Climate Risk Management xxx (2017) xxx–xxx

Contents lists available at ScienceDirect

Climate Risk Management

journal homepage: www.elsevier.com/locate/crm

A review of methodologies applied in Australian practice to evaluate long-term coastal adaptation options

Timothy David Ramm [a,b,*], Christopher John White [a,c,d], Andrew Hin Cheong Chan [a], Christopher Stephen Watson [e]

[a] School of Engineering and ICT, University of Tasmania, Hobart, Australia
[b] Bushfire and Natural Hazards Cooperative Research Centre, Melbourne, Australia
[c] Antarctic Climate and Ecosystems Cooperative Research Centre, Hobart, Australia
[d] JBA Consulting, Skipton, UK
[e] School of Land and Food, University of Tasmania, Hobart, Australia

ARTICLE INFO

Article history:
Received 22 December 2016
Revised 6 June 2017
Accepted 14 June 2017
Available online xxxx

Keywords:
Adaptation
Climate change
Coastal inundation
Evaluation
Sea level rise
Uncertainty

ABSTRACT

Rising sea levels have the potential to alter coastal flooding regimes around the world and local governments are beginning to consider how to manage uncertain coastal change. In doing so, there is increasing recognition that such change is deeply uncertain and unable to be reliably described with probabilities or a small number of scenarios. Characteristics of methodologies applied in Australian practice to evaluate long-term coastal adaptation options are reviewed and benchmarked against two state-of-the-art international methods suited for conditions of uncertainty (Robust Decision Making and Dynamic Adaptive Policy Pathways). Seven out of the ten Australian case studies assumed the uncertain parameters, such as sea level rise, could be described deterministically or stochastically when identifying risk and evaluating adaptation options across multi-decadal periods. This basis is not considered sophisticated enough for long-term decision-making, implying that Australian practice needs to increase the use of scenarios to explore a much larger uncertainty space when assessing the performance of adaptation options. Two Australian case studies mapped flexible adaptation pathways to manage uncertainty, and there remains an opportunity to incorporate quantitative methodologies to support the identification of risk thresholds. The contextual framing of risk, including the approach taken to identify risk (top-down or bottom-up) and treatment of uncertain parameters, were found to be fundamental characteristics that influenced the methodology selected to evaluate adaptation options. The small sample of case studies available suggests that long-term coastal adaptation in Australian is in its infancy and there is a timely opportunity to guide local government towards robust methodologies for developing long-term coastal adaptation plans.

Contents

* Corresponding author at: School of Engineering and ICT, University of Tasmania, Private Bag 65, Hobart, Tasmania 7001, Australia.
E-mail address: timothy.ramm@utas.edu.au (T.D. Ramm).

http://dx.doi.org/10.1016/j.crm.2017.06.005
2212-0963/

1. Introduction

Australia is an arid country with approximately 85% of the population settled near the coast (Australian Bureau of Statistics, 2004; McInnes et al., 2016). During the last few hundred years there has been a steady rise in the global mean sea level and the rate of sea level rise appears to have accelerated in recent decades (Church et al., 2013, p.1150; White et al., 2014). This trend is consistent in Australia, with regional sea level rise observations at many locations comparable to the global rate (CSIRO and Bureau of Meteorology, 2014, p.148). Sea level rise increases the frequency and severity of natural hazards (storm surge, coastal erosion; Hunter, 2010), whilst over multi-decadal (long-term) time scales can contribute to permanent loss of land in low-lying areas. It was estimated that a 1.1 m sea level rise across Australia would threaten over $200 billion of buildings, roads and rail, including 274,000 residential buildings (Commonwealth of Australia, 2011). Further impacts of sea level rise and changing coastal flooding regimes include more frequent impacts to the built environment, increasing threats to public safety, and disruptions to important resident lifestyle values (Graham et al., 2014).

Engineered shoreline management controls (e.g. sea walls, groynes) that mitigate the impact of coastal hazards are often designed with a serviceable life of 50–100 years (Hallegatte et al., 2012, p.5; Stafford-Smith et al., 2011, p.199), thereby carrying long-term commitments. Evaluating the effectiveness of different management controls in mitigating projected coastal impacts is difficult because of uncertainty in long-term changes to biophysical, socioeconomic, technological, institutional and built environment stressors (Smith et al., 2015). Such uncertainty is unlikely to be reduced in the short-term due to limitations in scientific knowledge, predictability and multi-decadal climate variability. For these reasons, new methods of decision support have been called for that can accommodate irreducible uncertainty (Hallegatte, 2009).

Local government plays an important role in promoting long-term climate change adaptation in response to the threat of changing coastal hazards. They are responsible for 'day-to-day' decision making in coastal planning and management, often guided by State policy and legislation (Commonwealth of Australia, 2009, p.244). Local government works with communities to raise awareness of climate change risks, manage public assets, deliver services and support local planning (Council of Australian Governments, 2012). As local government are at the forefront of community decision-making, they are the target audience of this paper.

This paper systematically reviews characteristics of the methodologies used in current practice by Australian local government to evaluate long-term adaptation options to manage risks in low-lying coastal settlements. These characteristics include the decision objectives, approach taken to identify risk, time horizon over which risks and evaluation activities are assessed, management of uncertainty, choice of decision process and the decision metrics. Case studies are drawn from across Australia, including selected literature from the 2011 to 2012 Australian Government's coastal adaptation decision pathways program (CAPPs). The characteristics of the methodologies used to evaluate adaptation options in Australia are then compared with two state-of-the-art methods for decision-making under conditions of deep uncertainty – Robust Decision Making (RDM; Lempert et al., 2003) and Dynamic Adaptive Policy Pathways (DAPP; Haasnoot et al., 2013) – to identify any opportunities for local government to improve adaptation planning and the evaluation of long-term coastal adaptation options.

Whilst previous studies have reviewed (a) the challenges and successes of Australian coastal vulnerability and adaptation studies (Kay et al., 2014); (b) general decision support methods for climate change adaptation (Watkiss and Hunt, 2013;

Please cite this article in press as: Ramm, T.D., et al.. Climate Risk Management (2017), http://dx.doi.org/10.1016/j.crm.2017.06.005