

Institution of Civil Engineers

Making resilience count: the economic value of climate readiness

Consultation response by the
Built Environment Connective
12 June 2026

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The Built Environment Connective is a diverse community of individuals and organisations representing the whole of the built environment, with five mission-focused and connected communities for clients, investors, consultants, academia and systems specialists.

The Connective's vision is for a built environment that enables people and nature to flourish together for generations. Its purpose is to achieve this by working to unlock the power of systems thinking:

- Connecting system thinkers across government, industry, academia and civil society – the stakeholders and action-takers. Community.
- Co-creating the shared understanding and common language essential for meaningful dialogue. Consensus.
- Focusing on tangible and practical actions to drive positive systems change. Change.

The Connective is currently progressing three workstreams with support from the National Infrastructure and Service Transformation Authority (HM Treasury), the Infrastructure Client Group and the Green Construction Board:

- The Built Environment Systems Review – to establish the economic case for a systems approach to developing and operating economic and social infrastructure.
- Indicators – to establish mechanisms for assessing the performance and value of economic and social infrastructure
- Competencies – to establish the skillsets required for joined-up, systemic approaches to delivery, management and optimisation of economic and social infrastructure

Guiding insights, methods and recommendations are set out in [‘Connect to change’](#)

The Built Environment Connective is part of the Systems Connective.

The Built Environment Connective welcomes the ICE's consultation on the economic value of climate readiness. We strongly support the proposal for a national review of the economics of infrastructure resilience and adaptation.

Our response is centred around four key points, set out in the ICE's consultation paper:

- climate resilience and adaptation are under-valued
- many benefits are difficult to measure
- infrastructure systems are interconnected and interdependent
- those systems are increasingly exposed to interconnected climate risks.

Decisions about whether, when, where, how much and how to invest in adaptation and resilience, and evaluation of the economic, social and environmental value gained by doing so, require systemic framing.

This in turn requires competencies in systems thinking and doing that are currently under-developed across the infrastructure industry.

Systems competencies are needed to:

- address the substantial knowledge gaps resulting from siloed organisations, data and decision-making
- better understand the interplay between climate change, climate impacts, and the composition, performance, resilience and adaptation of infrastructure
- understand risks, define desired outcomes, set objectives, secure investment, provide effective governance and regulation, learn and improve.

The review should consider 'economic value' inclusively, taking account of the effects of climate impacts and infrastructure performance on people, public services and community resilience, and nature and natural systems. These are inextricably linked to economic performance and productivity, efficiency and fiscal sustainability.

It should recognise the deep interdependencies between economic and social infrastructure – encompassing energy, water, transport, digital, housing, health, education, civic and municipal functions, retail and logistics, commercial, food, land, natural systems, and more. A failure in one system can rapidly cascade to create consequences and costs within the system more widely, and in others. Equally, adaptation within a system must take account of knock-on effects in other parts of that system, plus connected systems, recognising the potential for those effects to be negative or positive.

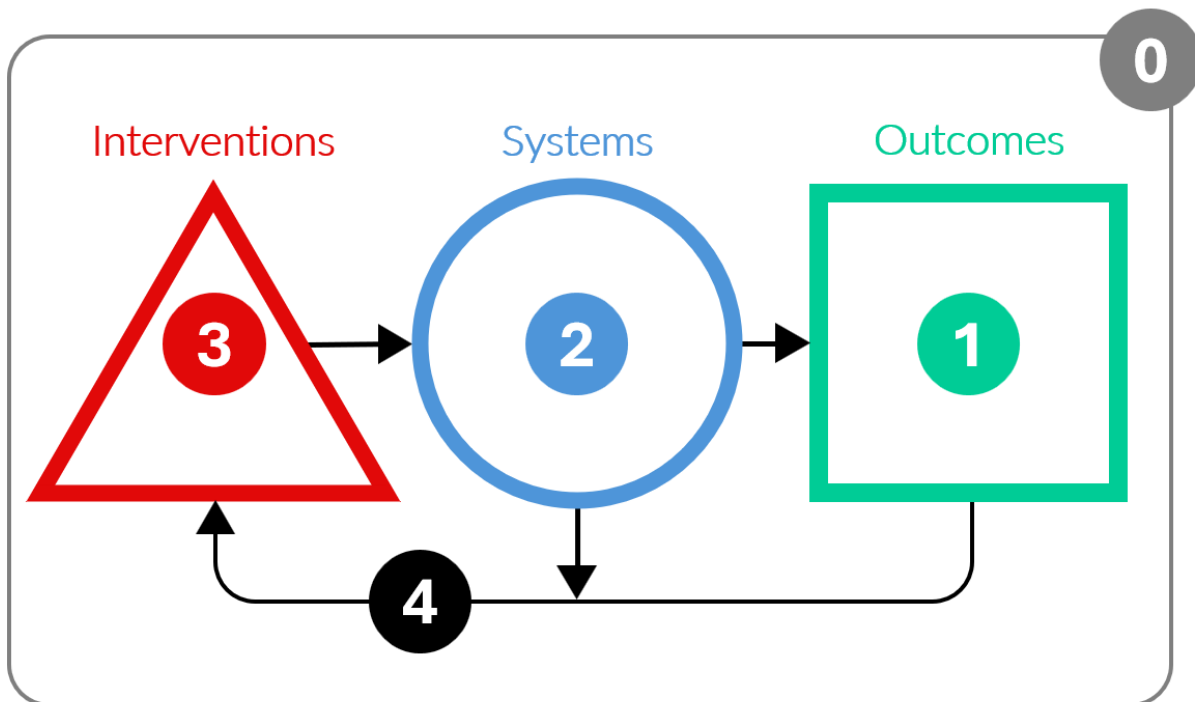
The review should focus on the services and outcomes that infrastructure enables for people, nature and the economy, not only on the resilience of assets themselves.

Built and natural infrastructure should be considered together, because the services nature provides, such as flood protection, water security, cooling, soil health, biodiversity and carbon storage, all affect the resilience and performance of economic and social infrastructure.

The consultation also highlights that resilience benefits can be difficult to measure: success is often reflected in avoided disruption and losses, rather than positive additions to the balance sheet. The review should address this by encouraging a better appreciation and quantification of the services infrastructure provides, and outcomes delivered. This would

make it easier to recognise the potential adverse effects of climate events, and the value of maintaining services under stress.

We suggest that the review could usefully be informed by a simple systems-change logic, which can be found in [‘Connect to change’](#).



0. **Know the scope.** The concept of ‘step zero’ is common in industries that require careful planning, risk assessment, and foundational groundwork before initiating a project. It is a preliminary phase where essential considerations are identified and mapped. In this instance, step zero involves outlining what it is you want to influence and at which level. Define the system of interest and its related outcomes, acknowledging that this is a dynamic process. Drawing an exploratory system boundary helps clarify what is in scope, what is out and who the key stakeholders are. This ensures that the entire system, including its interconnected components and actors, is considered in the planning process. As systems are complex and constantly evolving, the system boundary requires continuous reflection and adjustment.
1. **Focus on outcomes.** At the highest level, desirable outcomes – including resilience – will be a combination of environmental, social and economic factors. It is essential to understand the gap between the outcomes that are desired and those delivered by the system as it currently is. This difference will be the key driver for systems change. Outcomes are experienced by people and nature in specific places, either as benefits or disbenefits. Therefore it is critical to include all stakeholders, particularly those who are unrepresented, including nature. This is vital both for identifying and agreeing the desired outcomes a system is intended to achieve, and trade-offs between different outcomes.
2. **Understand the systems.** Analyse the systems to understand how they can deliver the desired outcomes. This includes analysing root causes of issues, identifying leverage points for effective interventions, and recognising the gaps between organisational or informational siloes. There are established tools for mapping, modelling and visualising systems, to identify physical, digital and organisational relationships. When seeking to understand the system of interest, it important to remember there will be connections that cross the boundary, because systems are always parts of larger systems. Feedback from stakeholders with diverse

perspectives will provide vital insights into connections and gaps.

3. **Drive effective interventions:** Interventions should be designed to nudge the system towards achieving the desired outcomes. Interventions can be small or large, operational or structural. They can be entirely new additions, or modifications to the existing system. It is important to recognise that existing systems are vastly larger than new projects, both in terms of value and the outcomes they deliver. Therefore the greatest positive difference can often be achieved by focusing on interventions that modify what already exists.
4. **Observe, learn and repeat:** Systems thinking is iterative. Regular reflection and refinement are necessary to ensure continuous improvement. Monitoring the impact of interventions and understanding system performance against target outcomes will allow for data-driven decision-making. Systems thinking requires a culture of learning, curiosity and evidence-based improvement. It is a culture well suited to the process of continuous review and improvement that underpins preparedness planning.

This framework provides the focus on systems and outcomes that is required to help stakeholders move from fragmented and potentially conflicting adaptation activities towards shared and coordinated action, with common outcomes, clear responsibilities, better data, awareness of interdependencies and transparent trade-offs.

Q1. Which sectors and timescales should the review examine?

As clearly set out in the consultation paper, climate impacts demonstrate the connectedness of assets, systems, organisations, services and sectors. A failure in one system or part can quickly cascade into others. Effects can be widespread, and the consequences can be more severe in connected systems and sectors than in those first impacted. Therefore, the review should take a deliberately multi-sector and system-of-systems approach.

The review should examine nationally significant infrastructure sectors and the essential services they enable, including energy, water, transport, digital and telecoms, flood and coastal protection, waste, housing and the wider built environment, health and care, food and agriculture, land use and natural infrastructure. It should also examine the interfaces between these systems and local government, emergency response, regulated and privately owned infrastructure, communities and natural systems.

Sectors should be selected not only because they contain climate-exposed assets, but because their failure would affect essential outcomes for people, nature and the economy. The review should therefore consider criticality, interdependence and consequence: which services are essential, who and what depends on them, where disruption would have the greatest social, economic or environmental impact, and where vulnerable communities or fragile natural systems would be most affected.

Climate change and its impacts are uncertain, probabilistic and unevenly distributed. The review should therefore avoid relying on a single central forecast. It should test decisions against a range of plausible futures, drawing on recognised climate scenarios, including IPCC emissions and socio-economic pathways, UK climate projections and sector-specific risk evidence. This should include high-impact scenarios, not because the worst case is certain, but because infrastructure decisions often have long lifetimes, high lock-in effects and consequences that are difficult to reverse.

The review should cover multiple timescales. It should assess immediate and short-term risks, including current exposure, known vulnerabilities, maintenance backlogs, emergency preparedness and near-term adaptation needs. It should examine medium-term risks linked to investment cycles, regulatory periods, asset-management plans, renewal programmes and adaptation pathways. Finally, it should consider long-term risks over the lifetime of infrastructure assets, land-use decisions and natural systems, including heat, water stress, flooding, coastal change, sea-level rise and strategic choices about protection, adaptation, renewal, relocation or managed change.

Planning adaptation pathways will require different responses in different sectors, places and timescales, triggered by changing evidence, risk thresholds, asset condition, service performance and acceptable levels of risk. The aim should be to identify robust, adaptive pathways that can be adjusted as climate risks, demand, technology, funding and public expectations change.

We believe that the five-step systems-change model set out above provides a useful way to overcome the sector-, asset-, and organisation-based silos that have historically contributed to the creation of infrastructure systems increasingly at risk from climate impacts.

Each owner should start by drawing an indicative boundary around the asset, system, place or service they wish to protect and ask: what is it connected to; what is it dependent on; what depends on it; who are the key stakeholders; and what outcomes would be affected if it failed or degraded under climate stress?

Q2. Which department, institution or individual should lead and coordinate the review?

The review should be led and coordinated by a body with sufficient authority and credibility to work across government departments, regulators, devolved administrations, local government, infrastructure owners and operators, industry, investors, insurers, professional bodies, communities and the natural environment sector. It should also have access to independent systems, infrastructure, adaptation, regulatory, data, finance, insurance, community engagement and natural-systems expertise, so that the review is not constrained by existing departmental, sectoral or asset-based boundaries.

The review should combine three functions: strategic ownership within government; independent analytical challenge; and practical coordination across sectors, places and affected stakeholders. These functions could sit across a carefully orchestrated group of entities, with a lead department, NISTA, supported by an independent advisory group and specialist delivery partners.

NISTA is a credible candidate to coordinate the review, given its infrastructure strategy and delivery remit. However, the review would need explicit cross-government sponsorship and a clear mandate to examine interdependencies between infrastructure systems, public services, places, natural systems, regulators, investors, industry, communities and infrastructure owners and operators.

Two specific functions will be particularly important:

- The review should include an **independent systems-challenge function**. Whether this is provided by an existing body, an advisory group or a dedicated review function,

it should be able to test whether policy, regulation, investment and delivery decisions are coherent across sectors, places and stakeholder responsibilities.

It should ask whether proposed approaches are based on a sufficiently comprehensive understanding of system performance, interdependencies, risks, outcomes and distributional impacts. This function should support policy coherence, interdependency management, risk and resilience assessment, accountability, transparency and mission delivery. It should also help ensure that the review is focused on outcomes for people, nature and the economy, rather than only on asset protection, sector-specific compliance or the interests of individual institutions.

- The review should also include a **built-environment and infrastructure-performance function**. This should provide a joined-up view of how existing and future infrastructure, buildings, places, natural systems and digital systems contribute to climate resilience. It should examine whole-life and whole-system performance, cross-regulator alignment, outcome-based objectives and metrics, interdependency risks and opportunities, and the data and digital infrastructure needed to support better decisions.

This should help the review improve cross-sector decision-making, long-term planning, public confidence, economic and resource efficiency, and collaboration between central government, devolved administrations, regions, local government, regulators, infrastructure owners and operators, industry, investors, communities and environmental stakeholders.

These two functions align with recommendations made by the Built Environment Connective in 2025 for an 'Office for Systems Responsibility' and a 'Built Environment Commission'. Those recommendations are relevant here because a review examining the economic value of climate readiness requires many of the same capabilities: independent systems challenge, whole-life and whole-system performance assessment, outcome-led appraisal, interdependency analysis, cross-regulator alignment, data capability and stakeholder convening.

The Built Environment Connective would be well placed to contribute to such an advisory and/or delivery ecosystem, particularly where systems thinking, built environment interdependencies, outcome-led appraisal, cross-sector convening and learning across action communities are required. Its emerging communities of action bring together clients, consultants, academics, systems specialists and investors, supported by a coordination group, providing a practical basis for connecting systems thinking with delivery experience. Its role should be considered alongside other relevant expertise from government, regulators, infrastructure owners and operators, industry, academia, local government, finance, insurance, communities and the natural environment sector.

In summary, the review should be government-sponsored, independently challenged and system-wide in scope, with meaningful engagement across those who own, regulate, finance, deliver, use and are affected by infrastructure systems. NISTA could provide a credible coordinating home, provided the review has the authority, independence, expertise and stakeholder reach needed to address climate readiness as a connected infrastructure, built environment, natural systems and public-value challenge.

Q3. What climate-risk and infrastructure-asset datasets exist, who owns them and where are the gaps?

The consultation rightly identifies fragmented and incomplete data as a major barrier to better adaptation decisions. Building on the consultation's point that asset-condition and system-performance data is often lacking or fragmented, the review should develop a structured inventory of the datasets needed for system-level resilience decisions. The key issue is not only whether climate-risk and asset data exists, but whether it can be accessed, connected, trusted and used to understand risks, interdependencies, outcomes and adaptation options.

Relevant datasets are spread across government, regulators, asset owners, operators, insurers, local authorities, research bodies and private organisations. The review should therefore avoid treating data as a static inventory. It should assess whether available data enables a systems-based approach to climate resilience: defining scope, understanding outcomes, mapping interdependencies, assessing interventions and supporting learning.

Relevant dataset types include:

- **Climate-risk and hazard data:** climate projections; flood, coastal erosion, water stress, heat, drought, wildfire and sea-level rise data.
- **Infrastructure asset data:** asset registers, location data, condition data, maintenance data, renewal plans, resilience plans, climate-risk assessments and adaptation reports.
- **Geospatial and place data:** exposed places, land use, communities, critical sites, service areas and spatial dependencies.
- **Service performance and disruption data:** outage, delay, failure, downtime, repair, recovery, customer impact and service-continuity data.
- **Emergency response and civil contingency data:** data held by local resilience forums, emergency responders, local authorities and relevant public bodies.
- **Regulatory data:** performance, investment, safety, resilience and reporting data held by economic and safety regulators.
- **Insurance and loss data:** insurance claims, catastrophe-loss datasets, risk models and loss estimates.
- **Social and public-service data:** health, education, social care, local authority, demographic, deprivation, vulnerability and customer/service-user data.
- **Natural systems data:** natural capital, biodiversity, land-use, water, soil, habitat and ecosystem-service data.
- **Economic, delivery, digital and cyber data:** project, maintenance and whole-life cost data; supply-chain, logistics and dependency data; investment-case data; digital connectivity, cyber resilience and asset information data.

Ownership

Ownership is distributed. Climate-risk and hazard data is largely held by public agencies, research institutions and specialist modelling bodies. Asset, condition, maintenance and resilience data is held by infrastructure owners and operators, including public bodies, regulated utilities and private providers. Regulatory data sits with economic and safety

regulators. Emergency response and civil contingency data is held by local resilience forums, emergency responders, local authorities and relevant public bodies.

Insurance claims and catastrophe-loss data is held by insurers, reinsurers and risk-modelling organisations. Social and public-service data is held across local authorities, health, education and care bodies. Natural capital and environmental data is held by environmental agencies, landowners, research bodies, local authorities and third-sector organisations. Supply-chain, logistics, project and whole-life cost data is held across infrastructure clients, suppliers, contractors, operators and investors.

Key gaps

The most important gaps are not only technical data gaps. They are also gaps in how data is connected, governed and used for public-interest resilience planning:

1. **Scope-setting data:** climate-risk analysis is often framed around individual assets or sectors rather than places, services, stakeholders and outcomes.
2. **Interdependency data:** there is insufficient shared data on how assets, services, organisations, communities, supply chains, digital systems and natural systems depend on each other.
3. **Asset condition and performance data:** data is often inconsistent, incomplete, commercially sensitive, inaccessible or not available at the right level of granularity or integrity.
4. **Private and regulated infrastructure data:** critical privately owned or regulated infrastructure is essential to resilience, but data is not always accessible for public-interest system planning.
5. **Outcome data:** there is limited evidence linking climate impacts or adaptation interventions to actual outcomes for people, nature, public services and the economy.
6. **Social and environmental impact data:** impacts on health, education, wellbeing, local economies, communities, biodiversity, water systems, natural infrastructure and ecosystems are often poorly captured.
7. **Natural infrastructure data:** the condition and performance of natural assets and nature-based solutions are not measured consistently enough alongside built infrastructure.
8. **Intervention-effectiveness data:** there is limited evidence on which interventions actually reduce risk, improve service continuity, protect natural systems and deliver whole-life value.
9. **Insurance-data limitations:** insurance and catastrophe-loss data provide a useful high-level view of trends and direct losses, but do not fully capture uninsured losses, service disruption, public-service impacts, local economic effects, agriculture and water impacts, or damage to natural infrastructure and ecosystems.
10. **Trusted data governance:** even where data exists, governance, standards, incentives, commercial sensitivity, security concerns and uncertainty over control of data can prevent effective use.

What the review should do

The review should map who owns relevant datasets, how accessible they are, what restrictions apply, and what would be required to make them useful for public-interest resilience planning. This should include common data standards, secure sharing protocols, incentives for data owners, safeguards for commercial, security and privacy concerns, and governance models that keep data owners appropriately involved in access, interpretation and use.

This should build on the ICE's recommendation for mandatory adaptation reporting by ensuring that reported data is not only collected, but made usable for public-interest resilience planning, interdependency analysis and learning over time.

Digital and data capability should be treated as a strategic enabler of climate readiness. Shared data standards, asset information systems, geospatial capability, modelling, digital twins, cyber resilience and analytical tools are essential for understanding interdependencies, managing risk and making better decisions across sectors and across the whole infrastructure lifecycle.

Important advances in data collation, interoperability and sharing have been made by the following organisations/initiatives, and should be aligned and connected. Climate resilience provides a powerful use case and reason for doing so:

- CReDo, the Climate Resilience Demonstrator led by Connected Places Catapult, is a useful example of how connected data and digital twin approaches can support cross-sector dependency analysis and climate-resilience decision-making.
- The [National Underground Asset Register](#) developed by the Government Digital Service and operated by Ordnance Survey provides secure and standardised access to mapped buried utility assets across England, Wales and Northern Ireland. It currently maps around 80% of known underground assets within that coverage, bringing together data from hundreds of asset owners. It provides an important foundation for improving asset visibility, data integration and the ability to combine underground asset data with other geospatial and risk datasets, including climate-risk data.
- The Universal Data Spine (UDS) is a new framework developed by the ADS Alliance to resolve data fragmentation in the built environment. It acts as a consistent technical foundation that captures minimum structured location and asset data, with the aim of improving the transfer of trusted, value-adding data across different phases of an asset's lifecycle.
- PAS 1958:2026 has been published by BSI to establish a unifying framework for the management and navigation of complex data and information management standards.
- The National Digital Twin Programme has developed an asset resilience demonstrator to test how digital twin technologies and processes can support better planning for and responses to climate incidents and strengthen regulatory requirements and national resilience standards.

Q4. What methodologies should be used to estimate the economic cost of inaction?

The consultation already makes the case that resilience and adaptation are under-valued because many avoided losses and wider benefits are not captured well in conventional appraisal. The review should build on that by interpreting the “economic cost of inaction” as the value lost when current, delayed or insufficient action pathways fail to deliver climate-resilient outcomes.

This means comparing those pathways with what could be achieved through timely, effective adaptation, across connected systems, services, people, places and natural assets. The assessment should include economic, social, environmental and natural-system impacts, recognising that climate risks rarely stop at the point of asset damage.

Building on the consultation’s recognition that uncertainty cannot be eliminated, a combination of quantitative, qualitative and systems-based methods will be needed. Impacts should be expressed in monetary terms where robust appraisal methods exist, but monetary valuation should not be forced where it would create false precision. Where monetary valuation is uncertain, impacts should be quantified in physical, service or outcome terms, and described qualitatively where important effects cannot yet be reliably valued.

A practical methodology for estimating the economic cost of inaction should move through five steps.

Know the scope: which hazards, places, services, assets and time horizons should be assessed?

The first step is to identify where the cost of inaction is likely to be material, and where that cost matters in relation to agreed public outcomes, acceptable risk, distributional impacts and strategic choices. As the consultation recognises, not every asset, service or place can realistically be protected to the same standard or at any cost. In some cases, the question may be whether to protect, adapt, accommodate, relocate, restore or accept change in order to secure greater long-term public value.

Relevant methods include:

- **Climate-risk screening:** identifying which hazards are material across places, sectors and time horizons. The UK Climate Change Risk Assessment provides a useful example.
- **Exposure and vulnerability assessment:** identifying which places, assets, services, communities and natural systems are most exposed or vulnerable. Climate Just provides a useful example of mapping exposure alongside social vulnerability.
- **Criticality and service-dependency assessment:** identifying which infrastructure services are essential, who and what depends on them, and where disruption would create significant consequences. Previous UK infrastructure-resilience work, including the former National Infrastructure Commission’s resilience framework, is relevant here.
- **Place-based and distributional risk mapping:** identifying where climate risks intersect with deprivation, health vulnerability, community resilience, economic dependency, natural-system fragility or limited adaptive capacity.

- **Materiality assessment:** prioritising the hazards, places, services, assets, communities, natural systems and time horizons where the cost of inaction is likely to be greatest, most unequal or most difficult to reverse.

Focus on outcomes: against which outcomes should the cost of inaction be assessed?

The review should define the outcomes against which the cost of inaction will be assessed. These should include environmental, social and economic outcomes, and should reflect how climate impacts are experienced by people and nature in particular places. The relevant outcomes will vary by hazard, place and infrastructure service.

For example, flood resilience may need to be assessed against safety, property damage, service continuity, displacement, insurance affordability, mental health, biodiversity and local economic disruption. Heat resilience may need to be assessed against health, productivity, comfort, energy demand, public-realm usability, hospital pressure and impacts on vulnerable groups. Water resilience may need to be assessed against public health, agriculture, industry, ecosystems, affordability and long-term resource security.

Relevant methods include outcome mapping to identify the desired environmental, social and economic outcomes; outcome-gap analysis to assess where current or future system performance falls short; service-to-outcome mapping to understand which infrastructure services enable which outcomes; social and environmental assessment to capture outcomes not well reflected in market or insurance data; and distributional analysis to identify who is most exposed to outcome loss. Useful examples include European Commission Better Regulation practice, Horizon Europe impact-pathway thinking, the UK Climate Change Risk Assessment, DfT social impact appraisal, HM Treasury wellbeing guidance and Defra's Enabling a Natural Capital Approach.

Understand the systems: where do risks, dependencies and cascading impacts arise?

The review should analyse how climate risks move through infrastructure, social, economic and natural systems. The cost of inaction often arises not from the first asset failure alone, but from the way that failure affects other services, organisations, communities, supply chains and natural systems.

Relevant methods include:

- **Systems mapping and dependency mapping:** identifying how assets, services, communities, organisations, supply chains, digital systems and natural systems depend on each other. Systems mapping can help define wider actors, institutions, incentives and feedback loops, while CReDo provides a useful example of dependency mapping through connected infrastructure data and digital twin approaches.
- **Cascading impact analysis:** examining how failure or degradation in one part of the system affects others.
- **Service-chain and failure-pathway analysis:** tracing how a climate hazard affects an asset or natural system, how this affects service performance, and how service disruption affects people, nature, public services and economic activity.

- **Top-down and bottom-up loss analysis:** starting with overall trends in climate-related losses, including insurance, claims and catastrophe-loss data, then drilling down by geography, sector, infrastructure system and outcome.
- **Whole-system consequence costing:** assessing costs across connected systems, including maintenance, adaptation, renewal, service continuity, recovery, residual risk and wider social and environmental consequences.

The review should pay particular attention to water, agriculture and food, health and care, transport, energy, digital connectivity and natural infrastructure, where climate impacts can rapidly become social, economic and environmental risks.

Compare action and inaction pathways: what is the value of acting now rather than later?

This builds on the consultation's point that early action is generally cheaper and more effective than emergency repair. The review should make that comparison explicit by testing proactive adaptation against delayed action, reactive repair, service failure and recovery.

The central question should be whether timely, proportionate and well-targeted interventions can shift systems towards better resilience outcomes and deliver better whole-life value than waiting until climate impacts become more visible or severe.

Relevant methods include:

- **Counterfactual analysis:** comparing proactive adaptation with delayed action, emergency repair, service failure and recovery. Flood and coastal erosion risk management appraisal provides a useful example.
- **Scenario and stress testing:** comparing how inaction and adaptation options perform under plausible future climate, demand, demographic, land-use and economic conditions.
- **Digital twin and connected-modelling approaches:** using asset, service, climate and dependency data to test how different adaptation options may affect system performance. CReDo provides a useful example.
- **Adaptive pathways:** identifying staged interventions that remain robust under uncertainty and can be adapted as risk conditions change. Thames Estuary 2100 provides a useful example.
- **Options appraisal across built and non-built interventions:** comparing conventional asset-based adaptation with natural infrastructure, operational change, demand management, behavioural change, community preparedness, digital capability, maintenance, renewal, relocation or service redesign. This should use methods such as broadened cost-benefit analysis, multi-criteria decision analysis, whole-life cost and value appraisal, real-options or adaptive-pathways appraisal, natural capital and ecosystem-service appraisal, distributional analysis and robust decision-making.

The cost of inaction should therefore be assessed not only as avoidable asset damage, but also as avoidable service disruption, social and environmental harm, weakened natural-system resilience and poorer long-term system performance.

Observe, learn and repeat: how should monitoring and learning improve estimates of lost value over time?

The cost of inaction should not be treated as a one-off calculation. The review should define the monitoring, evaluation and feedback arrangements needed to improve how the loss of value from inaction is assessed over time. This means setting out how expected impacts should be compared with actual events, how assumptions should be tested, how models should be updated, and how evidence should inform future appraisal, investment, regulation and delivery decisions.

Relevant methods include post-event and near-miss reviews; before-and-after evaluation; benefits-realisation review; adaptive monitoring and trigger-point review; model calibration and evidence feedback; learning-oriented indicators; and system-learning analysis.

The most important methodological principle is that climate impacts should not be treated as isolated events affecting individual assets. The review should examine how climate risk affects the services infrastructure provides, what value those services create, and what is lost when those services are disrupted or fail.

Q5. What economic valuation methods are most appropriate for adaptation projects?

The starting point for valuing adaptation projects should be to define what value needs to be assessed. Conventional economic valuation methods are necessary, but they are only useful if they are applied to the right outcomes, costs, risks and system effects. For adaptation projects, this means assessing not only direct asset damage avoided, but also service continuity, outcomes for people and nature, whole-life value, avoided disruption, integration benefits, reduced systemic inefficiency and the enabling conditions for long-term resilience.

In December 2026 the Built Environment Connective will complete a project sponsored by the National Infrastructure & Service Transformation Authority and the Infrastructure Client Group: The Built Environment Systems Review is designed to strengthen the evidence base for applying systems approaches to built environment policy, investment and delivery. It is intended to examine how systems approaches can help address fragmented decision-making, weak understanding of interdependencies and narrow appraisal, and how this could support better public value, resilience and long-term performance at lower whole-life cost. The Review is particularly relevant to HM Treasury because it is concerned with how national policy, appraisal and investment decisions can better account for whole-system costs, benefits, risks and outcomes. Infrastructure climate resilience falls directly within its purview.

As part of the Review, a proposed set of outcome-oriented performance indicators has been developed for testing, alongside related success factors that can help explain why some interventions perform better than others. These are intended to be applicable across a wide range of interventions and infrastructure contexts, including existing, new, in-development and proposed assets, systems and services. Together, the indicators and success factors provide a practical assessment framework for identifying what should be valued, evidenced and tested when considering adaptation projects. They can help determine which economic valuation methods are appropriate, where monetisation is robust, and where valuation should be supplemented by quantified, qualitative or judgement-based assessment.

Outcome-oriented performance indicators

The indicators have been designed with deliberate interventions in mind – actions intended to create, or change the composition, behaviour and performance of existing assets and systems. For adaptation appraisal, they can also be used to assess how climate hazards, shocks and stresses affect service performance, outcomes, whole-life value, disruption, integration and systemic inefficiency in the baseline or counterfactual case, and to compare those effects with the outcomes expected from planned adaptation.

The indicators are:

1. **Service performance** – How well does the relevant service work for the people and organisations who depend on it, and for nature?

Look for evidence of:

- improved reliability, continuity, availability or accessibility
- reduced disruption or downtime
- improved convenience, safety, usability or user experience
- better fitness for purpose
- improved maintainability, adaptability or recoverability
- better performance of an existing service or a stronger basis for a new service

2. **Outcomes** – What changes for people, organisations and nature will result from envisaged interventions?

Look for evidence of:

- improvement in one to three stated priority outcomes
- who or what benefits
- where the benefit is experienced
- whether the outcome relates to people, place, nature, economic activity, resilience, or a combination of these
- evidence of social, environmental, economic or system-level change
- any adverse, displaced, indirect or rebound effects that affect the net outcome judgement.

3. **Whole-life impact and value** – What lasting effects will the interventions have?

Look for evidence of:

- business case or appraisal evidence
- whole-life cost or value comparison
- benefits gained
- costs avoided
- risk reduced
- better use of existing assets
- social, environmental or economic value
- enabled system value, such as capacity unlocked, future bottlenecks avoided, supply-chain confidence, strategic optionality or improved ability to deliver national outcomes

4. **Efficiency, waste and disruption** – What measurable/observable impacts were there on waste, duplication or remediation?

Look for evidence of:

- reduced rework

- reduced duplication
 - fewer delays
 - lower process effort
 - resource use avoided
 - disruption avoided
 - cost avoided
 - improved use of time, materials, people or capacity
5. **Delivery/service predictability** – How were delivery or service provision affected by the intervention, considering cost, scope, timescale and quality?
Look for evidence of:
- cost variance
 - schedule variance
 - scope variance
 - quality variance
 - forecast accuracy
 - whether expectations were realistic
 - whether assumptions were explicit and evidence-based
 - whether changes were recognised and managed in a timely way
6. **Integration improvement** – To what extent were outcomes affected by good or poor connectivity across organisations, assets, systems, data or services?
Look for evidence of:
- improved coordination across parties
 - shared outcomes
 - active interface management
 - better data sharing or interoperability
 - improved joint decision-making
 - reduced interface failures
 - better connection between physical, digital, organisational or service elements
7. **Systemic inefficiency reduction** – Has the intervention reduced barriers, gaps or frictions that prevent the system from working well?
Look for evidence of:
- barriers removed
 - policy, regulatory, investment or governance frictions reduced
 - reduced operational silos
 - improved decision routes
 - fewer recurring failure patterns
 - improved system behaviour over time
 - changes to feedback loops, demand-capacity dynamics, delays, path dependencies or cross-system effects

NB – the indicators were still in the development and testing phase when this submission was written, and are subject to change. They nonetheless represent an emerging view from the Review work on key considerations when evaluating the benefits and costs of interventions.

Success factors

These are factors that determine whether an endeavour is set up to apply systems thinking successfully. When they are in place, systems thinking is more likely to improve real-world outcomes; when they are absent the risk of failure increases. They are not economic evaluation criteria in any conventional sense, but economic success is contingent upon them, which is why they are core to the Built Environment Systems Review.

1. **Outcome clarity** – Those leading an organisation or project, or responsible for a system, are clear what outcomes they are trying to achieve.
2. **Systems capability** – Those involved have the capability to understand and work with the system as a whole.
3. **Leverage focus** – Interventions are chosen to influence the drivers of outcomes, not just deliver outputs.
4. **Authorising leadership** – Leadership provides the authority and support to act coherently across boundaries.
5. **Incentive alignment** – People and organisations are rewarded for doing what improves outcomes.
6. **Decision quality** – Decisions are reasoned, evidence-based, free of bias and timely.
7. **Adaptive learning** – Those working in and across the system learn from experience and adapt their actions.

Taken together, the indicators and success factors should guide the choice of valuation method. They help identify which outcomes, costs, risks, dependencies and enabling conditions need to be valued, quantified, monitored or assessed qualitatively. Depending on the evidence available and the decision being made, this may include whole-life cost and value appraisal, avoided-loss and counterfactual analysis, broadened cost-benefit analysis, natural-capital and ecosystem-service valuation, social value and wellbeing assessment, distributional analysis, real-options and adaptive-pathways appraisal, multi-criteria decision analysis, and qualitative or indicator-based assessment where monetisation would create false precision.

Q6. What lessons can be learned from international approaches and other sectors?

The consultation already points to several useful tools and examples from other sectors and jurisdictions, including CReDo, PCRAM, adaptation taxonomies and Sustainable Asset Valuation. We agree that these are useful starting points. The wider lesson is that the UK should draw transferable principles, methods and governance approaches from different contexts.

Climate risks, geography, institutions, public expectations, regulatory systems, cultures, priorities and pathways to impact differ significantly between countries and sectors; the same hazard can affect different places, services, communities and natural systems in very different ways.

A useful way to organise the lessons is to ask what the UK can learn about five tasks:

- defining priorities, scope and responsibilities
- defining outcomes and value
- understanding interdependencies and pathways to impact

- comparing and funding intervention pathways
- learning, adapting and maintaining legitimacy over time.

Define priorities, scope and responsibilities

International practice shows the importance of being explicit about adaptation priorities, scope and responsibilities. This includes which climate risks, places, sectors, services and time horizons are most material; which are lower priority or less relevant for the purpose of the review; and where responsibility for action sits.

Finland's National Climate Change Adaptation Plan 2030 provides a useful example of linking national adaptation objectives to climate risk and vulnerability assessment, sector responsibilities and implementation pathways. Switzerland provides a relevant example of coordinated adaptation across federal offices, sectors and levels of government, informed by national climate-risk analysis.

The lesson for the UK is not that these governance models should be copied, but that the review should be explicit about which adaptation priorities are in scope, how responsibilities are distributed, and how national risk analysis is translated into sector and place-based action. This means clarifying the relevant hazards, places, sectors, services, stakeholders, responsibilities and time horizons, while recognising that not all risks, assets or places will have the same materiality or urgency.

Define outcomes and value

International and cross-sector practice shows that adaptation needs to be anchored in clear outcomes, not only asset protection. Singapore is a useful example because it treats climate adaptation as a national strategic issue linked to coastal and flood resilience, heat resilience, water and food resilience, long-term planning and public engagement. The transferable lesson is that climate-ready infrastructure should be assessed against the outcomes it enables for people, nature and the economy, not only against the condition of assets.

European Commission Better Regulation practice and Horizon Europe impact-pathway thinking provide a further lesson: economic, social and environmental impacts should be considered together, and activities should be linked to outputs, outcomes and longer-term impact. This is relevant because the cost of climate inaction includes impacts on people, nature, public services and long-term system performance, not only repair costs or insured losses.

Other sectors also offer useful outcome methods. The WHO Health Economic Assessment Tool provides a useful example of health-economic appraisal, particularly in relation to walking and cycling, while HM Treasury wellbeing guidance, DfT social impact appraisal and natural-capital approaches provide broader examples of assessing wellbeing, accessibility, environmental and social impacts.

The lesson for the UK is that the review should define the outcomes against which the cost of inaction will be assessed before selecting valuation methods. The outcome frame should vary by hazard, place and infrastructure service, and should include social, environmental and economic outcomes.

Understand interdependencies and pathways to impact

International and cross-sector practice shows that climate risk should not be assessed asset by asset. The more important lesson is to understand how risks move through connected

infrastructure, social, economic and natural systems, and how first-order asset impacts can become wider service, community, environmental and economic consequences.

Australia's national climate-risk work is relevant because it examines risks across systems and highlights cascading, compounding and concurrent risks. The lesson for the UK is that the review should examine how climate impacts interact across infrastructure, health, food, finance, communities, ecosystems and public services, rather than treating each sector in isolation.

Connected data, dependency mapping and digital twin approaches are also relevant. CReDo provides an example of using connected infrastructure data and digital twin approaches to understand dependencies across infrastructure networks. The transferable lesson is that digital tools are most useful when they reveal dependencies, shared risks and possible failure pathways, not simply when they create more asset-level data.

The insurance and catastrophe-risk sectors provide another useful lesson. They have experience in quantifying losses, modelling risk accumulation and identifying where hazards can produce large systemic losses. However, this evidence must be complemented by wider public-service, social, environmental and natural-system data, because insurance data does not fully capture uninsured losses, service disruption, health impacts, ecosystem impacts or community consequences.

Compare, value and fund intervention pathways

International and sectoral examples show that adaptation is not only about choosing individual projects. It is also about comparing intervention pathways, deciding when to act, and connecting evidence, appraisal and funding.

The Netherlands is a strong comparator for long-term flood, water and spatial-adaptation planning. Its Delta Programme uses adaptive delta management: taking timely decisions, keeping options open, and adapting as new information emerges. The lesson for the UK is that adaptation should be planned over long horizons, with decision points, monitoring and flexibility built in from the start.

New Zealand is relevant as an example of policy development around community-led retreat and adaptation funding, where climate risk raises difficult questions about whether communities, housing and infrastructure should remain, adapt or relocate. The lesson is that adaptation appraisal must sometimes consider not only how to protect assets, but whether continuing to protect, renew or rebuild in the same place remains the best long-term option.

Canada is relevant because it combines a national adaptation strategy with dedicated funding for disaster mitigation, adaptation and resilient infrastructure, including natural infrastructure. The lesson is that evidence, strategy and funding need to be connected if adaptation is to move from policy intent to delivery.

As the consultation notes, tools such as the Physical Climate Risk Appraisal Methodology, adaptation taxonomies and Sustainable Asset Valuation already provide useful starting points. The wider lesson is that these tools should be used to compare intervention pathways, not only individual projects. Intervention is not only about engineering protection. It may involve governance, funding, regulation, natural infrastructure, operational change, digital capability, behavioural change, community preparedness, relocation or service redesign. The review should therefore consider how different intervention pathways can be valued, funded and sequenced over time.

Learn, adapt and maintain legitimacy

International and sectoral examples show that adaptation is not a one-off decision. It needs monitoring, public engagement, periodic review and the ability to adapt as evidence changes. The Dutch adaptive pathways approach, Singapore's long-term coastal planning and Australia's climate-risk assessment all point to the importance of review points, transparent assumptions and learning over time.

Place-based and community-led approaches are also important. Examples such as Slowing the Flow at Pickering, the Environment Agency's work on community engagement for long-term flood and coastal adaptation, New Zealand's work on community-led retreat, and the Dutch Room for the River programme show that resilience measures are more credible and deliverable when affected communities help define risks, trade-offs and acceptable levels of service.

The lesson for the UK is that the review should not only estimate value technically. It should also help support legitimate decisions about priorities, trade-offs and acceptable risk. This is particularly important where adaptation involves visible disruption, land-use change, changing service expectations, natural flood management, relocation, or choices about which assets and places should be protected to what standard.

A key lesson from systems-oriented approaches is that first-order impacts are rarely the whole story. A flood, heatwave, drought or storm does not only damage assets. It can affect health, education, mobility, food supply, productivity, public confidence, nature and local economies. The review should therefore examine direct, indirect and cascading impacts, and use international and cross-sector examples to strengthen the UK's own approach rather than import a model that may not fit local conditions.

Q7. How can the review evaluate the role of economic and safety regulators in embedding adaptation into decisions?

The consultation rightly highlights that current regulatory frameworks may be ill-equipped for interconnected, uncertain and cross-boundary resilience risks. We agree. The review should build on this by evaluating not only what economic and safety regulators currently do, but what role they should play in embedding climate adaptation and resilience into infrastructure decisions. This can be assessed through five questions: know the scope; focus on outcomes; understand the systems; identify effective interventions; and observe, learn and repeat.

Know the scope: which regulators, sectors, risks and decisions are in scope?

The review should first define which economic and safety regulators are relevant, which infrastructure sectors and services they influence, and which climate-related decisions sit within or across their remits. This should include regulated utilities and infrastructure operators, but also interfaces between regulated and non-regulated systems, including local places, emergency response, natural infrastructure and digital systems.

A key question is whether regulators have sufficient remit, tools and incentives to embed adaptation in the decisions that matter, including price controls, safety cases, asset-management plans, maintenance regimes, resilience standards, investment submissions, reporting requirements and enforcement frameworks. The review should also examine where adaptation risks fall between regulatory regimes and where cross-regulator coordination is needed.

Focus on outcomes: what resilience outcomes should regulation support?

The review should assess whether government has clearly defined the resilience outcomes that economic and safety regulators are expected to support, including the acceptable level of risk and the trade-offs between affordability, resilience, safety, environmental sustainability and service quality. Regulators should not be left to define these public outcomes on their own. Policy should set the direction; regulation should then translate that direction into duties, incentives, standards, investment allowances and reporting requirements.

The review should therefore examine whether current regulatory frameworks support long-term resilience outcomes, service continuity, public safety, environmental protection, affordability and whole-life public value. It should test whether price controls, safety cases, asset-management requirements, performance incentives and reporting frameworks encourage adaptation, or whether they still focus too narrowly on short-term cost control, compliance or asset-level performance.

Understand the systems: can regulation address interdependencies, system interfaces and cascading risks?

Climate resilience is not only a matter of individual asset performance. It depends on interdependencies between energy, water, transport, telecoms, health, emergency response, natural infrastructure and local places. The review should therefore assess whether regulatory frameworks require asset owners and operators to identify cross-sector dependencies, cascading risks and the wider service consequences of infrastructure failure.

This should include whether regulators have the remit, data-sharing mechanisms, common reporting standards and cross-regulator coordination needed to address risks that cut across sectors or sit at system interfaces, while protecting legitimate commercial, security and privacy interests.

Identify effective interventions: does regulation enable timely and proportionate adaptation?

The review should assess whether regulation enables the right interventions, not only whether it creates compliance requirements. This includes requiring climate-risk assessment; allowing efficient anticipatory and preventive investment where it provides better whole-life value than delayed action or emergency repair; and embedding adaptation in asset-management plans, safety cases, maintenance regimes and investment submissions.

Regulatory frameworks should also enable natural infrastructure, demand management, operational change, digital capability and other non-built interventions to be considered alongside conventional asset-based solutions where these provide effective resilience.

The review should examine whether current regulatory arrangements unintentionally discourage adaptation. Price-control periods may be shorter than climate-risk and asset-life horizons; efficiency incentives may favour short-term cost reduction over long-term risk reduction; and regulatory silos may make it difficult to support cross-system adaptation.

Observe, learn and repeat: does regulation support adaptive learning over time?

Climate risk is changing, and uncertainty cannot be eliminated. The review should assess whether current regulatory arrangements support adaptive learning, and define what monitoring, reporting and review mechanisms are needed in future. This should include transparent risk assessment, monitoring of outcomes, periodic review of assumptions,

adaptation reporting, and revision of investment plans and resilience standards as evidence changes.

The review should also assess whether regulation is changing system behaviour in the right direction. This means asking whether regulatory duties, incentives, reporting requirements, investment allowances and enforcement mechanisms are shifting decisions towards long-term resilience, better whole-life value, appropriate risk allocation, cross-sector coordination and adaptive learning.

This will require transparent evidence, independent challenge and safeguards against regulatory frameworks being captured by short-term affordability pressures, sectoral incentives or narrow asset-based thinking. Consistent with the consultation's point that no service can deliver 100% resilience at any publicly acceptable cost, regulators should help expose the choices being made, the risks being accepted, who bears those risks, and what the long-term consequences are.

In summary, regulators should be treated as critical enablers of climate readiness, but not as substitutes for policy. Government should define the public outcomes and acceptable risk envelope. Regulators should then ensure, within their remits, that infrastructure owners and operators understand system risks, choose effective interventions, invest efficiently in resilience, report transparently, manage interdependencies and learn over time.

Q8. How should success be monitored over time, given the often invisible benefits of adaptation and resilience?

The Built Environment Connective's five-step systems change model sets 'Observe, learn and repeat' as its fifth step. Systems thinking is iterative. Regular reflection and refinement are necessary to enable continuous improvement. The impact of interventions on system behaviours, service performance and outcomes must be monitored. This calls for appropriate and practical metrics and reporting, to inform decision-making.

As set out in our response to Q5, outcome-oriented performance indicators and success factors can help define what should be monitored, evidenced and learned from over time. For adaptation and resilience, this is especially important because success is often reflected in avoided disruption, maintained service performance, reduced losses, improved recoverability and better outcomes under stress.

It is important that metrics:

- do not become targets: they should be used to assess the effectiveness of interventions in delivering desired outcomes, not to create narrow compliance incentives
- are not a barrier to designing and implementing interventions – improvements can be started using simple, available and proxy data; metrics can be refined and expanded over time
- are proportionate – used to provide insight that adds value; metrics are a means to an end, not an end in their own right.

Success should be measured in terms of outcomes: the quality, reliability, affordability and sustainability of the services that infrastructure assets and systems are intended to deliver, and any intended improvements.

It will be difficult to prove success directly; instead it will have to be inferred by correlating data from different sources. This should include comparing actual outcomes with a clear baseline: what level of damage, disruption, recovery cost or outcome deterioration would reasonably have been expected in the absence of the adaptation or resilience measure. Success should therefore be monitored through a combination of leading indicators, such as reduced exposure, improved asset condition, better preparedness and clearer interdependencies, and lagging indicators, such as disruption avoided, losses reduced, recovery time improved and outcomes maintained during climate events.

A promising example is the Ibis index developed by Turner & Townsend. It correlates data on infrastructure provision and performance with national social indices for educational attainment, health and life expectancy, income, employment and crime – social outcomes. Over time such approaches may help infer the impacts of improving or declining infrastructure provision and performance on social outcomes. With further development work, the model could potentially be extended to account for meteorological events and climate-related damage to infrastructure, disruptions and failures. This could help indicate whether adaptation measures are associated with improved outcomes, especially when combined with more direct evidence on hazards, exposure, asset performance and service disruption.

Insurers and catastrophe-risk organisations hold valuable data on insured losses, claims, exposure and modelled losses, and may also estimate uninsured losses. This can help identify trends in climate-related damage and disruption, including impacts on infrastructure and services, but it should be complemented by evidence on public-service impacts, social outcomes, environmental consequences, local economic disruption and damage to natural systems. The success of adaptation and resilience measures may be partly inferred by evaluating damage and disruption – or lack thereof – relative to wider recorded impacts. This evidence should be interpreted alongside an understanding of the social, economic and environmental services and outcomes provided by the asset or system of interest.