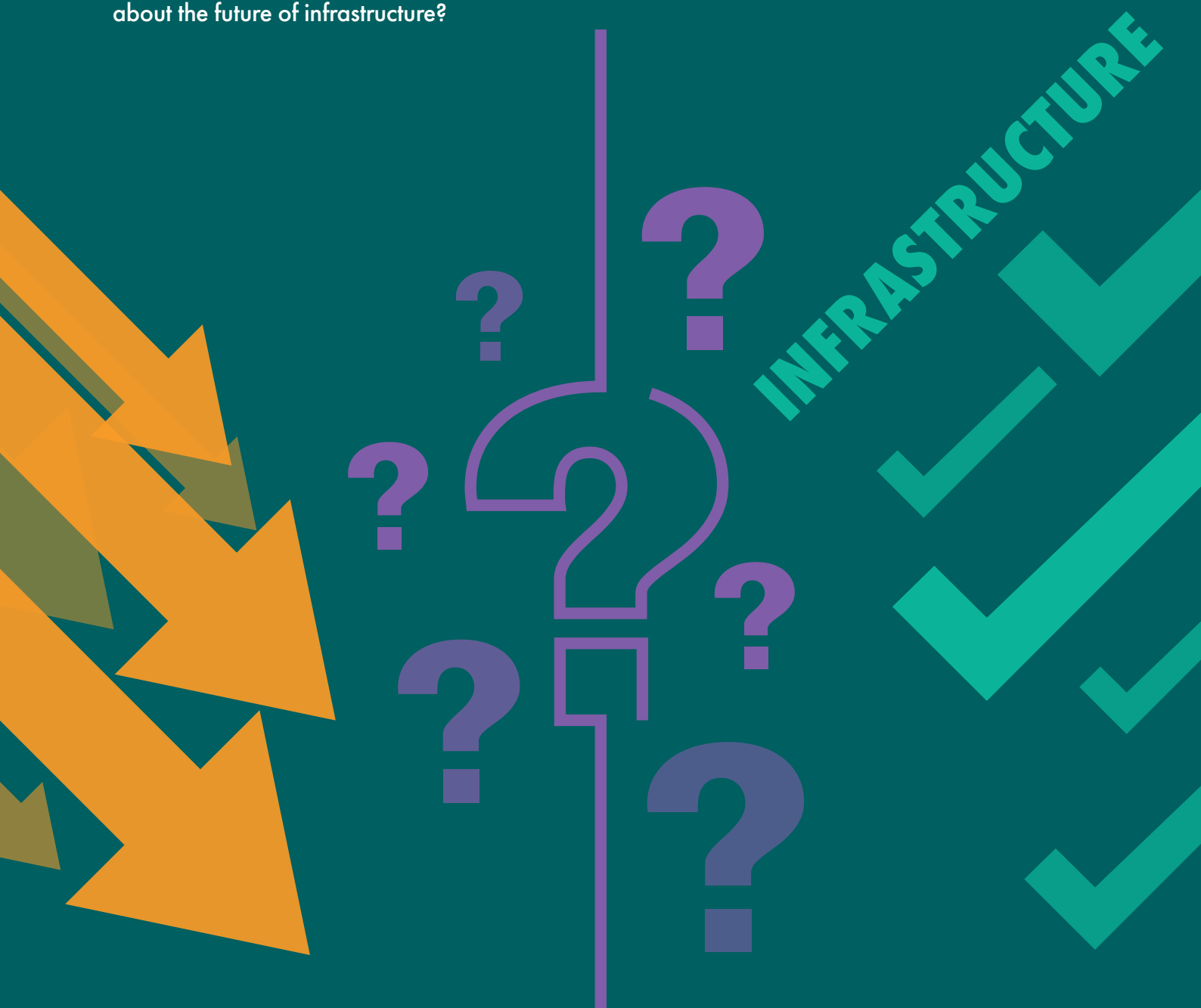


# ENGINEERING A SAFER FUTURE

## LEARNING FROM CRISIS: FROM DISRUPTION TO TRANSFORMATION

What has the Covid-19 pandemic taught us  
about the future of infrastructure?





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## ACKNOWLEDGEMENTS

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# CONTENTS

ABOUT THE SERIES: LEARNING FROM CRISIS	1
ABOUT THIS CONVERSATION	2
PARTICIPANTS	3
EMERGING INSIGHTS	4
PRIORITY ACTIONS / KEY TAKEAWAYS	8

## ENGINEERING A SAFER FUTURE

### LEARNING FROM CRISIS: FROM DISRUPTION TO TRANSFORMATION

This report, *What has the Covid-19 pandemic taught us about the future of infrastructure?*, is one of a series of related reports and podcasts available at [www.lrfoundation.org.uk/en/learning-from-crisis](http://www.lrfoundation.org.uk/en/learning-from-crisis)



Summary report



Data



Safety at work



Education



Infrastructure



Public understanding of risk

## ABOUT THE SERIES: LEARNING FROM CRISIS

**Resilience is the ability to withstand, adapt to changing conditions, and recover positively from shocks and stresses.**

The Resilience Shift is committed to understanding how crisis can reveal both the weaknesses and strengths of the systems on which we rely, and to sharing stories and insights across a variety of sectors towards building long-term resilience.

We have investigated the experience of recent crises, bringing together diverse experiences and perspectives across stakeholders to bear witness to the impacts of deeply disruptive events, and the individuals, decisions, technologies and processes that shaped the response and recovery.

*Learning from Day Zero*<sup>1</sup> is a series of film-based learning modules capturing reflections from key individuals involved in the response to the 2017-18 water crisis in Cape Town, South Africa. Developed in partnership with the Cape Town Drought Response Learning Initiative, these modules feature insights curated from over 50 hours of in-depth, filmed conversations with government officials, civil society activists, academics, and business and community leaders.

The *Resilient Leadership*<sup>2</sup> project is a real-time reflective learning document that captures reflections from city government and corporate leaders navigating their organisations' responses to the Covid-19 pandemic. Through insights distilled from weekly conversations over a 4-month period, the project reveals key attributes of leadership during a crisis and identifies three questions to shape the future of resilient leadership.

*Engineering a Safer Future*<sup>3</sup> – insights from which appear in this publication – seeks to explore the impact of disruption and its ability to create a window of opportunity for transformative change. The insights emerged from in-depth expert conversations with senior leaders about the ramifications of the Covid-19 crisis in more detail within specific sectors.

Collectively, these investigations not only strengthen our broad understanding of resilience in practice, but also help us to shape and influence future work. They also actively explore different and innovative approaches to capturing and sharing learning.

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1 <https://www.resilienceshift.org/cape-town-learning-from-day-zero/>

2 <https://www.resilienceshift.org/resilient-leadership/>

3 [www.lrfoundation.org.uk/en/learning-from-crisis](http://www.lrfoundation.org.uk/en/learning-from-crisis)

## ABOUT THIS CONVERSATION: INFRASTRUCTURE

**In the *Infrastructure* session, conducted on 15 September 2020, participants were asked to examine how their work life had changed between January and September 2020 due to the Covid-19 pandemic; how they have managed to stay resilient, both personally and professionally; and how they intended to prepare for a 'new normal' future.**

The session was a moderated conversation framed around infrastructure challenges in a post-Covid world, from small-scale practical issues to long-term institutional and systemic consequences. Participants reflected on how the Covid crisis has disrupted existing practice across critical infrastructure systems and related industries, how systems have adapted, and what lessons the current disruption holds for our shared future.

### ENGINEERING A SAFER FUTURE

At The Resilience Shift, we have long recognised that the past is an increasingly unreliable predictor of the future, and that deep uncertainty around challenge and risk is felt across many sectors. In 2020, the rapid global impacts of Covid-19, and its consequences across every aspect of the work that Lloyd's Register Foundation supports, provided a unique opportunity for us all to consider the transformations we'd like to see as we emerge from this crisis.

Together, Lloyd's Register Foundation and The Resilience Shift have developed this series of conversations as an antidote to

the pervasive online 'noise' that confronts us as we seek serious discussion and meaningful insight into the ramifications of this crisis. We sought to bring together innovators working within the Lloyd's Register Foundation's grant programme, joined by outside subject matter specialists, with the aim of surfacing insights on the likely scale and permanence of changes that Covid-19 has triggered. Our participants also examined how we approach infrastructure systems and interdependencies, and what the pandemic can tell us about our existing preparedness and horizon-scanning practices.

With the five sessions respectively focused on safety at work, data and information systems, education, infrastructure and public understanding of risk, this series explores both the impact of disruption and how disruption can create windows of opportunity for change.

### APPROACH AND FORMAT

The closed-door, intimate roundtable format was designed to facilitate fluid interaction amongst a small group of partners, associates, subject matter experts and grantees of the Lloyd's Register Foundation and of The Resilience Shift. Participants were given latitude to steer the conversation towards their specific sector or area of concern, their experience of challenges, and their thoughts on plausible ways forward.

## PARTICIPANTS

### ABOUT THE MODERATORS

**Dr. Juliet Mian** | The Resilience Shift\*  
Deputy Director

An experienced Civil Engineer of over 20 years' experience working on infrastructure projects both in the UK and overseas, Juliet is a systems thinker who cares deeply about delivering engineering solutions to meet the challenges our planet faces.

**Dr. Jan Przydatek** | Lloyd's Register  
Foundation Director of Technologies

Jan is currently Director of Technologies at Lloyd's Register Foundation whose portfolio includes the Foundation's grants to the Structural Integrity Research Foundation and ICON.

### ABOUT THE PARTICIPANTS

**Nick Godfrey** | Coalition for Urban  
Transitions Co-Founder & Programme  
Director

Currently working as the Director of the Coalition for Urban Transitions, a special initiative of the New Climate Economy, focused on supporting national decision makers to transform their cities to improve economic, social, and environmental prosperity.

**Dr. Hayaatun Sillem** | Royal Academy of  
Engineering\* Chief Executive

Extensive leadership experience in UK and international engineering, innovation and diversity & inclusion activities. She is a trustee of the London Transport Museum and Engineering UK; serves as a member of the Made Smarter Commission and chairs its Expert Stakeholder Panel; chairs the judging panel for the St Andrews Prize for the Environment. Was named one of the 'Inspiring Fifty' women in tech in 2018.

**Jerry Buckwalter** | American Society of  
Civil Engineers Chief Operating & Strategy  
Officer

Served in various appointed roles on the National Infrastructure Advisory Council under both Presidents Barack Obama and George W. Bush. He is a member of the board of the Center for Public Policy Innovation and has also served on the board of the National Homeland Defence Foundation and the executive committee of Virginia's Institute for Defence and Homeland Security.

**Dr. Ana Mijic** | Imperial College Senior  
Lecturer

Currently a Systems Analysis Lead for the UK NERC CAMELLIA impact programme focused on integrated water infrastructure planning system. Ana lead the UK-India 3-years project on Coupled Human and Natural Systems Environment for water management under uncertainty in the Indo-Gangetic Plain and 5-year programme on Community Water Management for a Liveable London.

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\* Lloyd's Register Foundation grant recipient

## EMERGING INSIGHTS

The *Infrastructure* session revealed themes around biases inherent to planning for disruptive events, how resilience manifests on different scales and at different schedules, and the responsibility borne by the sector for embedding, and resolving, inequities in access and crisis response.

*“What we now give seminars about as ‘holistic thinking’ used to be called common sense.”*

*“Inequality is something that those of us that work in infrastructure have to feel a degree of ownership for”*

Telecommunications are estimated to have saved each country between 20 and 25% of GDP for the period of limited mobility due to Covid-19 lockdowns.<sup>4</sup>

### EMERGING INSIGHT 1

#### Nothing broke; we should recognise and build on this success

Without minimising the enormous human and economic cost of the Covid-19 pandemic, it's important to realise that within the infrastructure sector as whole, no system or network *failed* catastrophically, despite many physical systems being placed under critical and often unprecedented stress. While at the national scale policy decisions have often complicated responses to the crisis, the infrastructure upon which our response has depended has remained reliable despite massive, rapid shifts in demand, labour availability, and economic fluidity.

That ‘nothing broke’ during the initial shock of the Covid-19 crisis is a testament to the degree to which resilience principles and planning have already taken hold in the sector. Our task is now to learn from and extend those successes, in order to ensure even greater resilience for future challenges.

#### THINGS TO THINK ABOUT:

- Which examples of resilience success during the pandemic are particularly applicable for your organisation, and could be adopted to extend resilience across disciplines?
- What systems or structures in the sector proved less robust, or experienced critical stress? How can your organisation work to reinforce or support these areas?

<sup>4</sup> Inter-American Development Bank.  
<https://publications.iadb.org/publications/english/document/The-Impact-of-Digital-Infrastructure-on-the-Consequences-of-COVID-19-and-on-the-Mitigation-of-Future-Effects.pdf>

## EMERGING INSIGHT 2

### Resilience emerges at different rates and on different scales around the world

The Covid-19 crisis has demonstrated that while resilience is a key value for both infrastructure and many other sectors globally, how that resilience manifests itself, through what mechanisms and at what pace are all widely variable and dependent upon economic priorities, communication styles, and to some extent national psyche.

A key component of global and organisational response to future disruptions will be the ability to tap different types of resilience across nations and sectors *as they emerge* and generalise those lessons for global use.

## THINGS TO THINK ABOUT:

- Which regions or areas of your sector responded to the Covid pandemic most quickly and effectively? What factors (policy, regulation, logistics, management, etc) were responsible for the speed of this response?
- How can your organisation better track, adopt and extend emerging solutions to disruption in your sector globally?

Companies that came out ahead after the financial crisis of 2008 typically moved fast and hard on productivity (including cost reduction), rapidly reallocated resources, and made bold moves (including early divestitures and acquisitions in recovery) to prepare for the future.<sup>5</sup>

In 2020, global carbon dioxide emissions fell by 6.4%, or 2.3 billion tonnes during the Covid-pandemic (roughly double Japan's yearly emissions) but picked up in the second half of the year.<sup>6</sup>

5 McKinsey & Company. [www.mckinsey.com/business-functions/operations/our-insights/how-construction-can-emerge-stronger-after-coronavirus](https://www.mckinsey.com/business-functions/operations/our-insights/how-construction-can-emerge-stronger-after-coronavirus)

6 Nature. [www.nature.com/articles/d41586-021-00090-3](https://www.nature.com/articles/d41586-021-00090-3)



### EMERGING INSIGHT 3

#### Current planning models are biased towards optimism

For years before the Covid-19 crisis, 'global pandemic' had been correctly identified in futures research across many sectors, infrastructure included, as a likely risk. The Covid experience has shown that simply identifying the risk is not enough; the widespread assumption that a pandemic event would be severely disruptive but resolved reasonably quickly represents both a failure of imagination and a dangerous bias towards optimism.

Our willingness to invest in preparedness for 'outlier scenarios' - things that can come as a complete surprise because they lie way beyond usual observations - has historically not been in proportion to their consequence. Covid-19 stands as an object lesson in our need to both better address low-probability, high-consequence events in planning, and better balance this requirement against the need for ongoing responsiveness to more frequent stresses.

#### THINGS TO THINK ABOUT:

- What aspects of the Covid pandemic caught your organisation by surprise, or proved more challenging to respond to than expected?
- How can your planning and strategy operations use the experience of the pandemic to broaden general responsiveness for future disruptions?

### EMERGING INSIGHT 4

#### 'Siloisation' is the enemy of resilience

While the acceleration of specialisation over the past century has resulted in extraordinary progress across a wide variety of disciplines, this trend has also produced an extraordinary degree of 'siloisation'. Our societies, while dependent on a wide variety of interconnected systems, simply aren't structured to operate in an interconnected manner, particularly in response to complex disruptions.

Covid-19 has illustrated the inherent fragility of multiple disparate critical systems, the unpredictability of crisis causality chains (the need for epidemiologists and transport engineers to interface with care home nursing staff, as one example) and the urgent need for greater multidisciplinary communication and understanding.

#### THINGS TO THINK ABOUT:

- How can your organisation enhance support for internal multidisciplinary communication and understanding?
- What new sectors or industries did the Covid pandemic require your organisation to consider or interact with? How can you maintain and extend those links?

## EMERGING INSIGHT 5

### Choices around infrastructure are choices around equality

Infrastructure has a direct impact on how and to what degree individuals are affected by both the direct and indirect effects of Covid-19. Issues of who can and can't work from home, who does and doesn't have access to quality medical care, and even who can and can't safely isolate from others are all fundamentally infrastructure related.

The pandemic has shown in sharp relief not only the stark physical and digital systems infrastructure divides between global north and south, but also the degrees of access inequality pervasive among wealthy western societies. A better, more resilient set of responses to the next major global challenge will to a large degree depend upon making infrastructure choices that don't reinforce structural inequality.

## THINGS TO THINK ABOUT:

- What are some potential resilience benefits to your organisation of supporting or extending social equity and resource access components through your work?
- How can your organisation integrate measurable improvements to social equity and wellbeing outcomes into projects?

Energy, transport, building and water infrastructure make up more than 60% of global greenhouse gas emissions. Aligning financial flows with low-emission, resilient development pathways is now more critical than ever to meet the goals of the Paris Agreement and deliver on the 2030 Agenda for Sustainable Development.<sup>7</sup>

<sup>7</sup> OECD. [www.oecd.org/environment/cc/climate-futures/policy-highlights-financing-climate-futures.pdf](https://www.oecd.org/environment/cc/climate-futures/policy-highlights-financing-climate-futures.pdf)

## PRIORITY ACTIONS / KEY TAKEAWAYS

### KEY TAKEAWAY 1

#### **There is an ongoing generational shift towards thinking on longer timescales**

Infrastructure, like all sectors, is seeing an influx of younger practitioners and consumers from a generation that is both more climate-conscious and more politically active than their elders.

The sector should be prepared to engage with and capitalise on this shift, particularly as this generation seem more inclined to think on longer timescales than previous generations of consumers, designers and regulators. This new perspective can change how the sector as a whole approaches planning, projects and social responsibility.

### KEY TAKEAWAY 2

#### **Industry can play a key role in moderating vested interests**

So far there has been little electoral return for most politicians deciding to prioritise climate planning, largely to the misalignment between the timescales for climate investment and terms in office, but that is starting to change.

National governments around the world, including in the global south, are sensitive to favouritism in procurement and regulation; industry groups will be increasingly important in moderating different vested interests and assuring governments that beneficial partnerships can be maintained while achieving climate goals.

### KEY TAKEAWAY 3

#### **We need to plan in proportion to consequence, and account for human behaviour**

The fluctuations in demand in response to stresses of the Covid-19 pandemic has illustrated the impact on human behaviour within the infrastructure sector. Public responses to crisis, particularly as regard logistics and supply chains, are fairly predictable and might have been better modelled to anticipate early constraints in availability of goods and services.

Digital modelling allows us to test scenarios and explore increasingly complex sets of long-term consequence chains. Our planning should reflect this available degree of refinement, and more clearly differentiate between actual 'black swan' (low-probability, high-consequence, zero warning) events and the far more prevalent 'grey rhino' (high-probability, high-consequence, considerable warning) events like Covid-19. Resource allocation in response to this modelling needs to be pursued in a clear-eyed, rather than optimistic, manner.

#### KEY TAKEAWAY 4

##### **We need to understand whole systems, and how those systems relate to one another**

'Systems thinking' has long been a watchword in resilience circles; the Covid-19 pandemic has provided a global case study in the importance of understanding whole systems rather than their constituent parts, and how those systems interrelate.

We live in an interlinked world, where complex systems may be economically or even physically connected but managed, maintained and overseen by discrete entities. Recognising this means encouraging multidisciplinary conversations and supporting both systems thinking and management of intersystem relationships by engaging across the value chain, identifying points of integration and transference ability, and managing uncertainty.

#### KEY TAKEAWAY 5

##### **A data-first worldview can help solve complex challenges.**

Effective systems thinking and integration requires massive amounts of reliable, current data. Understanding the follow-on effects of infrastructure investment decision-making on structural inequality requires massive amounts of impartial, longitudinal data.

Taking a data-first worldview – including thinking critically about collection, processing, analysis and display of data to allow discovery of insights, holistic understanding and guard against 'data overload' – can help ensure that our planning, prediction and crisis response is agile, effective and appropriate to an increasingly interconnected world.



#### ABOUT LLOYD'S REGISTER FOUNDATION

The Lloyd's Register Foundation seeks to secure for the benefit of the community high technical standards of design, manufacture, construction, maintenance, operation and performance for the purpose of enhancing the safety of life and property at sea, on land and in the air.

The *Engineering a Safer Future* programme is designed to focus on sharing existing experience and knowledge within and between sectors, and forms an important part of the delivery of our strategic theme accelerating the application of research.

The Lloyd's Register Foundation's programme supports resilience, by addressing:

- Governance: incentives, standards, rules, legal and financial
- Capacity building and engagement: professional development, publications, communication and public engagement
- Data and supporting tools: shared datasets, modelling and simulation, decision support
- International and global scale networks: studies of global systems, supply chains, knowledge networks.

#### ABOUT THE RESILIENCE SHIFT

The Resilience Shift is a catalyst for positive change. We seek to inspire and empower a global community to make the world safer through resilient infrastructure. Our mission is to help ensure the safety and continuity of the critical infrastructure and services that make our lives possible. From water and transportation to communications and energy, resilience is essential to everything we do. We're working globally to help define resilience and provide pathways from theory to practice.

Supported by Lloyd's Register Foundation and Arup, The Resilience Shift provides knowledge and tools to those responsible for planning, financing, designing, delivering, operating and maintaining critical infrastructure systems. We are not just a think tank, not just a grant-making body, and not just a convening network. Our impact is achieved through a proactive approach combining all three of these roles.

The Resilience Shift's approach is through learning by doing in collaboration with others, as well as by sharing knowledge and fostering a global community. We want to create value for those we are seeking to influence, thereby maximising the positive impact for society. We focus on tools and approaches to put this shift in resilience thinking into practice, identifying the drivers and enablers for infrastructure resilience, and advancing a common understanding of resilient systems, within and between critical infrastructure sectors.

THE RESILIENCE SHIFT

[www.lrfoundation.org.uk/en/learning-from-crisis](http://www.lrfoundation.org.uk/en/learning-from-crisis)



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