21. Energy

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Energy and water resources are critical for human wellbeing, but measures to secure their supply are inextricably linked and often conflict (Pittock 2011). Common to these resources is the need to supply a growing and wealthier global population while sustaining environmental health and responding to climate change. The following chapters explore key links between sustainable management of water and energy supply.

Energy

Currently the world's energy is overwhelmingly sourced by combusting fossil fuels, a process that emits dangerous levels of greenhouse gases. Thermal electricity generators, including fossil fuel and nuclear power stations, require large volumes of water for steam generation to drive turbines, as discussed by Byers (Chapter 22) and Spang (Chapter 23). To mitigate climate change and increase energy self-sufficiency, there is great interest in low-carbon and renewable energy sources. Many renewable energy generators, however, also consume large volumes of water (Gerbens-Leenes et al. 2008). First-generation biofuels consume (transpire) an order of magnitude more water than other energy sources. Evaporation from reservoirs makes hydropower another thirsty energy source. Solar thermal power stations and geothermal generators may also require a lot of water, depending on the technologies used. While wind and solar photovoltaic technologies use little water directly, the deployment of these intermittent generators may require energy storage technologies or complementary sources that do consume significant volumes of water, such as hydropower.

Natural gas may be a 'transition fuel' that emits less carbon per unit of energy as our societies work out how to decarbonise our energy supplies. The combination of new technology and desire to source low-carbon energy domestically is driving the rapid expansion in exploitation of unconventional gas resources globally. This is exemplified by the debate over development of a shale gas industry in India, as outlined by Biswas and Kirchherr (Chapter 25). These resources include shale and coal seam (coal bed methane) deposits that are accessed by drilling, dewatering relevant geological structures and hydraulic fracturing (fracking). Water resources may be impacted by dewatering of aquifers and pollution from some types of fracking fluids, well blowouts and disposal of production water, as discussed by Hildebrand et al. (Chapter 24). This example highlights the risk that well-meaning policies in one or a few sectors, such as energy and climate change, may have perverse impacts on sectors like water if they are not managed well. Hence future energy policies will depend on adequate consideration of water management (Hussey and Pittock 2012).

Water

Water resources are unevenly distributed around the world. A growing portion of the world's people live in water-scarce areas that are naturally dry, or where increasing populations reduce the per capita share. Around a third of the world's people lack access to improved sanitation services and a sixth do not have adequate drinking water supplies. In most cases there are technological interventions that can supply water to people, and the global water community has concluded that lack of funding (economic water scarcity) and poor governance are the main barriers to more sustainable management (World Water Assessment Programme (WWAP) 2009). Water requires a lot of energy to move and can require a lot of power to purify. From a positive perspective, reducing water demand can also reduce energy consumption. However, as water becomes more scarce, or polluted and requiring of treatment, or where the sources of water supply are diversified as an adaptation to climate change, then the energy required to secure supplies increases. The high energy consumption of desalination plants exemplifies this trade-off (Pittock et al. 2013). Better practices may bring positive synergies, for example, use of wastewater treatment to generate energy (Byers, Chapter 22).

Further, as freshwater ecosystems are the most species-rich per unit area, one consequence of the growing exploitation of water resources is a loss of biodiversity. Ecosystems services (such as fisheries) that millions of people depend on for their livelihoods are also diminished, as they are usually externalities in water infrastructure development decisions (Millennium Ecosystem Assessment (MEA) 2005). Orr (Chapter 26) (Orr et al. 2012) outlines a particularly stark example of hydropower development on the Mekong River. The dam developments are driven in part by China's climate change mitigation policy and will seriously impact on freshwater biodiversity, and diminish the wild fish supply that is the main source of protein for the people of the lower Mekong. The research projects the significant land and water resources required to produce protein supplies to replace the fish lost to hydropower and highlights the risks of negative impacts from poorly considered sectoral policies.

The nexus approach

The four following chapters, as introduced above, are examples of the energy–water trade-off that, in recent years, has been dubbed a 'nexus' (Hoff 2011). Many other sectors are closely linked with energy and water and various international forums have been considering nexuses, including the links between climate, energy, health, food and water policies and practices. It is worth asking whether this nexus approach is just the latest piece of academic jargon, or whether it provides a useful, new way to better manage positive synergies and trade-offs across sectors?

Critics of the approach note that the various nexuses identified are subsets of and a possible distraction from the broader need to implement sustainable development. A further criticism is the anthropogenic focus of the current resources framing of these nexuses that largely excludes consideration of biodiversity and other aspects of environmental health. A contrary perspective of nexuses is that they enable focused debate between specific sectors that may otherwise be frustrated by the complexity of sustainable development writ large. This may enable identification of tractable solutions among a few sectors that have lessons for resolving other complex, multidisciplinary, multi-sectoral problems. The challenge for people applying the nexus approach is to move beyond naming problems by focusing on elucidating practical solutions. In one typology, the solutions that emerge from research on the energy–water nexus, and other nexuses, fall into four categories (Pittock et al. 2013): providing and drawing on information across sectors in decision-making; applying new technologies; using market-based mechanisms to reduce externalities; and, enhancing regulation and other forms of governance.

This contribution and the five following chapters highlight the trade-offs between energy supply and water consumption. Hopefully these writings will inspire readers to redouble efforts to identify positive synergies and find ways to minimise negative trade-offs between the energy and water sectors and, as a result, among a range of sectors that are vital for the wellbeing of people and the environment.

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