Adapting roads to climate change

Overview
The AdaptRoads pilot project builds resilience to road infrastructure by developing a business case for adaptation. The tool uses road asset data and hazard geospatial data both from Manly Council and national and international climate change sources to analyse current and future risks associated with different climate change scenarios. This analysis shows that extreme weather events such as bushfire, riverine flooding and coastal inundation are likely to increase in severity and frequency, which will result in greater risks to road assets. Adaptation pathways were developed and analysed to plan cost-effective adaption options.

Background
NSW local governments manage 90% of the state’s road network. Council road assets are valued at over $65.7 billion and cost approximately $1.1 billion per year to maintain. Flooding events, coastal inundation, bushfire and extreme windstorms can disrupt use, damage and sharply reduce their usable life.

Road infrastructure will be more vulnerable through increased intensity and frequency of climate and weather hazards. The Metropolitan Sydney Region is expected to experience more hot days (>35°C) with an additional 4 hot days in the near future and 11 days more hot days in the far future. The region is also expected to experience an increase in average and severe fire weather in the near future and the far future (OEH, 2014).

Climate change may affect the intensity, frequency and duration of east coast lows with implications for coastal erosion, inundation, flooding, storm-water infrastructure and water security. Current research indicates that extreme storm events associated with east coast lows in warmer months may increase in number (OEH a, 2016). Global sea level rise will also over time contribute to higher projected storm surge and inundation levels (OEH b, 2016). Coastal councils in NSW have already incurred expensive clean up bills as a result of east coast lows. From example, after the east coast low storm in April 2015, Newcastle City Council spent $11m clearing fallen trees from roads and $24m on road repairs (Climate Risk, 2016).
Implementation

Manly Council partnered with Climate Risk Pty Ltd to pilot AdaptRoads with the support of a Building Resilience to Climate Change grant. The pilot project uses a cloud-based computational tool which was developed by Climate Risk and Sydney Water to understand how and where the risks to infrastructure increase as extreme weather events become more severe and more frequent. The aim of this project is to build resilience within the roads asset portfolio, by providing roads managers with a sophisticated understanding of risks, costs and options to respond.

The AdaptRoads pilot project examined 2,300 sections of roads in Manly, in order to quantify risk cost to the asset portfolio and to test and compare the efficacy of a number of proposed adaptation actions. A number of road assets were identified with:

- Flood risk today or exacerbated by climate change in the future.
- Increasing risk of bushfire over time.
- Increasing tree clean-up costs as the risk of wind damage increases 4 fold over the century.

The tool contains a library of adaptation actions that can be applied to an asset group to analyse the effectiveness of risk reduction. These adaptation actions have been developed from extensive consultation with infrastructure managers in the development phase of the tool. During the AdaptRoads pilot, consultation with Manly Council identified some additional adaptation actions that were incorporated into the tool.

Adaptation actions are analysed in order to consider the effects of reduction in asset risk cost compared with a ‘do nothing’ scenario. An adaptation pathway is a combination of proposed adaptation actions that optimises planning in terms of discounted net present value, cash flow, and timing. Adaptation pathways are developed and analysed for their effectiveness, and can be reviewed or updated as operational or material aspects of an organisation change. This enables the comparison of multiple adaptation pathways (or adaptation options) to select the preferred pathway that best optimises the outcome (referred to as ‘optioneering’). This allows a user to test each decision and review the implications before implementation.

A number of risk mitigation/adaptation options have been identified, and initial analysis indicates that implementation of many of these options could have a net positive present value to Council, as well as potentially improving future cash flows. The adaptation pathways also highlighted how Council can take advantage of the existing asset renewal cycle to incorporate adaptation actions.

Outcomes

The project identified a substantial number of road assets within the Council area that are vulnerable to the risk of riverine flooding, coastal inundation, bushfire or extreme wind events. Modelling indicated that if no adaptation measures are implemented the risk to these assets will increase as a result of climate change. The tool displays changes in the risk profile of existing assets in an intuitive and easily interpreted way, supported by a suite of quantitative outputs and analytics.
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This chart shows the extent to which risk is reduced by installing additional drainage around sites that are significantly exposed to riverine flooding. In this analysis, the cost of building additional drainage into selected roads is implemented in 2040. This not only reduces the annual risk in the year of implementation, but also the rate of risk increase in subsequent years. The line colour shows the Present Value of Asset Risk Cost.

Adaptation pathways such as investment in stormwater drainage infrastructure, increasing vegetation buffers between the road and bushland, maintenance of verge vegetation and strategic placement of seawalls (or increase in the height of existing seawalls) all have the potential to reduce the impact of climate change on road assets. Moreover, within the software package there is the capacity to develop additional adaptation measures that can then be analysed to determine the potential benefit prior to being implemented.

As a result of the project, the tool has been made available to Manly Council (now Northern Beaches Council) for use when determining asset maintenance and upgrades. Ongoing training of Council staff and dissemination of the projects findings will ensure that the results of the project will continue to be used to assist in the decision making processes and improve the ability of Council road assets to be more resilient to the impacts of climate change. Having trialled this approach in one council, the tool is now ready for other councils to input their data and use it.

Key Learnings

A road surface can last 25 years, the pavement can last 40 years, while the easement may remain in place indefinitely. Decisions about where roads are placed, how they are designed, and what they are made of, lock in the future resilience or vulnerability of the community’s access and mobility in the face of extreme weather and climate change. Factoring climate change impacts over the operational life of a road ensures investment is optimised. If climate change is not incorporated into the decision-making framework for roads, then increased road repair, maintenance and replacement costs can be expected (Climate Risk, 2016).

Some extreme weather events can seriously damage roads, but in ways that may not become apparent for weeks, months or years. Bushfire not only damages the superficial elements to a road such as the signage, but can also burn the binders in the surface seal. There are suggestions that the integrity of the sub-base or ground works can also be undermined by intense heat. In floods, the fine particles critical to the structural integrity of the sub-road can be washed away, while on the surface the road looks unharmed. Such delayed impacts may result in major damage being overlooked when claiming disaster recovery funds (Climate Risk, 2016).
Road networks are heavily relied on and are critical in extreme weather events to get people away from hazards, to get emergency services into hazard prone areas, and to provide access for other infrastructure owners seeking to maintain or restore their systems. A loss of road access can have important secondary impacts on water, power and communications.

Understanding and planning for the interconnected nature of infrastructure is important if the true extent of the risk is to be properly understood and captured in infrastructure and emergency planning (Climate Risk, 2016).

Some adaptation measures can solve one problem, but worsen another. Many councils are looking to increase tree cover though ‘urban forests’ to combat increasing heat island affects and the consequent community health impacts. However, in this project, windstorms causing tree fall events have been noted as a major cause of disruption, damage and ‘clean-up’ costs for councils. To manage these conflicting interests, the opportunity exits to investigate different tree species for both canopy needs and wind gust survival. Indeed, research into understanding how different tree species withstand high wind speeds, drought, extreme heat and other extreme weather events can contribute to more resilient urban forests (Climate Risk, 2016).

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