost estimates valued these works at $24m-31m, with development of the seawall concept currently proceeding with the objective of refining this cost.

Stormwater Flooding

The Port Adelaide stormwater catchments selected for detailed analysis for the Study presented a complicated problem that required assessment not only of the capacity of the underground drainage system, but a rigorous assessment of the consequences of larger storm events. Many of the catchments in the Study Area are extremely flat (< 0.10% longitudinal grade) and in many cases a single flood flow path was not clearly evident.

The TUFLOW model was utilised to develop a 1D model of the underground pipe network, dynamically linked to a 2D model of the surface to allow for modelling of overland flow paths and surface ponding.

A number of Council drainage systems were reviewed to identify works required within these selected catchments to achieve an adequate level of protection against the combined seawater and stormwater flood risk.

In several low-lying catchments, gravity stormwater drains were found to no longer be feasible under the sea level rise scenarios considered, and a number of stormwater pump stations have been proposed. Indicative construction cost estimates for these works are $11m-18m depending on the adopted future design scenario.

Development Pressure

The Port Adelaide waterfront area is currently undergoing a complete redevelopment (similar to the Docklands in Melbourne) with dense residential apartment living (including Newport Quays), marina developments, the construction of the Port River Expressway road/rail bridge over the Port River and renewal of industrial and Government owned land.

Following the outcomes of the first Phase of the Study, the Coast Protection Board increased its requirements for minimum finished floor levels, which was then applied for the first time to the Newport Quays development to ensure it would have adequate protection for up to 500mm sea level rise and 100mm land subsidence, and a 100yr storm tide.

The Gillman region, to the east of Port Adelaide, which contains a number of important stormwater detention basins, is also earmarked for the development of an industrial precinct. The use of this land, including portions of the basins, clearly will require careful consideration given the implications of sea level rise on the performance of the basins.

Conclusion

The costs of adaptation to sea level rise are clearly significant for the Port Adelaide region. The Port Adelaide Enfield Council, in particular, will bear significant costs associated with works identified with the stormwater network.

Concept design development of the seawall is ongoing, however already this is highlighting issues associated with funding of the works, ownership of the seawall and maintenance obligations. In the meantime, pressure to develop and renew land in this region increases due to the natural advantages of Port Adelaide’s location. This provides the City of Port Adelaide Enfield with significant challenges in upgrading infrastructure and ensuring that development provides appropriate protection to long-term sea level rise scenarios.

References

Belperio, A.P. (1993), Land Subsidence and sea level rise in the Port Adelaide estuary: Implications for monitoring the greenhouse effect, Australian Journal of Earth Sciences, vol 40 p359-368.

Culver, R. (1970), Summary Report – Beach Erosion Assessment Study, Department of Civil Engineering - University of Adelaide.

IPCC (2001), "Summary for Policymakers - A Report of Working Group 1 of the Intergovernmental Panel on Climate Change", WMO / UNEP.