**Developing engagement in river basin management to support improved climate mitigation and adaptation**

***Dr Katherine Daniell, The Australian National University***

Rivers are the life force of many of our societies. Throughout history, access to river water has provided a basis for human development. Rivers and their extended basins are also home to rich and complex ecosystems. These systems have both intrinsic value and value in providing significant ecosystem services to the societies who inhabit them. Key human uses of rivers over centuries have included water supply, navigation, sanitation, wastewater disposal and energy production; uses which sit alongside rivers' aesthetic, cultural, recreational and food production value to societies. The ways that river basins have been developed and populated has also led to people understanding not only the life-giving force of rivers, but their life-taking force—the force exhibited when rivers fill and flood or dry-out in a manner too violent for surrounding inhabitants.

Rivers and the societies living around them have thus been managed with an understanding of such climate and related river flow variability. Human ingenuity over thousands of years has led to attempts to control many rivers and tame their flows to allow for greater and more productive human development. This includes the building of tens of thousands of dams, weirs, locks, aqueducts, drainage and irrigation canals, and storm and wastewater systems in cities. Technical expertise systems, coupled with sophisticated governance have been developed to manage these infrastructures and the water within them. Such development has indeed been very productive and provided a basis for sedentary populations to grow and prosper around the world. It is also such development and its associated population growth that has led in large part to the greenhouse gas emissions causing global warming and climate change. Rivers, and how we have lived with them and managed them, have therefore been an enormous contributor to the 'Anthropocene'; the era where the human impact on earth can be seen as a geological phenomenon.

As we look to the future, rivers and the societies who rely on them can be seen to be at the heart of how we can more effectively mitigate and adapt to changing climates. How development occurs from now on will either add to the acceleration of climate change or efforts to reduce it.

Within the current development paradigm, hydropower, river water cooled nuclear power or river-based navigation may support certain lower carbon intensive futures, when compared, for example, to fossil fuel production and on-road transport. The current systems of canalised and segmented river systems also provide a certain level of control to managers to distribute water in more optimal manners for climate change mitigation and adaptation objectives. Yet, such structural development paradigms also come with negative attributes for adapting to and mitigating climate change. In particular, they often have irreversible impacts on river ecosystems and livelihoods of people who depend on particular types of ecosystems and ecosystem services, such as flood-based agriculture or fish availability. Such structural management systems can also heighten the risks of loss and damage for communities from extreme events in multiple ways. One mechanism being that such infrastructure leads to development in areas such as flood plains where residents assume that the infrastructure provides adequate protection—the reality being that if either the infrastructure fails or the design

level of the infrastructure is exceeded (e.g. the levee design in Hurricane Katrina in New Orleans, US), the people and businesses in these areas are very vulnerable to flooding impacts.

Alternative development paradigms that seek to maintain the water balance in a closer to natural state are also emerging in river basins, sub-basins and urban development zones. This includes 'green infrastructure' or ecosystem-based or informed systems for river management, including for flood mitigation, and 'water sensitive urban development'. Such systems aim to keep water in the landscape to contribute to ecosystem services such as water treatment, flood detention/attenuation or land cooling.

Both river development paradigms present opportunities for integration with stakeholder engagement, including local communities, in collaborative or cooperative river management approaches. They also provide the basis for use of smart technology, water trading and market-based approaches to managing water and associated energy demands, and collective or individual infrastructure.

Each development pathway for rivers will have a range of supportive and less-supportive stakeholders. This is due to how such approaches reflect their interests and cultural values. The climate change mitigation and adaptation impacts will also be very varied since benefits and costs will accrue at different levels of management and scales of interest. For example, the impacts of green infrastructure in urban river systems may be most beneficial to local residents, their temperature, lower energy usage, amenity and their housing prices, but leave councils with significant maintenance costs in terms of mowing, weeding and upkeep compared to concrete-lined canals. New hydropower dams on the other hand may be detrimental to the livelihoods of farmers living in the dam area who will lose their land and/or water access, but provide the provincial or country scale with large amounts of low-carbon energy.

This complexity leads to the need to engaging stakeholders in decision-making processes for river management that explicitly address both water management and climate change objectives. Due to likely high levels of value conflict over preferred climate-sensitive river management pathways, stakeholder engagement processes will require careful 'co-engineering', i.e. collective organisation by some strategic thinkers and river management champions. These should aim to work through inter-cultural conflict and tensions with the broadest range of stakeholders including governments, businesses, NGOs, communities and researchers. Such processes should also have a major focus on empowering and reconnecting citizens with their river systems, regardless of whether they live in rural or urban settings. Re-connection and appreciation of both the aesthetic and service values of rivers will help citizens to reflect on the importance of rivers and how their effective management underpins environmental quality, economic development and social well-being.

Development of such a shared understanding—specifically that rivers are a global life-blood and in need of greater care to maintain their health—could support broad-scale social mobilisation towards more sustainable river management and improved climate change mitigation and adaptation.