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## Editorial

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# Editorial: Sustainable and resilient infrastructure

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Welcome to this themed issue from the Institute of Civil Engineering's Engineering Sustainability Journal entitled 'Sustainable and Resilient Infrastructure'

While news media may continue to pick and choose what they decide is to be our priority focus of the day, the focus of impacts from climate change is not so ephemeral. The inconvenient truth is that the intensity of geopolitical headlines has eclipsed global focus on climate action since the COVID pandemic. Energetic calls globally to Build Back Better (EDA, 2025/UNEP) have been largely drowned out by mass population calls for human rights. Meanwhile, almost muted are the ongoing climate scientists' alarming calls to take greater action urgently, while we still can (IPCC, 2023).

Since 2016, the annual *World Economic Forum (WEF) Global Risk Report* shows extreme weather/climate action failure is consistently ranked in the top two risks of likelihood and/or impact severity (WEF, 2020–2025). More recent results show these two are ranked at or near the top for short (2 years) and long-term (10 years) periods. Finally, it seems stakeholders realise these are real, imminent, and severely impactful threats set to continue for the foreseeable future (WEF, 2025). Every year, we see records of climatic extremes being broken; 2024 beat 2023's record of being the hottest year in 175 years (WMO, 2025).

A common driver for the design of infrastructure and insurance models is to minimise their exposure to risk, typically based on well-established climatic/market trends. We are now in the uncharted waters of climate change. Our understanding of Mother Nature's highly complex systems is superficial, although advancing; meanwhile, our infrastructure remains vulnerable and exposed.

The insurance sector is particularly aware, summed up by the 2024 report from world-leading insurer Munich RE, '*Climate change is showing its claws*'. Natural disasters, predominantly driven by extreme weather in 2024, caused global losses of US\$320bn, with US\$140bn being insured. Only 2 years since 1980 represented greater losses for the insurance sector (MunichRE, 2024). PWC's *Climate Risk and Insurance Report* states, '*many of the challenges of risk transfer in property insurance markets can be attributed to the fact that our physical*

*infrastructure is not resilient. ... making some [insurance] policies prohibitively expensive*' (PWC, 2024).

As we have indicated here, forewarnings are not only from climate scientists but are cross-sectoral, representing finance/economics, property, and national security. Regardless of the flavour of the headlines or politics of the day, our only choice is to double down acceleration of actions to understand, adapt to, and mitigate the impacts of climate change. The good news is that technology and expertise *do* exist towards achieving this, as per the *Climate Resilient Infrastructure Report* (ICSI, 2024). The design of sustainable and climate-resilient infrastructure is central to longer-term adaptation. Ageing infrastructure was typically not designed for the nature, scale, and frequency of extreme events today. Whether maintaining existing or constructing new infrastructure, understanding the long-term challenges is key to optimising its design life and resilience to climate change. The OECD report *Infrastructure for a Climate Resilient Future* states that '*achieving climate-resilient infrastructure systems requires a whole-of-government approach, combined with strong collaboration among public and private sectors, and other international and local actors*' (OECD, 2024). Looking ahead, the forthcoming *IPCC Special Report on Climate Change and Cities* (IPCC, 2025) will be a valuable information resource support to advance the research of our featured authors.

This themed issue comprises five separate papers focused on how engineering design can advance understanding of requirements for sustainable and climate-resilient infrastructure and over-riding objective of UN SDGs, for example, SDGs 9, 11, and 13. The publication complements nicely the announcement earlier this year that the ICE is working with the British Standards Institution on the new PAS 3090 standard on climate adaptation pathways for infrastructure, building on the previous delivery of the PAS 2080 Carbon Management Standard (ICE, 2025).

Starting out with the concept of developing a Holistic Framework for Infrastructure Resilience Assessments, the papers proceed to a life cycle assessment (LCA) focus, separately establishing the environmental and economic value of Transport Infrastructure in the UK before presenting the case study of an EXIOBASE analysis. The issue closes with an appraisal of carbon assessment tools applicable within the geotechnical sector.

In the first paper, Medland *et al.* (2025) present a comprehensive scoping review of resilient assessment frameworks towards the development of a holistic framework that *enables resilience forecasting to inform infrastructure design and adaptation, increasing resilience while preventing infrastructure overcapitalisation, resource overconsumption, or maladaptation*. The review *inter alia* includes a very useful, thoroughly researched, tabulated review of 110 different assessment tools, frameworks, and methodologies from around the world. This scoping review concludes that a practically applicable, holistic framework that meets the UK's National Infrastructure Commission (NIC) brief is not evident in the literature to date. However, equally, it identifies that various elements could be drawn from the significant range of available tools to develop a tool capable of satisfying NIC requirements. The paper advises that adopting a place-based, holistic resilience assessment approach, aligned with the NIC brief, could enable both far-scenario analysis and enhanced forecasting capabilities.

The next three papers are generated from the valuable work led by Dr Nikolaos Kalyviotis of the University of Crete, focusing on UK transport infrastructure. Our second paper by Kalyviotis (2025) investigates linear assumptions typically applied in LCA of infrastructure and whether non-linear assumptions may be more appropriate. Demonstrating the research's awareness of reality in the field of road design and construction, the paper identifies how actual integration of LCA findings in designs can be limited. As readers familiar with infrastructure design and construction projects may be aware, delivery timelines may not adequately facilitate the execution/integration of findings from LCA/environmental/sustainability assessments. The need for further research to develop a new assessment tool that accommodates non-linear relationships is illustrated by a case study on aggregate road design.

In the third paper of this issue, Kalyviotis *et al.* (2025a) address the differences between the bottom-up approach of cost-benefit analysis and the top-down approach of input–output analysis, notably how the latter keeps environmental and social value distinct from economic value. The team develops a model of the accounting process using the World Input–Output Database.

Our fourth paper from the same team (Kalyviotis *et al.*, 2025b) builds on the previous paper, undertaking an EXIOBASE analysis to research the environmental value of transport infrastructure in the UK. Describing five different LCA methods for environmental evaluation of a project, the paper selects the two models with the least inherent uncertainty for a detailed discussion. Using Pearson's correlation coefficient, the paper provides a carefully structured infographic illustrating the complexity of linkages between the transport, waste, water, energy, and communications sectors, with transport and energy being the most closely linked. The nature, source, and interaction of various pollutants arising from transport infrastructure are a key focus of the research. A

conclusion is that by further research integrating both quantitative and qualitative data, policy makers will better understand the cause-and-effect of pollution from transportation, aiding improved decisions regarding the promotion of sustainable transport infrastructure.

The fifth and final paper in the issue, by Maria Marquez Mancha and Hunt (2025), also explores the range of available carbon assessment tools, this time in relation to the geotechnical sector, for which carbon assessment is in its early stages. The results highlight the need for guidance on how to select the most appropriate assessment tool, with only two of the five tools examined generating similar results, while also concluding that no single tool can cover all geotechnical assets. The paper provides a clear decision support flowchart to enable projects to select the most appropriate carbon footprint assessment tool based on their project requirements.

Together, these papers provide the reader of this themed issue a comprehensive insight into the great range of available assessment tools, an understanding of their relevance, and of the internal mechanics of a focus few, together with guidance on how to navigate a path through them all to identify the most appropriate one(s) for a particular project. A key take-home for the reader should be that having all these tools is fine, but of limited value if the findings of the respective assessments are not integrated by the designers, supported by the policy makers, and implemented during the construction and operation of the infrastructure assets.

Furthermore, mounting losses from extreme events are literally eroding the traditional basis for infrastructure design lives. While budget holders strive to avoid costs of perceived over-engineering, a robust understanding of future trends to enable revision of design basis is far from mature. The assessment tools reviewed in this issue are therefore of fundamental importance to building this new knowledge base. To optimise the sustainability and resilience of our infrastructure to withstand the increasing ravages of extreme climatic events, we must properly apply the most appropriate tools available to infrastructure planning, design, construction, and maintenance, while continuing to improve them to accommodate the complexities of inter-sectoral relationships.

On behalf of the wider Editorial Team of the Engineering Sustainability Journal, we would like to personally thank you for your interest in this themed issue and hope that you enjoy it, finding it as informative as it is inspirational on maintaining a positive, solutions-oriented outlook on our ability to achieve sustainable and climate-resilient infrastructure.

#### REFERENCES

- EDA (Economic Development Administration) (2025) *American Rescue Plan*. U.S. Department of Commerce, Washington, DC, USA. See <https://www.eda.gov/funding/programs/american-rescue-plan/build-back-better> (accessed 24/09/2025).

- ICE (Institution of Civil Engineers) (2025) ICE Starts Work on Climate Adaptation and Infrastructure Productivity Standards. ICE, London, UK. See <https://www.ice.org.uk/news-views-insights/latest-news/ice-starts-work-on-climate-and-productivity-pas> (accessed 24/09/2025).
- ICSI (International Coalition for Sustainable Infrastructure) (2024) *The Climate Resilient Infrastructure Report a Focus on Implementation*. See [https://sustainability-coalition.org/publication/climate-resilient-infrastructure\\_issue\\_1\\_implementation/](https://sustainability-coalition.org/publication/climate-resilient-infrastructure_issue_1_implementation/) (accessed 24/09/2025).
- IPCC (Intergovernmental Panel on Climate Change) (2023) *AR6 Synthesis Report Climate Change 2023*. IPCC, Geneva, Switzerland. See <https://www.ipcc.ch/report/ar6/syr/> (accessed 24/09/2025).
- IPCC (2025) *Authors for the IPCC Special Report on Climate Change and Cities Selected*. IPCC, Geneva, Switzerland. See <https://www.ipcc.ch/2025/02/03/pr11srcities/> (accessed 24/09/2025).
- Kalyviotis N (2025) Life cycle assessment tools for road design: analysing linearity assumptions. *Proceedings of the Institution of Civil Engineers – Engineering Sustainability* **178(5)**: 358–368, [10.1680/jensu.24.00038](https://doi.org/10.1680/jensu.24.00038).
- Kalyviotis N, Rogers CDF and Hewings GJD (2025a) The economic value of transport infrastructure in the UK: an input–output analysis. *Proceedings of the Institution of Civil Engineers – Engineering Sustainability* **178(5)**: 369–381, [10.1680/jensu.24.00015](https://doi.org/10.1680/jensu.24.00015).
- Kalyviotis N, Rogers CDF and Hewings GJD (2025b) The environmental value of transport infrastructure in the UK: an EXIOBASE analysis. *Proceedings of the Institution of Civil Engineers – Engineering Sustainability* **178(5)**: 382–399, [10.1680/jensu.24.00023](https://doi.org/10.1680/jensu.24.00023).
- Maria Marquez Mancha A and Hunt DVL (2025) Carbon assessment tools for geotechnical applications. *Proceedings of the Institution of Civil Engineers – Engineering Sustainability* **178(5)**: 400–409, [10.1680/jensu.24.00047](https://doi.org/10.1680/jensu.24.00047).
- Medland CJ, Chenoweth J and Mulheron M (2025) Infrastructure climate change resilience: a review of resilience assessment frameworks. *Proceedings of the Institution of Civil Engineers – Engineering Sustainability* **178(5)**: 344–357, [10.1680/jensu.23.00105](https://doi.org/10.1680/jensu.23.00105).
- MunichRe (2025) *Climate Change Is Showing Its Claws: The World Is Getting Hotter, Resulting in Severe Hurricanes, Thunderstorms and Floods*. See [https://www.munichre.com/content/dam/munichre/mrwebsitespressreleases/MunichRe-Mediarelease2025-NatCat2024.pdf/\\_jcr\\_content/renditions/original/MunichRe-Mediarelease2025-NatCat2024.pdf](https://www.munichre.com/content/dam/munichre/mrwebsitespressreleases/MunichRe-Mediarelease2025-NatCat2024.pdf/_jcr_content/renditions/original/MunichRe-Mediarelease2025-NatCat2024.pdf) (accessed 24/09/2025).
- OECD (2024) *Infrastructure for a Climate-Resilient Future*. OECD Publishing, Paris, France. See [https://www.oecd.org/content/dam/oecd/en/publications/reports/2024/04/infrastructure-for-a-climate-resilient-future\\_c6c0dc64/a74a45b0-en.pdf](https://www.oecd.org/content/dam/oecd/en/publications/reports/2024/04/infrastructure-for-a-climate-resilient-future_c6c0dc64/a74a45b0-en.pdf) (accessed 24/09/2025).
- PwC (PricewaterhouseCoopers International Limited) (2024) *Climate Risk and Insurance: The Case for Resilience*. See <https://www.pwc.com/us/en/industries/financial-services/library/climate-risk-and-insurance.html> (accessed 24/09/2025).
- UNEP (United Nations Environment Programme) (2025) *Investing to Build Back Better*. United Nations Environment Programme/Coordinating Unit for the Mediterranean Action Plan Barcelona Convention, Athens, Greece. See <https://www.unep.org/unepmap/covid-19/investing-build-back-better> (accessed 24/09/2025).
- WEF (World Economic Forum) (2025) *Global Risks Report 2025*. World Economic Forum, Cologny/Geneva, Switzerland. See <https://www.weforum.org/publications/global-risks-report-2025/digest/> (accessed 24/09/2025).
- WMO (World Meteorological Organization) (2025) *State of the Global Climate 2024*. World Meteorological Organization (WMO), Geneva, Switzerland. See [https://library.wmo.int/viewer/69455/download?file=MO-1368-2025\\_en.pdf&type=f&navigator=](https://library.wmo.int/viewer/69455/download?file=MO-1368-2025_en.pdf&type=f&navigator=) (accessed 24/09/2025).