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**Raising the Seas, Rising to Greatness?  
Meeting the Challenge of Coastal Climate Change**

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**At the Confluence of Land and Sea**

Today, upward of 40% of the world's population are living on the 5% of the world's land area that is within 100 km of the coast, exerting tremendous human pressures on coastal and marine ecosystems and resources (McGranahan, Balk and Anderson 2007). While many ocean-bordering countries have majorities of their populations in coastal areas, this is particularly true for Australia, with 84% of its population living within 50 km from its nearly 26,000 km of coastline (Fletcher et al., this volume). The reason for this high population concentration is that we all want so much from the coast: while some of us build and live there, others come to visit and recreate; we fish and farm, ship, transport and trade; we extract resources, oil, gas, minerals and water; we discharge our waste and station our troops there; and we grow our economies and tend our coastal cultures. Amidst all these benefits we derive from the coast, we also try to protect and save the remains of natural shorelines and ecosystems so that those who come after us may continue to enjoy them.

Yet, the challenge to the sustainability of our coasts is profound. As ongoing research over decades has shown, all of these human activities are continuing and accelerating the loss of habitat and species, the declines in water and air quality, the hardening of the shoreline, and the threats to human health and security (UNEP 2007; Agardy et al. 2005; Wong et al. 2005). Moreover, with continued influx of people to this narrow strip of land, these pressures are growing at the same time that climate variability and change, sea-level rise, and related hazards are making human habitation in these areas less secure (Nicholls et al. 2011; Hinrichsen 2011). In fact, global sea-level rise poses threats already today, and over the long term will cause practically permanent alterations of our

coasts. Together with storms, flooding, erosion, rising temperatures, reductions in sea ice, changes in freshwater runoff, increasing variability and climatic extremes, and acidification of coastal waters (IPCC 2013), low-lying coastal areas and islands face the prospects of increasingly significant (and largely negative) ecological, social and economic impacts worldwide (Moser, Williams and Boesch 2012; Nicholls and Cazenave 2010; Williams and Gutierrez 2009). Yet in Australia as in other developed and developing nations, the beauty, benefits and wealth of coastal areas as well as the risks from climate change are not distributed equally, leading to significant differences in vulnerability and in the capacity to manage the growing risks (e.g., Martinich et al. 2013; Preston et al. 2008; Nicholls et al. 2007).

## **The Challenges Before Us**

The challenges before us are staggering indeed. This is clearly the impression one can get from the contributions to this section. Woodroffe et al. (this volume) lay a foundation for understanding and predicting the physical risks Australians face from sea-level rise and coastal climatic hazards. Driven by an overriding goal to be practice relevant, they show how climate change considerations can be integrated into familiar risk assessment approaches and combined with state-of-the-art engineering models to create more comprehensive assessments of the changing risks faced at the coast.

Hadwen and Capon (this volume) then add to these the ecological and human complexities to help us understand the vulnerabilities as well as the capacities and limits of human and other-than-human communities to adapt to the coming changes. Similar to Woodroffe et al., Hadwen and Capon offer a pragmatic step-by-step approach to identifying key ecological vulnerabilities and then make a convincing case for a more integrated approach to coastal zone management, one that deliberately considers spatial, temporal and sectoral interconnectivities between coastal ecosystems, human land and resource uses so as to minimize the risk of maladaptation.

Ports and harbors are the special focus of McEvoy and Mullett's chapter (this volume), illustrating how much of the Australian economy is dependent not just on functional and well-adapted coastal trade, transfer, and transportation infrastructure, but also on the protection of port assets and on a well-prepared workforce that can meet the twin challenges of near-term disaster preparedness and long-term adaptation to climate change. The authors clearly recognize that climatic and non-climatic drivers influence the business decisions of port authorities. They make a strong case for adaptation as an iterative social learning process in which researchers and decision-makers engage in continual co-production of relevant knowledge.

Fletcher et al. (this volume) and Waters and Barnett (this volume) then take us into a range of Australian coastal communities to explore the economics, equity, and institutional arrangements for adaptation. Fletcher and colleagues set out from the simple, if for many difficult-to-accept fact, that coastal impacts of climate change, as the adaptation options that communities will choose to manage them, will affect some harder than others. Accepting this premise of winners and losers from climate change as much as from adaptation, the onus is on governments to find a path to navigate the tricky social and economic territory of adaptation. Their study suggests that coastal residents and managers will often prefer familiar, incremental, and less legally risky adaptations over novel, more disruptive, if maybe more effective ones over the long term. The price – quite literally – for this preference is lower economic efficiency. In other words, adaptation "in the real world" is not a rational, cost-minimizing optimization process, but instead a messier and more expensive sequence of adjustments. Few economic assessments to date are guided by this more realistic assumption. Likewise, few systems-thinking scientists would recommend such a course of action, and few if any politicians to date are willing to acknowledge this more costly, and likely more disaster-prone and loss-ridden future.

So what governance arrangement is best suited then to navigate these thorny trade-offs? Waters and Barnett (this volume) try to answer this question by delineating – on the basis of detailed interviews with coastal managers and stakeholders in two Australian communities – a preferred multi-level governance approach to coastal adaptation. While not suggesting unanimity in opinion, nor general applicability to all coastal areas, they find that local stakeholders have clear preferences for the roles and responsibilities of different levels of government, households and the private sector. They see local governments ideally placed to manage local public assets, regulate decisions over private assets (which in turn are largely implemented by individuals and businesses), and coordinate public input into local planning, while the state level is expected to play largely a coordinating role across locales and regions. The federal level in turn should preferably provide relevant information and generate and distribute the necessary financial resources for adaptation.

Of course, these preferences from the local perspective may not spell success for all interested parties, in light of the many stakes nations have in their coastal areas: the economic assets and activities there, along with the infrastructure that connects coastal and inland areas, not to speak of the ecological jewels and other commons. In highly interconnected national and global economies, the jury is still out on how to maximize the likelihood of successful adaptation for the greatest number of stakeholders at all levels, while preserving the commons – the life support systems and biodiversity on which we all depend, and which many consider to have an intrinsic right to exist

regardless of human needs and desires (Moser and Boykoff 2013; Moore and Nelson 2011).

### **Toward a Human Response Equal to the Test**

Taken together, none of the findings in this section – neither on the multiple stresses and threats to coastal areas, the differential vulnerabilities and human-ecological complexities and uncertainties, the conflicts between public preferences for adaptation strategies and other ecological or economic goals, nor the preferred roles and responsibilities of different participants in governance – are entirely unique to Australia. Public views on desirable categories of adaptation actions and on the roles and responsibilities of different levels of government are also not unique to coastal adaptation, as a recent review of the adaptation literature on these questions found (Moser 2014).

This does not make them any less daunting however. The clash of human development at the coastal fringe with the rising sea can easily create a sense of inevitable loss and paralysis. Yet, the future of the Australian coast – or any coast – is not hopeless.

Hopelessness as maybe the ultimate failure to adapt is *not* an option when so many people, so much economic activity, and so many ecological riches are at risk. So, it is all the more important that coastal regions of the world learn from and with each other how to prepare for and minimize the negative consequences of climate change, and do so fast. Too much is at stake to reinvent the wheel countless times over, even as each coastal community and each coastal industry have to find locally contextualized and tailored, as well as regionally coordinated answers to the shared challenges ahead.

American political and environmental scientist, David Orr, once said that it is our obligation as scientists and individuals – at this time in the history of humans on Earth – to tell the full truth of what we see happening to our planet, and thus to ourselves. But "truth telling" in his mind does not mean merely listing a litany of (global) environmental crises to create a sense of doom. Instead, for him truth telling is a way of calling forth the best in humans:

"Telling the truth means that the people must be summoned to a level of extraordinary greatness appropriate to an extraordinarily dangerous time."

(Orr 2011, p. 330)

In the contributions to this section, we find the increasingly sophisticated capacity of science to detect, explain, and project forward the unfolding impacts of climate change and sea-level rise on coastal areas (Woodroffe et al., this volume; Hadwen and Capon,

this volume). We might see it as one measure of "extraordinary greatness" just how mature that understanding has become over the past 30 or more years of climate change research. Maybe even more encouraging are the distinct advances reflected in these chapters in how to integrate not just physical and ecological knowledge, but also the social and economic sciences (McEvoy and Mullett, this volume; Waters and Barnett, this volume; Fletcher et al., this volume).

What's more, each of the chapters expresses a willingness to engage with decision-makers, to learn from each other and to co-produce use-inspired and practice-relevant knowledge. This marks a step out of the academic comfort zone and as such a step closer to the extraordinary greatness demanded of us as scientists in this increasingly and extraordinarily challenging time. But this alone will not suffice to meet it.

Without a doubt, reliable, sophisticated, locally relevant, and co-produced science as presented in these pages will help, may even be indispensable. Sharing data, tools and approaches up and down our coasts and across the seas will be extremely valuable. Even more beneficial will be greater cooperation across sectors and integration across scales of governance. But the difficult recognition and public articulation of just how big the coastal adaptation challenge is lies yet ahead for most. And the tough decisions and unpopular trade-offs undoubtedly to come will need to be made by a few and supported by many. Maybe the greatest of these challenges lies in collectively finding a path beyond our narrow, short-sighted interests, a path toward a greater, common self-interest that ensures that our coasts continue to offer the riches that draw us and sustain us. In this way, every inch of sea-level rise calls on each of us – in academia, in businesses and in public office – to rise to a human greatness more extraordinary than we have achieved to date.

## References

Agardy, T., Alder, J., Dayton, P., Curran, S., Kitchingman, A., et al. (2005). Coastal systems. In: *Ecosystems and Human Well-Being: Current State and Trends: Findings of the Condition and Trends Working Group of the Millennium Ecosystem Assessment*, Hassan, R.M., Scholes, R.J., and Ash, N. (eds.). Washington, DC: Island Press, pp. 513–549.

Hinrichsen, D. (2011). *The Atlas of Coasts and Oceans: Ecosystems, Threatened Resources, Marine Conservation*. Chicago, IL: Univ. Chicago Press.

IPCC (2013). Summary for Policymakers. In: *Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC)*, Stocker, T.F., D. Qin, G.-K.

Plattner, M. Tignor, S. K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.). Cambridge, UK and New York, NY: Cambridge University Press.

Martinich, J., Neumann, J., Ludwig, L., and Jantarasami, L. (2012). Risks of sea level rise to disadvantaged communities in the United States. *Mitig. Adapt. Strateg. Glob. Change* 18(2):169–185.

McGranahan, G., Balk D., and Anderson, B. (2007). The rising tide: Assessing the risks of climate change and human settlements in low elevation coastal zones. *Environ. Urban.* 19:17–37.

Moore, K. D. and M. P. Nelson (2011). *Moral Ground: Ethical Action for a Planet in Peril*. San Antonio, TX: Trinity University Press.

Moser, S.C. (2014). Communicating climate change adaptation: The art and science of public engagement when climate change comes home. *Wiley Interdisciplinary Reviews—Climate Change*, in press, doi: 10.1002/wcc.276.

Moser, S.C. and M.T. Boykoff (eds., 2013). *Successful Adaptation to Climate Change: Linking Science and Practice in a Rapidly Changing World*. London: Routledge.

Moser, S.C., Williams, S.J. and D.F. Boesch (2012). Wicked challenges at land's end: Managing coastal vulnerability under climate change. *Annu. Rev. Environ. Resour.* 37:51–78.

Nicholls, R.J., Marinova, N., Lowe, J.A., Brown, S., Vellinga, P., et al. (2011). Sea-level rise and its possible impacts given a 'beyond 4 degrees C world' in the twenty-first century. *Philos. Trans. R. Soc. A* 369:161–181.

Nicholls, R.J. and Cazenave, A. (2010). Sea-level rise and its impact on coastal zones. *Science* 328:1517–1520.

Nicholls, R. J., P. P. Wong, V. Burkett, J. Codignotto, J. Hay, et al. (2007). Coastal systems and low-lying areas. In: *Climate Change 2007: Vulnerability, Impacts and Adaptation, Contribution of Working Group II to the IPCC Fourth Assessment Report*, M. L. Parry, O. F. Canziani, J. P. Palutikof, P. J. v. d. Linden and C. E. Hanson (eds.). Cambridge, UK: Cambridge University Press, pp. 315–356.

Orr, D. W. (2011). Hope (in a hotter time). In: *Hope is an Imperative: The Essential David Orr*, D. W. Orr (ed.). Washington, DC: Island Press, pp. 324–332.

Preston, B. L., T. Smith, C. Brooke, R. Gorddard, T. Measham, G. Withycombe, K. McInnes, D. Abbs, B. Beveridge and C. Morrison (2008). Mapping Climate Change Vulnerability in the Sydney Coastal Councils Group. Aspendale: CSIRO Marine & Atmospheric Research.

United Nations Environment Program (UNEP) (2007). *Global Environmental Outlook 4: Environment for Development*. Valletta, Malta: UNEP/Progress Press.

Williams, S.J. and Gutierrez, B.T. (2009). Sea-level rise and coastal change: causes and implications for the future of coasts and low-lying regions. *Shore Beach* 77:1–9

Wong, P.P., Marone, E., Lana, P., Fortes, M., Moro, D., and Agard, J. (2005). Island systems. In: Hassan, R.M., Scholes, R.J., and Ash, N. (eds.) *Ecosystems and Human Well-Being: Current State and Trends: Findings of the Condition and Trends Working Group of the Millennium Ecosystem Assessment*. Washington, DC: Island Press, pp. 663–680.