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Climate change impacts on freshwater and urban environments

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Some of the most profound impacts of anthropogenic climate change are expected to occur in freshwater and urban environments. This is because freshwater impacts potentially shape future human water, food and energy security, as well as damages from flooding and land degradation, changes in ecosystem properties and water quality (Whitehead et al., 2009). As the growing concentration of urban populations and their assets are exposed to extreme weather events, so could harmful effects accrue from heat waves, poor air quality, flooding, and biodiversity loss, particularly amongst vulnerable groups (Wilby, 2007).

This talk will situate climate risk assessment within a much broader decision-making framework that ultimately informs adaptation and development planning. The case will be made for a decision- rather than scenario-led approach (Brown and Wilby, 2012). This perspective focuses attention on the most vulnerable features of the system of interest whilst creating space to evaluate climate risks within the context of a much broader suite of non-climatic pressures on human and natural systems. Conversely, more conventional scenario-led (or 'top-down') approaches can be helpful for preliminary risk screening but seldom lead to tangible adaptations beyond low regret measures. This is because greater emphasis tends to be on uncertainty characterisation.

Two case studies will be used to illustrate the strengths of the decision-centric approach for managing freshwater and urban impacts. The transferability of the tools and techniques will be stressed in each case.

The first describes the development and application of a methodology for identifying 'hot spots' of climate risk and to guide adaptation activities in Yemen (Wilby and Yu, 2013). The project was commissioned by the United Nations International Fund for Agricultural Development (IFAD) in order to identify ~500 village units that are vulnerable to a range of water impacts (from flash flooding, soil erosion, water scarcity and reduced crop potential). Surface meteorological observations, remotely sensed (TRMM and NDVI) data, physiographic indices, and regression techniques were blended to produce gridded maps of annual mean precipitation and temperature, as well as parameters for site-specific, daily weather generation for any location in Yemen. Climate sensitivity analysis was then applied to the impact models alongside socio-economic criteria to identify communities that are potentially most at risk. A Google Earth tool was provided to enable field officers to locate communities and interpret climate risks within a wider landscape context.

The second describes a holistic approach to flood risk assessment for the City of Shanghai taking into account the combined effects of precipitation variability and change, urban drainage features, and waterlogging (Wu et al., 2012). Despite continuing efforts to upgrade the urban storm sewer system since the late 1950s, the City of Shanghai remains vulnerable to persistent rainstorm waterlogging due to excess surface runoff and sewer surcharge, which frequently cause significant damage to buildings and disruption to traffic. Aerial photographs reveal that over recent decades the natural drainage network has shrunk by 270 km, significantly reducing the city's capacity to evacuate excess surface flow. Although there is no significant overall trend in annual rainfall totals, seasonal and monthly rainfall intensities have increased.

Compared to pre-1980s there has been an increase in the number of wet days with precipitation exceeding 25 mm (heavy rainfall). The number of consecutive wet days with precipitation maximum and average exceeding the threshold known to cause waterlogging also shows an increasing trend. The study shows how emergent climate risks in urban (and freshwater) environments can seldom be interpreted in isolation of co-stressors.

The final part of the talk will outline opportunities for future research into freshwater and urban environments, again emphasizing the information and tools needed to assist adaptation planning. Two main recommendations are made. First, that the international community develops concerted field campaigns to test adaptation interventions and to develop evidence for practitioners. Brief reference will be made to the specific cases of low flow and water temperature management to illustrate the point (Wilby et al., 2010). Second, that researchers, policy-makers and public groups assemble 'tool-kits' for addressing climate risks across a range of space and time-scales. This should include networks for routine monitoring and evaluation of emergent hazards and adaptation outcomes; models for risk assessment and warning; as well as boundary organisations, data platforms, codes, and governance as part of a broader enabling environment (Wilby and Keenan, 2012).

Both sets of recommendations are made on the assumption that the time has come to make smarter use of climate risk information. That is, to accept the reality of uncertainty and focus more energy on testing the efficacy of adaptation options.