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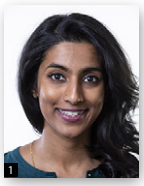
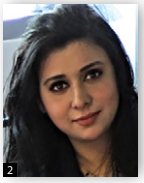
INTRODUCTION May 2025

Nature-based solutions





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When we published the first *Nature-Based Solutions* (NBS) special issue of *Civil Engineering* in November 2024, we were responding to a growing recognition: that civil engineers must evolve our relationship with the natural world. That issue proved to be so popular that we are here now with a follow on issue. It was popular not simply because the idea of nature-based solutions was novel, but because it resonated with a deepening sense of urgency. Engineers, policymakers, and communities alike are increasingly looking for ways to deliver infrastructure that is more resilient, regenerative, and responsive to the challenges of the 21st century.

As we move from *possibility* to *practice*, our community is thinking about embedding nature-based thinking into everyday engineering, learning from real-world implementation. We are asking how we can monitor, evaluate, improve and scale up these approaches to meet the demands of a rapidly changing world.

Looking ahead, later in 2025 we will publish a Special Issue focusing on the Thames Tideway Tunnel project in the UK. This multi-billion-pound infrastructure scheme is designed to intercept almost all untreated sewage and rainwater discharges from London's combined sewer system during heavy rainfall, dramatically improving water quality in the River Thames. The Tideway project stands as one of the largest civil engineering undertakings in recent UK history and represents a major step towards restoring urban waterways for future generations.

A turning point in our profession

The environmental challenges we face continue to grow since our first special issue. Flooding, droughts, wildfires, and ecosystem degradation are not just isolated disasters but as interconnected signals of a planet under stress. Meanwhile, landmark initiatives like the UN Decade on Ecosystem Restoration and new policy frameworks — such as the UK's mandatory Biodiversity Net Gain requirements — have underscored the need to align development with ecological recovery.

For civil engineers, these developments represent both a challenge and an opportunity. Historically, our profession has excelled at managing risk through control: building higher walls, stronger barriers, and more impermeable surfaces. But in today's complex climate, control alone is no longer sufficient. Resilience demands adaptability, flexibility, and collaboration.

Nature-based solutions offer a compelling pathway forward. By integrating natural processes into our designs, we can reduce risks, enhance biodiversity, sequester carbon, and deliver multiple co-benefits for communities. Yet doing so requires more than technical innovation; it requires a cultural shift within engineering practice itself.

From pilot projects to mainstream solutions

Even since the last issue, we have seen growing momentum in applying nature-based solutions at larger scales. In the UK, river restoration projects like the River Eden Demonstration Project have shown how re-meandering rivers can reduce flood risks downstream while improving habitat quality. Coastal schemes such as the Medmerry Managed Realignment in West Sussex continue to provide living proof that working with tidal processes, rather than against them, can deliver more sustainable protection for vulnerable communities.

Internationally, cities from Rotterdam to Singapore are embracing green infrastructure — from wetlands that filter stormwater to rooftop gardens that cool urban heat islands — as essential elements of climate adaptation strategies. These examples demonstrate that nature-based solutions are not limited to small, pilot-scale interventions. They can be, and increasingly must be, integral components of major infrastructure systems.

However, these successes also highlight important lessons. Nature-based solutions are context-specific. They require careful site analysis, stakeholder engagement, and adaptive management. They often involve longer timelines for full benefits to materialize. They can introduce new uncertainties — not in terms of whether they work, but in how quickly and predictably they deliver outcomes compared to traditional "hard" engineering. Understanding and embracing these complexities is vital if we are to move beyond demonstration projects toward mainstream adoption.

Challenges we must address

Scaling up nature-based solutions is not without its barriers. Some are technical: How do we model the performance of living systems under future climate conditions? How do we design maintenance regimes for green infrastructure that are robust but flexible?

Some challenges are institutional. Existing procurement models, insurance frameworks, and design standards are often geared toward conventional approaches that prioritise immediate functionality over long-term ecological health. Regulatory frameworks are evolving — as seen with the UK's Environment Act and Biodiversity Net Gain policy — but further shifts are needed to fully support nature-based approaches.

Perhaps the most profound challenge is cultural. For generations, civil engineering education and practice have been grounded in assumptions of stability, certainty, and control. Working with nature demands a different mindset: one that embraces uncertainty, values adaptability, and recognizes the interconnectedness of human and natural systems. It demands that we collaborate across disciplines — with ecologists, hydrologists, landscape architects,

social scientists, and communities — to co-create solutions that are not only technically sound but socially and ecologically responsive.

We must also rethink how we define success and traditional metrics. This issue covers some examples of solutions and projects, but also includes papers which discuss evaluating cost and the gap between research and practice.

A call to action: growing a regenerative future

The papers in this second special issue offer insights not only into the design and delivery of nature-based solutions but into the governance, financing, monitoring, and maintenance strategies that underpin long-term success. They highlight the importance of partnership and learning, of patience and ambition.

Above all, they remind us that nature-based solutions are not a panacea. They will not replace all conventional infrastructure, nor are they appropriate in every context. But they represent a powerful, necessary evolution in our approach to building resilient societies in an era of climate and ecological crisis.

As civil engineers, we stand at a crossroads. We can continue to build in ways that harden and isolate us from natural systems — or we can choose to integrate and regenerate, creating infrastructure that supports both people and the planet. To do so, we must invest not only in new technical skills but in new ways of thinking and working.

We thank all the contributors to this special issue for advancing this vision. We hope their work inspires readers to deepen their engagement with nature-based solutions — and to help lead the transformation toward a truly regenerative civil engineering practice.