Book Review by Angela H. Arthington

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Review of *Replenish: The Virtuous Cycle of Water and Prosperity* By Sandra Postel

Island Press, Washington, DC (2017)

Sandra Postel is the author of four books on fresh water – its amazing properties, global distribution patterns, human uses, ecological values, and water management practices. Her first, the *Last Oasis: Facing Water Scarcity* published in 1992, was followed by *Pillar of Sand: Can the Irrigation Miracle Last?* (1999), *Rivers for Life: Managing Water for People and Nature* (with Brian Richter, 2003) and now *Replenish: The Virtuous Cycle of Water and Prosperity* (2017). She has also published numerous papers on these themes, modestly listing eight titles in the *Replenish* reference list, all with intriguing titles and powerful messages.

Replenish builds upon Postel's remarkable body of knowledge and insights garnered over 25 years. It takes the reader on a journey through 12 chapters of narrative, pertinent facts and revealing case studies about new and emerging solutions to global water problems. Chapter by chapter, she demonstrates the benefits and then the downsides of many large-scale water engineering and land management projects. Her accounting is couched in terms of the trading of nature's services for technological solutions to universal problems: denuded and degraded watersheds (catchments), soil erosion, salinisation and flooding. Problems extend to depleted and unreliable water supplies, sedimentation of waterways, eutrophication, toxic algal blooms, diminishing food fish populations, river and wetland degradation, and the resulting societal consequences.

Chapter 1 (*Water Everywhere and Nowhere*) begins with the water cycle and an account of how humans have manipulated and controlled water's natural flows through landscapes and rivers for at least 5,000 years. Postel does justice to the many ways that water engineering projects have been of immense benefit to humans, but with little regard for the intrinsic values of the freshwater ecosystems they disturb, nor concern for the ecological services lost to society.

While Chapter 1 lays out this rather bleak perspective, Chapter 2 (*Back to Life*) is much more positive, indeed joyful. It introduces the first of numerous case studies about ecosystem replenishment and revival, recovery and ecological resilience. Postel describes the history of remarkable efforts to recover parts of the Colorado River Delta by sending an engineered pulse of flood-water from Morelos Dam on the Californian border into Mexico and thence through the desiccated delta to the Gulf of California. Many scientists, including Dr Rebecca Lester from Deakin University, Australia, were witness to this ground-breaking environmental flow experiment. Watching the front of river water moving along the dry channel, Dr Lester was excited by the proliferation of copepods hatching from eggs long dormant in dry sands, and the feeding of fish larvae on these minute creatures. This was clear evidence that the riverine food web was already beginning to develop. Behind the unfolding drama of the delta's ecological recovery lies a long and complex history of human endeavour:

scientific investigations, recommendations, persistent negotiations, fund raising, an intergovernmental treaty, a special memorandum, and in the end fortuitous weather events before the gates at Morelos Dam were finally opened to release the flood pulse to the delta. Planning for further pulse flows and restoration of baseflows has continued since 2014, with several NGOs working on a project called *Raise the River* (<https://raisetheriver.org/stories/>). Postel's concluding message is prescient "*How much life returns, and ultimately lives on, is now largely in human hands*". It is a theme echoed throughout the book.

Chapter 3 (*Put Watersheds to Work*) continues with a focus on watersheds as "*nature's water factories*". She describes the massive degradation of watersheds around the world and the consequent heightened risks of fire, floods, soil erosion, water pollution and water shortages. Her stories include devastating effects of rainforest clearing in the Amazon basin, erosion of the Loess Plateau in northern China ("*a classic example of the tragedy of the commons*"), and forest fires over vast areas of Alaska, Alberta, Manitoba and the Pacific Northwest USA. Fires followed by heavy rains and flooding can dump tons of ash and debris into water storage reservoirs, threaten drinking water supplies and significantly increase the cost of water treatment. Postel shows how watershed protection and "*nature's way of treating water*" can enable major cities (e.g. New York) to save billions of dollars in water treatment and enhance water security while protecting the scenic, wildlife and recreational values of forest reserves, catchments and waterways. An Australian initiative, '*Building Catchment Resilience*', is using catchment modelling and cutting-edge landscape visualisation tools to guide large-scale investment in catchment restoration strategies. Such strategies are aimed to mitigate flooding, reduce erosion and sedimentation, maintain water quality and protect riverine and estuarine biodiversity in southeast Queensland (https://www.griffith.edu.au/_data/assets/pdf_file/0033/883536/Building-Catchment-Resilience-Factsheet.pdf).

Chapter 4 (*Make Room for Floods*) resonated with me after two decades of research and writing about Australia's dryland and tropical floodplain rivers where natural flood pulses are critical to the health of the rivers and the breeding cycles of native biota. Yet living in a river city during the infamous 1974 Brisbane River flood has brought the human risks of flooding very close to home – too close in fact. A small billabong (oxbow lake) at the bottom of my garden filled and sent a sheet of muddy water and plant debris into the living room, later to rise and rise until the entire house was under water for three days. Postel recounts numerous similar flood disasters, massive human evacuations, urban and rural devastation and deaths. The traditional solution has been to tame rivers, dampen flood pulses, regulate flows and deprive floodplains of replenishing water, by constructing expensive engineering works – dams, levee banks, dikes and diversion canals. Often these have served their prime purpose but when they fail the results can be catastrophic. When levees failed during the 1995 flood on the Rhine, large areas of the Netherlands were inundated. A new approach was needed and the '*Ruimte voor de rivier*' program began by lowering dikes, creating setbacks and allowing parklands destined for development to store floodwater when the rivers overflowed. In 2007, the European Union's Water Framework Directive was expanded to include a flood directive, including measures to restore river-floodplain connectivity. Similar efforts to "*work with*

nature's ability to control floods rather than against it" are emerging around the world. A method called eco-engineering decision scaling (EEDS) integrates ecology and engineering while designing dams and levees for future changes in climate and flood probabilities (Poff et al., 2016). The idea is to build resilience into flood risk management while restoring the ecological functions of channels and floodplains by giving rivers more "*room to roam*". What solution could possibly be more obvious and so long overdue?

Chapter 5 (*Bank it for a Dry Day*) is all about groundwater depletion "*the sleeping tiger of global water threats*". Chapter 6 (*Fill the earth*) addresses rangelands management and sustainable production of beef, while Chapter 7 (*Conserve the City*) turns to ensuring urban water security, through efforts to lower household demand, fix utility distribution systems, reduce landscape irrigation and make better use of stormwater and treated wastewater. Building desalination plants as an insurance policy against the next "Big Dry" in Australia gets a serve for creating a legacy of largely "*stranded desalination assets*". Postel says that "*Fossil-fueled desalination plants contribute to climate change, which increases the risk of drought - a less-than-elegant solution, to say the least*". She promotes a large-scale pivot to "*green infrastructure*" to help cities weather the coming age of floods, droughts, and water stress.

Chapter 8 (*Clean it Up*) begins with a famous quote attributed to Luna Leopold – "*The health of our waters is the principal measure of how we live on the land*". Excess nitrogen from human wastes and fertilizers, toxic algal blooms, fish and shellfish contamination and human deaths are the main focus. The solutions involve reducing the use of fertilisers and the flow of nutrients to waterways, enhancing nature's water purification systems by restoring wetlands and riparian forests, and generally promoting sustainable agriculture at large scales. Chapter 9 (*Close the Loop*) explores treating and reusing wastewater to drought-proof or augment water supplies. For example, in Fulton County, Georgia, on-site treatment and reuse of wastewater allows more water to remain in the Chattahoochee River, which has an exceptionally high diversity of fish, mussels, and other aquatic life. Constructed wetland treatment systems provide another means to remove pollutants and cleanse water supplies, and they often support wildlife species that have lost much of their natural habitat.

In Chapter 10 (*Let it Flow*) Postel explores the well-established impacts of dams, large and small, that have fragmented riverine ecosystems and caused the decline of numerous migratory fish species, including one of the largest runs of Atlantic salmon in the United States. As well as blocking fish passage, large dams and IBTs (inter basin transfers of water) are largely responsible for replumbing the planet, to the enormous detriment of riverine ecosystems and freshwater biodiversity. Restoring water to rivers to mimic important features of their natural flow regimes and ecological functions became a global movement in the 1980s (Postel and Richter, 2003). According to Postel, two countries stand out for their contributions to this movement. South Africa's 1998 Water Act made the environment a priority, while Australia began a comprehensive process of water reform to help restore waterways and aquatic ecosystems. Postel describes the effects of excessive water extraction from the semi-arid Murray-Darling (M-D) river system. Spanning 14% of mainland Australia, the catchment supports 40% of its agricultural production, as well as Ramsar

wetlands, iconic river redgums, and large breeding populations of fish and waterbirds. Saving the M-D from decades of over-extraction and the 10-year Millennium Drought has involved the development of an interim cap on water extractions, the 2007 Water Act designed to restore water to the basin's river systems and its floodplain wetlands, the promulgation of the intergovernmental Murray-Darling Basin Plan (*"an extraordinary achievement"*), the appointment of the Commonwealth Environmental Water Holder to manage delivery of flows to designated areas of the basin, and *"the best-functioning water markets in the world"*. Postel sees the Millennium Drought as *"a trial run for adapting to the new normal"* – less runoff arriving even less predictably. How would she react, one wonders, to the multitudes of fish killed during destratification events in the impounded and regulated Darling River near Menindee – a potent biological indicator of water management gone badly wrong (<https://www.science.org.au/supporting-science/science-policy-and-sector-analysis/reports-and-publications/fish-kills-report>).

Chapter 11 (*Rescue Desert Rivers*) is a neat segue to the final chapter (*Share*), the nutshell of the book. Postel says that for the last 25 years, the idea of using less and sharing more, especially with the natural world, has framed her work. It is time *"to boldly adapt how we live, work, and manage our lands and watersheds to prepare for what's coming—more extreme floods, droughts, and fires; the drying of soils and streams; the shrinking of lakes, the contraction of wetlands, the loss of habitats, the expansion of dead zones, and the decline of fisheries and aquatic life"*.

This inspiring book shows how Postel's vision is being achieved through numerous water sharing and stewardship initiatives and programs around the globe, and the range of options and lessons for success. The ingredients and steps vary hugely with geography and context, but the biggest successes seem to be those that motivate diverse groups of people and different sectors of society to engage and garner the skills and resources needed to drive their vision to the highest levels of governance and policy. These processes require imagination, commitment and of course, time. In Australia, scientists and environmental groups began agitating about the impacts of large dams and the degradation of rivers in the early 1970sm when the wild rivers of Tasmania were threatened by hydropower developments. It took another 20 years of agitation, advocacy, conferences, research evidence and a disastrous toxic blue-green algal bloom in the M-D system to get all three tiers of government (Commonwealth, State/Territory and Local) committed to a process of national water reform (Arthington and Pusey, 2003).

In closing, Postel asks *"On balance, are rivers getting healthier, aquifers being recharged, floodplains being rejuvenated, and wetlands being expanded? Are we becoming more resilient to droughts, floods, and fire? Is the water cycle being replenished and repaired?"* Yes and no. *"Yes, the water cycle is broken, but one river, one wetland, one city, one farm at a time, we can begin to fix it"*. Yes, we have ample water management tools and environmental flow techniques, we know what works and what needs more research, but are we doing enough? No. Increasing the number of practical riverine restoration projects and expanding their influence from local to regional scales is the immediate challenge. Integrating water reforms with social and cultural norms, governance systems and country

land and water management policies is another challenge. Achieving all this in contexts of population expansion, shifting societal expectations and uncertain climatic futures is the third grand challenge. Postel's final message is very clear. "*Our challenge as a society is to build resilience — the ability to cope with disturbance while continuing to function. As the stories in this book have shown, replenishing the world's natural flow of water is among the best ways to build that resilience*".

Literature Cited

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