

RESILIENCE STUDY

Summary of consultation responses

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1. Introduction

The National Infrastructure Commission provides impartial, expert advice to government on long term infrastructure challenges, through the National Infrastructure Assessment, in depth studies into the UK's most pressing infrastructure issues as set by government, and an annual monitoring report taking stock of government's progress taking forward recommendations made by the Commission.

Once every five years, the Commission is required to carry out an overall assessment of the UK's infrastructure requirements, looking 30 years ahead, covering all the key sectors of economic infrastructure: transport, energy, water and waste water, flood resilience, digital connectivity, and solid waste. Each Assessment is guided by the government's objectives for the Commission to support sustainable economic growth across all regions of the UK, improve competitiveness and improve quality of life. The first Assessment was published in July 2018.

On 29 October 2018, the Chancellor asked the Commission to undertake a study on the resilience of the UK's economic infrastructure. Under the terms of reference for the study the Commission has been asked to:

- Review UK and international knowledge and approaches relating to resilience of current and future economic infrastructure systems, including how this can be understood, definitions, ways of assessing resilience, treatment of interdependencies and the management of the risk from different threats and hazards.
- Develop an understanding of public expectations and response to the potential loss of infrastructure services and review alternative options and contingency planning, for example, in the light of technological advances such as cyber threats, and behavioural changes.
- Develop an analytical approach that can be used to better understand the resilience of economic infrastructure systems, and the costs and benefits of measures to improve this.
- Undertake pilot analysis of infrastructure systems (for example through 'stress tests' of sectors, geographical areas or companies) to identify actions to improve the resilience of national infrastructure systems and inform investment decisions.
- Make recommendations to government on the resilience of economic infrastructure, how best to assess resilience, sharing of good practice, actions needed and data collection or analysis to inform the next National Infrastructure Assessment.

The full terms of reference for the study can be found at www.nic.org.uk/resilience/.

In undertaking the study, the Commission has adopted a two-stage approach:

- **a scoping phase** – including a scoping consultation, which has looked at current evidence and approaches to resilience; and
- **a main stage** – concluding with a final report, with details of analysis undertaken, key findings, and recommendations to government, expected to be published in Spring 2020.

The scoping phase was concluded by the scoping report, which this consultation response is published alongside. The report, which also sets out the Commission’s approach to the main phase of the study, can be found at www.nic.org.uk/resilience/.

About this consultation

The purpose of this consultation was to inform the Commission’s approach to resilience, both within the Resilience Study and in the longer term. The four questions in the consultation addressed two themes:

- the desired approach for the Commission to take on resilience in the second National Infrastructure assessment; and
- to gather information on sectoral interdependencies.

Respondents were invited to address all or any of the questions, and encouraged to reference all evidence and data supporting their responses. The NIC invited consultees to provide responses of a maximum of one A4 page answer to each question.

The consultation ran from 5 March until 1 April 2019.

As well as the consultation, the Commission ran a number of workshops and held bilateral meetings with relevant groups and organisations. Discussions were also held with researchers and technical experts.

Overview of the responses

A total of 69 consultation responses were received. One response was provided in confidence and therefore has not been included in the summaries in this report. The responses were from a range of organisations and individuals (Table 1.1), representing a wide variety of interests, industries and perspectives. A full list of respondents is provided at Appendix A.

Table 1.1 Respondent Type

Respondent type	No. of Unique Respondents	Respondent type	No. of Unique Respondents
Academic	8	Private sector: digital	3
Charity	1	Private sector: energy	8
Individual	1	Private sector: other	11
Industry/trade body	14	Private sector: transport	2
Local public body	2	Private sector: water	6
National public body	8	Third sector organisation	3
Other	1	Confidential	1

2. Approach to consultation analysis

Upon receipt of the submissions, respondents were logged with a unique reference number and allocated a respondent type, using the categories set out in Table 1.1. At this stage, any duplicate or additional responses from a respondent were identified. All the responses were received in digital format.

Structured responses were analysed to identify key issues and themes for each answered question. The same approach was adopted for the analysis of the unstructured responses. However, an additional first step was taken to allocate text to the Consultation Report sections and questions where possible and appropriate.

Respondents were encouraged to provide details of the evidence and data supporting their positions. A log has been created detailing the documents appended to responses for the NIC to consider during its ongoing work; however, this material is not discussed in this report.

Report structure

The rest of this report summarises the responses to each of the consultation questions. As they both asked about respondents' priorities for the Commission's work on resilience, the first two questions have been grouped together.

Questions 1 and 2

What are the key questions that the next National Infrastructure Assessment should answer about resilience?

On the basis of your response to question 1, what issues should be prioritised in the resilience study?

Questions 1 and 2 drew a wide range of responses on what resilience issues the Commission should prioritise. These are summarised within the themes set out below.

A common understanding of resilience

One theme that emerged from responses related to developing a common understanding of resilience. Some respondents asked the NIC to agree on a definition of resilience so that it could be interpreted consistently and to ensure resilience actions are taken in coordination. Many of the responses gave examples of a favoured definition of resilience, or suggested characteristics which the definition should include. For example, the Department for Transport highlighted the need to differentiate whether resilience refers to “the ability to bounce back quickly, provide redundant systems to reduce impact while an event is occurring or both”.

However, several respondents also noted the value in taking a broader approach to resilience and avoiding focussing too narrowly on definitions. For example:

“Although understanding resilience ... is important, it is not necessary to dwell on definition development. There is a need to take advantage and embrace the broad definitions / perspectives of resilience when taking action to strengthen resilience.”
(Roger Street)

In conjunction with recommending taking a broader approach to definitions, many respondents recognised the need for understanding of why resilience is important and what constitutes good resilience. This included questions such as: do decision makers and institutions understand resilience and put it at the centre of planning? Others suggested that the way we think of resilience must go beyond conventional risk calculation, which inherently deals with foreseeable events, as infrastructure interacts with so many areas and people.

Systems based approach

Respondents also welcomed the Commission taking a systems based approach to resilience. This included an interest in developing an understanding around cascade failures between sectors or, as the Alan Turing Institute described them, “channels of contagion” where disruptions in one area propagate throughout the system of systems. Some respondents suggested that mapping of dependencies would be a valuable exercise.

In particular, respondents highlighted the increasing reliance on the digital sector as a growing interdependency which merits further consideration. For example:

“New networks of digitally connected infrastructure present unintended vulnerabilities and unforeseen cascade effects which need to be ... investigated; understood; planned for; and anticipated. Enhanced digital connectivity facilitates the development of smart infrastructure and while it enables more efficient management and maintenance it also carries more risk.”
(Institution of Engineering Technology)

There was also a clear recognition of the central role of energy within the infrastructure system of systems which, like the digital sector, other infrastructure sectors are highly dependent on. In some cases this was linked to the UK’s transition to a decarbonised energy network, as increasing renewables intermittency necessitates more active management.

Methods to assess and monitor resilience

Respondents frequently highlighted the need for robust methods to assess and monitor resilience, including suggestions such as modelling, scenario planning and root cause diagnostics. This was related to increasing understanding and benchmarking the current resilience of the UK’s economic infrastructure, as well as identifying gaps where resilience ought to be improved and ongoing monitoring of the efficacy of resilience interventions.

Resilience standards and outcomes

A related theme identified by respondents was around resilience standards and outcomes, such as levels of service or resilience metrics. Some consistency around assessing resilience was viewed as positive in allowing for cross sector comparison and identification of the most significant system vulnerabilities. However, respondents also highlighted that sufficient consideration should be given to sectoral and spatial variations in resilience requirements.

There is, therefore, a perception that any metrics or technical standards ought to be multidimensional, as demonstrated by the suggestion from Arup that resilience metrics need “to consider both outcome-based approaches (i.e. those which ‘measure’ resilience, such as downtime, recovery time) and attribute-based approaches (i.e. those which assess the characteristics and behaviours of resilient systems)”.

Assessing the value of resilience

How we value resilience, including economic, societal, environmental and political dimensions, was important to respondents. Many suggested that that pure cost benefit analysis does not adequately capture the value of resilience across areas such as quality of life impacts.

Respondents also recognised the impact of trade offs on infrastructure investment for resilience. For example, the removal of a redundancy to deliver short term efficiency, at the expense of damage to longer term resilience. A number of responses therefore put forward the view that there needs to be consideration of the broader value of investments, rather than a focus on lower costs.

Cross sector planning and strategies

Responses around cross sector planning and strategies emphasised the need for greater collaboration across sectors. While planning was thought to include most potential cascading impacts or large scale events, it was suggested that the Commission explore the effectiveness and comprehensiveness of these plans. In particular, respondents questioned whether such plans are able to manage cross sectoral interdependencies.

Several respondents indicated that the Commission should explore areas where increasing collaboration would be most beneficial, such as aligning planning cycles, joining up planning and data sharing.

Policy and regulation

Some respondents were concerned with how resilience is approached in policy and regulation. Several responses indicated that they believe regulators should provide more effective coordination to mitigate the impact of sector silos and, where appropriate, provide regulatory incentives or obligations to increase cross sector collaboration on resilience issues.

Respondents also noted that regulators’ approaches can inhibit resilience planning in two ways. Firstly, that regulatory timeframes (for example, five year cycles) can lead operators to prioritise short term efficiency and investor returns over long term resilience. And secondly, that a focus on managing upward pressure on consumer bills may be inhibiting resilience as:

*“There is a challenge here in that regulators are putting high expectations on infra providers to keep bills the same – which can inhibit investment on long tail events”
(100 Resilient Cities)*

An increased role for the government was also suggested by some responses, given that resilience requires policy instruments and financial incentives. Respondents were interested in how the government could best work with stakeholders to improve resilience and clarify what aspects of resilience they should be involved with. In particular, ensuring resilience is accounted for appropriately across different sectors and the need to act in the long term interest of consumers were highlighted as key roles for the government.

Investment and funding resilience

As described in the theme on valuing resilience, respondents are aware of the financial constraints on resilience investment and whose responsibility it is to fund resilience. Respondents suggested that the Commission should explore what priorities for investment operators currently use and advise under what circumstances it is beneficial to invest in resilience.

Future resilience

Many respondents were concerned that current approaches to resilience do not adequately address some of the longer term, evolving challenges to the UK’s economic infrastructure and that a different approach may be needed:

“Resilience planning is not just about assessing current risk but also involves anticipating future developments. Effective resilience planning needs to be dynamic and to involve ongoing dialogue” (Institution of Engineering Technology)

“Do we need infrastructure decisions to be more forward looking, especially as investment decisions lock in vulnerabilities for decades?” (John Dora Consulting)

Climate change, technological development and societal changes were all cited as a developing challenge for infrastructure, which need to be considered now if future resilience needs are to be met.

Addressing hazards

Views varied regarding whether the Commission should take a hazard agnostic approach, or if there is a need to look more closely at specific risks facing the UK’s economic infrastructure.

Several responses noted the potential impact of rapid, widespread technological progress on infrastructure systems which have not been designed to cope with technologies such as electric vehicles and a highly renewable energy mix. This can be summarised by the Energy Network Association’s comment that understanding “how resilience can be maintained in this new era amidst growing threats such as cyber activity and extreme weather events, while continuing to keep costs low for the public” will be of particular concern.

Other specific concerns for respondents included the impacts of climate change and population growth on ageing infrastructure assets.

Society and public engagement

Respondents were interested in the extent to which infrastructure operators engage with the public when making decisions about resilience, especially given that perceptions and expectations change over time. For example, one highlighted:

“[the] importance of building public trust and confidence in infrastructure by specifically designing with the public in mind. This helps with managing public expectations, engaging with the public in a meaningful way when issues arise and providing business with an organisational mindset for resolving issues quickly.”
(Ombudsman Services)

When considering public perceptions, some respondents noted that assessments of people’s ‘willingness to pay’ were seen as misleading, unless they were triangulated with other approaches. A question was therefore posed to the Commission about establishing best practise for testing consumers’ appetite for resilience investment.

Question 3

Are there specific (e.g. policy, knowledge, data sharing or other) barriers to addressing resilience emerging from cross sectoral interdependencies?

Consistency

Consistency around resilience language, approaches and standards were identified as barriers to assessing the resilience of UK infrastructure. Different sectors have their own interpretations of resilience, meaning it is difficult to effectively agree on a common set of resilience principles. Consistent language around resilience could therefore be applied to help the understanding of resilience and enable joined up thinking.

Respondents also suggested that a consistent approach for resilience should be established and shared across sectors. This would be useful as currently there is no standard framework for non financial resilience benefits:

“[There] needs to be a consistently applied appraisal framework across sectors eg common approach to CBA and uncertainty; assumptions made during options appraisal.” (Network Rail)

Comparing and assessing resilience is also difficult when design standards are not consistent. There are no consistent standards of whether to include climate change forecasts, for example. Limited sharing of best practise was also cited as a major barrier to improving resilience.

Methods to assess and monitor resilience

The absence of any unified analytical approach for understanding system interdependencies was identified as a significant barrier to addressing cross sector interdependencies, including that:

“there is no dominant technique for analysing infrastructure interdependency, and there is even less evidence of practical application of the approaches in industry.”
(Kristen MacAskill)

“No detailed assessment of infrastructure cross sector dependencies exists today, nor any assessment of how these may change with future trends in respective infrastructure sectors.” (National Grid)

“No attempt has been made to quantify the risk of systemic shocks or collapse.” (Individual response)

Several respondents welcomed the Commission acting on this to develop a system based framework for infrastructure resilience assessment, although some also highlighted the potential difficulties of developing a unified cross sector analytical framework.

Funding resilience

The significant costs of increasing resilience and constraints on available funding were also regarded as being barriers to resilience. This may be related to the inadequate valuation of resilience, which was identified as a theme of responses to questions 1 and 2. Specifically, the “inability to demonstrate the value of resilience to either justify investment decisions or develop cases for joint funding” for resilience was identified by Southern Water.

Challenges with funding may also be related to issues with the regulatory framework and funding cycles. Some respondents believe that there are limited regulatory incentives to invest in resilience, as regulators seek to balance long term infrastructure needs with affordability of bills. Similarly, the mismatch in timing between different regulatory cycles and lack of regulatory mechanism for cost sharing was cited as a barrier to co funding within and across sectors.

Sectoral silos

Respondents point to a culture of working in silos within the UK’s infrastructure sectors, which prevents data and knowledge sharing, and leads to a lack of understanding of cross sector interdependencies. This critique often extended beyond the operators to encompass regulation, which it was felt does not adequately encourage cross sector coordination. Although some acknowledged the existence of cross sector resilience forums, these were seen to have limited tangible impact on decision making:

“In practice we see a need for sectors to meet and work closer together to achieve a better understanding of interdependency which may lead to improved capacity to function in times of shock and stress.” (Lloyd’s Register Foundation)

Data

Issues with data, including a lack of standardisation and data sharing, were frequently seen as a barrier. Respondents brought up both availability and quality, which are seen to vary considerably within and across companies and sectors. There was also recognition that data protection requirements, security and commercial confidentiality can inhibit the sharing of data.

Regulation and policy

The absence of policies and regulatory incentives for resilience were seen as barriers to delivering cross sector resilience. Some respondents highlighted the need to align the priorities of government, regulators and industry to find solutions to a wide array of challenges.

The planning system was cited as a specific barrier as it prevents joint planning – due to planning and regulatory cycles not being aligned – and is not seen to effectively consider resilience generally.

Respondents noted that the culture of government departments and within sectors plays a part in addressing resilience emerging from cross sectoral interdependencies. Some suggested that overcoming status quo bias is key to addressing the barriers. This includes aligning departmental priorities and addressing the resilience culture within sectors.

Question 4

Are there any examples in which barriers to resilience issues, arising from sectoral interdependencies or other causes, have been addressed or overcome?

The examples of barriers to resilience which have been overcome highlighted a broad array of projects. These looked at a range of areas, including; mapping interconnections of services and utilities, analysis of vulnerabilities and improving current UK infrastructure. Project Iceberg (a multi organisation project looking at managing underground assets and geological conditions) was cited by multiple respondents as an example of where data exchange between utility sectors has delivered better resilience outcomes.

Examples were also provided for applied approaches and methodologies which have supported resilience and incentivised joined up working, including:

- the National Infrastructure Modelling Service, which was seen to be able to address the complexity of exploring resilience through a system of systems approach
- the multi objective robust decision making approach used by Water Resources East, which allows sectors to work together to develop water resource management and resilience plans.

Cross sector coordination was also an important theme in examples of addressed or overcome barriers. Respondents believe that events which brought together a range of sectors and organisations have helped to understand interdependencies and become more resilient to future challenges, such as:

- The Infrastructure Operators Adaptation Forum, which was seen to provide a useful space to discuss infrastructure interdependencies, as well as exploring case studies on the prevention of cascade failures
- The National Underground Assets Group was cited as a good example of cross sector coordination, as it is seen to be successfully addressing the issues of transport network interference from the maintenance of buried assets.

Respondents also gave examples of policies which have improved collaboration within sectors and how regulators have encouraged communication between these sectors. A key example of this was Ofwat's Resilience in the Round report, which provides water companies with good practise on resilience and notes the range of interconnected threats facing the sector, including threats not directly under water company control.

3. Next steps

As described above, following the publication of this consultation summary and of the Commission's Scoping Report alongside it, the Resilience study is now into its main phase.

Full details of next steps and how the Commission will approach the rest of the study are set out in the scoping report, which can be found at www.nic.org.uk/resilience/.

Appendix A: list of respondents

100 Resilient Cities	National Grid System Operator
AECOM	Network Rail
Airport Operators Association	NeuConnect
Arup	Nichols Group
British Ceramic Confederation	Nominet
British Water	Ombudsman Services
BT	Ordnance Survey
Buckinghamshire County Council	RAEng & ICE
Cadent	Resilience First
Citizens Advice	Scottish and Southern Electric
Chartered Institute of Water and Environmental Management	SGN
COMIT Projects Limited & Royal Engineers	South West Water
Committee on Climate Change	Southern Water
Consumer Council for Water	SP Energy Network
Confidential	Stantec
Cambridge centre for Smart Infrastructure and Construction	Suffolk SPSL
Data & Analytics Facility for National Infrastructure	The Alan Turing Institute
Department for Transport	Turner & Townsend
Digital Framework Task Group	UKCRIC
Drax	United Utilities
EDF Energy	University of Oxford
Energy Networks Association	University of Sheffield
Energy & Utility Skills	Vodafone
Energy Technologies Institute	WRE
Energy UK	WRSE
Environment Agency	WSP
Future Water Association	Yorkshire Water
Gatwick Airport	
HR Wallingford	
Institute of Asset Management	
Institution of Engineering Technology	
Institute and Faculty of Actuaries	
Imperial College London	
Jacobs	
John Dora Consulting	
KCOM	
Kristen MacAskill	
Landscape Institute	
Lloyd's Register Foundation	
Met Office	
National Grid	

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