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# Coastal vulnerability and progress in climate change adaptation: An Australian case study

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## HIGHLIGHTS

- An integrated framework is used to measure vulnerability to coastal hazards.
- The majority of coastal suburbs are exposed and sensitive to climatic drivers.
- Vulnerability should be reduced improving in adaptive capacity.
- Understanding vulnerability can help to improve the level of adaptation progress.

## ARTICLE INFO

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## ABSTRACT

Coastal areas in South East Queensland (SEQ) are exposed to coastal hazards and climate change and Local Governments are responding to these threats by developing a range of strategies for adaptation. Here we show the results of a spatial vulnerability assessment for SEQ's coastal region and use them as the basis to assess progress in adaptation in five coastal Local Government areas. An integrated framework based on external (exposure) and internal (sensitivity and adaptive capacity) dimensions is used to produce one single index to provide a measure of SEQ's vulnerability to coastal hazards. Coastal Local Governments' progress in adaptation is evaluated based on a semi-quantitative assessment of pre-determined Adaptation Functions adapted to the SEQ context. The assessment reveals information specifically relevant for adaptation investment at the local government level. It is concluded that the five coastal Local Governments analysed have considerable capacity to deal with coastal hazards. However, there are numerous coastal suburbs that are highly vulnerable and this is mainly, due to the fact that the majority of the SEQ coastal region is intrinsically highly exposed and sensitive to climatic drivers. We argue that this vulnerability can be reduced if Local Governments continue to further their progress in adaptation through coastal planning and management frameworks.



## 1. Introduction

South East Queensland (SEQ) (Fig. 1) is one of the most urbanised and fastest growing coastal regions in Australia. This trend is set to continue as its current population of 4.7 million people is expected to grow by approximately 70% in the next 20 years (Queensland Government, 2011). SEQ's coastal settlements, distributed across 5 coastal Local Government areas (Sunshine Coast Regional Council,[1] Moreton Bay Regional Council, Brisbane City Council, Redland City Council, and Gold Coast City Council) are extremely vulnerable to sea-level rise (SLR), changing wave climate and extreme sea levels associated with storm tides. In Castelle et al. (2007), they say that The Gold Coast beaches are exceedingly fragile and that the beaches would not be able to withstand the impact of an increased frequency of extreme events.

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[1] The Sunshine Coast Regional Council de-amalgamated in 2014 and now comprises two separate Local Governments, Sunshine Coast Regional Council and Noosa Shire Council.

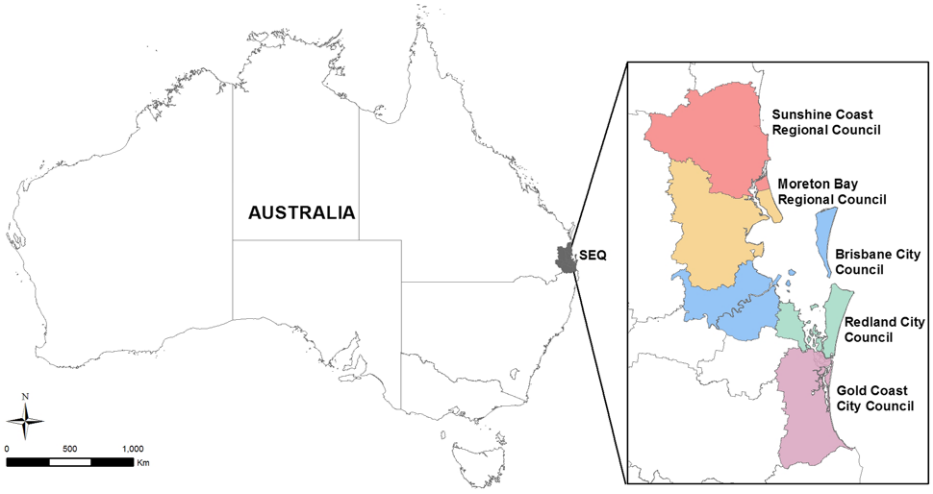


**Fig. 1.** Location of SEQ and its 5 coastal Local Governments' boundaries until 2014.

The study carried out by Treloar et al. (2011) comments that distant tropical cyclones which may be several hundred kilometres north of Moreton Bay have been known to cause storm surge, high waves and erosion inside Moreton Bay. A more recent study (Splinter et al., 2014) says that over a 6-month period, four named cyclones (Dinah, Barbara, Elaine, and Glenda) and three East Coast Lows caused a cumulative erosion volume greater than the predicted 1 in 100 year event in the Gold Coast beaches.

The SEQ coastal zone, from the northern boundary of the Sunshine Coast to the Queensland-New South Wales border, has a linear extension of around 280 km. However, the total length of the shores exposed to changing sea water level is approximately 1900 km including numerous natural waterways and artificial canals extending landwards from the coastline.

The high concentration of population within the coastal zone as well as its exposure to climatic drivers such as SLR and extreme storms has prompted the IPCC in its Fourth Assessment Report to explicitly identify SEQ as highly vulnerable to the impacts of climate change (Hennessy et al., 2007). Global mean sea level has risen at a rate of about 1.7 mm per year in the last two centuries. While long term observation are not available for SEQ, measurements show a SLR of approximately 3 mm per year during the last two decades (NTC BOM, 2011). Current projections based on the IPCC AR5 (Collins et al., 2013) suggest a global worst-case scenario of SLR of around 74 cm by 2100. These figures, combined with regional variations from global averages, suggest a SLR for the Eastern Australia of around 80 cm by 2100 (CSIRO, 2011) while other authors suggest scenarios of up to 180 cm (Nicholls and Cazenave, 2010). SLR is not the only impact of a changing climate, with average wave conditions and extreme weather events also expecting changes. In SEQ the average wave climate, the frequency of extreme events and consequently the transport of sediments and ultimately the shape of the coast are mainly driven by two types of storms: tropical cyclones and east coast lows. Both types of weather systems have been responsible for extreme erosion, storm surges and floods in the past; future predictions are still uncertain and are currently under investigation (Butler et al., 2012; Nose et al., 2013; Resio and Irish, 2015).

SLR, changing wave climate and extreme storms can exacerbate the already complex issue of managing human settlements and infrastructure on dynamic coastal environments. SEQ coastal management framework includes a range of policies, plans and strategies issued by the three tiers of government. The Federal Government has a limited direct role in coastal zone management, most of the power is in the hands of the States. For instance, the Federal Government has released a Commonwealth Coastal Policy in 1995 and a National Cooperative Approach to Integrated Coastal Zone Management (ICZM) in 2006, both instruments were adopted as non-statutory guidance by the States. In SEQ, the State Government of Queensland has the responsibility for natural resource management and statutory land use planning, including coastal zone management. This includes the preparation of the Queensland Coastal Plan under the Coastal Zone Management Act of 1995. The latest version of the Coastal Plan released in 2011 included specific provisions related to climate change such as adaptation planning in high hazard areas by developing a specific *Coastal Hazard Adaptation Strategy*.[2] At the local level, Local Governments are responsible for integrating State coastal policies into local instruments including planning schemes, coastal strategies (e.g. the *Sunshine Coast Waterways and Coastal Management Strategy 2011–2020*) and shoreline erosion management plans (e.g. the *Gold Coast Shoreline Management Plan*, 2011). This includes the voluntary development of the above mentioned *Coastal Hazard Adaptation Strategy* for areas at risk.

The combination of climate change pressures, in particular SLR, a spreading population in low lying coastal areas and a complex management framework makes SEQ coastal areas particularly vulnerable to climate change (Cooper and Lemckert, 2012). However, numerous initiatives at the local level are contributing to the progress towards adaptation to climate change, including local strategies, policies and projects. In this paper we present our approach in assessing the vulnerability of coastal settlements and their progress in adapting to a changing climate.

For the vulnerability assessment we use the IPCC AR4 concept of vulnerability as a combination of exposure, sensitivity and adaptive capacity to map differences in vulnerability at the suburb level. These terms were defined by IPCC in the following way; Vulnerability is understood as "a function of the character, magnitude, and rate of climate change and variation to which a system is exposed, its sensitivity, and its adaptive capacity" (Hennessy et al., 2007). Exposure refers to the expected changes to climatic stimuli in a given location. For example, coastal regions

[2] However, this type of compulsory adaptation planning was revoked as part of a planning reform introduced by the last State Government (2012–2015). The current government elected in early 2015 is yet to pronounce itself regarding this policy.