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To solve climate change, we need to restore our Sponge Planet

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Climate strategies focus primarily on carbon, largely ignoring the destabilized water cycle that's amplifying disasters and accelerating climate change. Slow Water projects can reverse this trend.

Getting off fossil fuels is undeniably a critical step in slowing climate change. But even if we did that tomorrow, it would not be enough. Agriculture, forestry, grazing, mining and building has degraded 75% of land on Earth[1], significantly altering the water cycle. That's a problem because a healthy water cycle plays a key role in stabilizing the climate. Yes, water vapour is a greenhouse gas that can amplify the impact of excess carbon dioxide. But water is also the primary way the planet cools itself, via the reflection of solar energy off clouds and via its phase change from gas to liquid, which releases heat high in the atmosphere, where some escapes to outer space[2].

But our impact on the natural water cycle has been extreme. We've drained or filled as much as 87% of the world's wetlands and dammed and diverted two-thirds of the world's large rivers. Just since 1992, human encroachment onto floodplains has paved an area the size of Ukraine. We need policies and funding that protect, restore, or mimic natural slow water systems, such as wetlands, floodplains, mountain meadows and forests.

Decades ago, land use's effect on the water cycle was an important focus of climate science. But because of water's complexity, climate models represented it with simplified assumptions. Ongoing uncertainties such as the role of clouds and plants' responses to climate change have been hard to communicate, so over time climate scientists, journalists and thus government policies have narrowed the focus primarily to carbon. And while a small percentage of climate crisis interventions address land-use change, they typically focus on carbon stored in plants and soil.

Climate change impacts involving water, including increased droughts and floods, are gaining more attention now, with the advancement of attribution science. In response, many decision-makers call for bigger, stronger infrastructure. But that 'grey' infrastructure — aqueducts, dams, and levees aimed at controlling water — is part of the problem. That's because engineered approaches to water management often focus on solving a single problem at a time. Worried about flooding? Build a wall. Does water scarcity loom? Build a dam and pipeline to bring in more from somewhere else. But such singular focus ignores and damages complex natural systems and their inhabitants who keep them functioning.

By eradicating space for water's natural slow phases, such interventions cause flooding. Humans respond by speeding water off the land, reducing groundwater recharge and causing scarcity soon after. This rush to get water off the land even contributes significantly to sea-level rise.

Inflexible and brittle, grey infrastructure requires ongoing maintenance and causes more carbon emissions due to the use of concrete and the destruction of natural ecosystems that store carbon. It is also unjust to marginalized people. A levee protects one community but

Haikou Meishe River Restoration transforms a concrete drain into a dynamic waterway, combatting flooding and pollution, weaving nature back into human habitat.

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Adaptation to sea-level rise. The Haikou Breathing Sea Wall converts a traditional sea wall into a resilient, permeable barrier against climate change. With terraced planters and revitalized mangrove habitats, it strengthens coastal defences and biodiversity, protecting urban districts while fostering ecological and recreational value[15].

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raises the water level in the river, increasing flood risk for a neighbouring community. Dams are also unjust. Over 40 years, dams brought water to 20% of the world's population but decreased water to 24% of the population[3]. These problems and others underscore the need for integrated green–grey solutions to ensure long-term resilience and sustainability.

Drawing inspiration from natural systems and many thousands of years of human adaptation to irregular rains and changing climate[4], the Sponge Planet model has three foundational principles: absorb rain where it falls, restore water's natural slow phases, and adapt modern humans to accept more slow water on the land. These principles are exemplified in the global Slow Water movement, in which projects protect and restore wetlands, floodplains, mountain meadows and forests, and mimic these natural systems with permeable surfaces[5]. Many thousands of small projects distributed across the landscape increase infiltration into soils, hyporheic zones, and aquifers, effectively creating a Sponge Planet, the necessary extension of the smaller-scale initiatives of "Sponge City" and "Sponge Watershed"[4–6]. Because Sponge Planet deploys systems thinking, it does not solve one problem while creating others but instead reaps multiple benefits simultaneously.

Multiple benefits

Sponge Planet is climate adaptation. In absorbing high flows, it reduces upstream and downstream flood risk. In recharging groundwater and storing it locally, it increases the water released into streams during the dry season[7,8]. Sponge Planet is also climate mitigation because ecosystems such as wetlands and mangroves store carbon at rates higher than many terrestrial forests.

Restoring the natural water cycle plays a significant role in moisture and temperature regulation both locally and beyond, helping to reduce heat deaths and extreme forest fires. Intact ecosystems such as forests and wetlands cool the local area via shade and evapotranspiration. Urban water bodies, street trees and parks can mitigate heat island effects, while rural practices such as selective forestry and agriculture that retains rainfall and conserves wetlands restore local microclimates and support climate stability[9].

Between 1970 and 2020, monitored species living in freshwater habitats have lost, on average, 85% of their populations, largely due to pollution and grey infrastructure, which causes habitat fragmentation and degrades ecosystems. Protecting habitats such as rivers, lakes and wetlands is crucial to support the survival of many species. Restoring their homes is not just ethical, it also benefits humans because the systems they evolved together help to break down pollution and to stabilize the water cycle and climate.

Sea levels are rising not just due to melting ice and because warming expands oceans. Human development that pumps groundwater and rushes surface water off the land also contributes. Recharging depleted aquifers could not only shore up surface water but slow the rate of sea-level rise by as much as half[8]. Restoring tidal marshes, mangroves, eelgrass beds and other coastal ecosystems also offers a natural defence against sea-level rise.

Better accounting

The Sponge Planet model, comprising many thousands of Slow Water projects scattered across the globe, might be characterized as nature-based solutions. However, this term is developing a negative connotation because nature-based solutions often ignore socio-economic inequalities and are singularly focused on carbon at the expense of systems thinking — causing them to fail. Sponge Planet recognizes that climate, water and biodiversity are inextricably linked. One cannot be sacrificed for another, such as a solar farm built on wildlands. And projects that address all three together reap exponential benefits.

For example, the common nature-based solution of planting trees for carbon offsets can be ineffective at best or greenwashing at worst, a concern highlighted by Pope Francis in *Laudato si'*[10]. Single-species plantations installed in an attempt to maximize rapid carbon storage can lead to local water scarcity[11,12]. Similarly, the global 30×30 initiative to protect biodiversity can also suffer from myopathy, seeing the protection of other species as a stand-alone issue, rather than acknowledging how they work together to maintain a healthy water cycle and climate. A singular focus on carbon or biodiversity can lead to pushing Indigenous peoples off their land, which is both unethical and counter-productive because Indigenous cultures have a better track record for protecting biodiversity than the dominant culture.

The Sponge Planet model recognizes that local people can be effective water cycle and ecosystem stewards.

The dominant economic system also has a detrimental single focus that does not account for the multiple benefits of Slow Water projects and therefore tends to dismiss them. For example, a standard economic analysis might measure whether a particular levee will protect one community from a certain level of flooding. But reconnecting the floodplain to the river can absorb flood waters, protecting multiple communities; provide water locally in the dry season, reducing costs for importing or desalination; store carbon dioxide; provide food for fish and people; clean water pollution; and offer recreation areas for people that enhance physical and mental health. For example, the Dos Rios floodplain restoration near Modesto, California, is part of the state's flood management plan that returns space to water. Helping the investment community understand this complexity requires a multi-featured, cost–benefit analysis, such as the UN's System of Environmental-Economic Accounting. Such accounting can also deduct points for environmental injustice and other economic externalities ignored by the dominant system, such as the loss of all those benefits caused by grey infrastructure alternatives.

Finally, effective Slow Water projects start with mapping what water did historically before human development altered it. Water has a memory and often tries to follow its innate path. That's why apartments built on wetlands are often the first to flood. In the United States, this type of mapping and planning is often called 'historical ecology'. In China, Sponge City innovator Kongjian Yu (lead author of this Comment) calls it mapping 'security patterns' because understanding the most effective places to return space to water will make human communities safer from flood and scarcity. Often these projects are less expensive than grey alternatives and their natural flexibility can offer greater protection.

Today, investors are often unsure where and how to invest in nature-based solutions. A targeted approach planned around historical ecology or security patterns prioritizes projects where water innately wants to go, relieving pinch points to offer the most bang for the buck[13]. For example, Seattle restored just 1,600 feet of the 15-mile-long Thornton Creek. But because it focused on two historical floodplains, and made space for the complex relationships among animals in the hyporheic zone, the project has eliminated flooding of a nearby road, school and homes[5].

Decentralized solutions — a matter of scale

Decision makers or engineers will sometimes say that nature-based approaches are "nice, but can't be a significant part of the solution". That is a fundamental misunderstanding of scale. Because humans have degraded 75% of the land on Earth, thereby altering the water cycle, we need Slow Water projects distributed across watersheds, countries and continents, ultimately recreating a Sponge Planet.

Slow Water strategies are unique to each place, working with local geology, hydrology, ecology and cultures. Because they are distributed, rather than centralized, they avoid the 'tragedy of the commons' in which many governments shirk their responsibility for climate change. Instead, local communities or even individual families are motivated and empowered to undertake projects to protect themselves from water extremes. This decentralized approach is cheaper, lowers waterborne disease risks, and fosters community engagement in sustainable practices[7]. It also increases food and water security amidst unpredictable climate patterns.

At the same time, the benefits of Slow Water projects are cumulative. Multiple projects add up to help to stabilize the water cycle and climate globally. Because watersheds can span multiple city or county jurisdictions, a 'nature's jurisdictions' model, such as that proposed by the San Francisco Estuary Institute[14], can help city, county and state governments to understand the exponential impact of working together. Restoring the land to heal the water cycle can increase rain locally, regionally and globally[11].

While climate change is ramping up floods and droughts, development choices, including grey infrastructure designed to control water, have made these disasters worse. And sooner or later, water always wins. To reduce human losses and suffering, it's time to change our relationship with water: rather than trying to control it, we must collaborate. In so doing, we can reduce impacts from floods and droughts, store carbon, support other forms of life, and create more liveable spaces for ourselves. Measuring the value of these projects' multiple benefits — and tallying the harm caused by traditional grey infrastructure — can show the cost-effectiveness of such investments. The toll of mounting climate disasters while global leaders stall can feel overwhelming and hopeless. But Slow Water projects empower people to collaborate with their neighbours and with water to make their own communities more resilient. Family by family, community by community, the success of their local projects inspires others, and piece by distributed piece, we can restore a Sponge Planet.

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Competing interests

The authors declare no competing interests.