

5 principles for infrastructure planning



Identify disaster risks



Apply robust methodologies
for CBA

Coordinate, centralise
and make available critical
data and information



Strengthen approval processes



Embed ongoing
monitoring resilience

5. Practical guidance for decision-makers

Key points

- Moving towards a system in which resilience is integrated in the decision-making process for new infrastructure will be a long-term process and will require commitment from both industry and government
- A key opportunity to improve resilience is at the strategic planning phase of new infrastructure projects, including the CBA process used to assess the cost-effectiveness of options

To support this shift, this report recommends adopting:

- **Practical guidance** for practitioners to integrate resilience into the CBA process for proposed infrastructure
- **A set of five principles** to help decision-makers systematically include disaster resilience in infrastructure planning approval processes. These are :
 1. Identify disaster risks
 2. Apply robust methodologies for CBA
 3. Coordinate, centralise and make available critical data and information
 4. Strengthen approval processes
 5. Embed ongoing monitoring of resilience.

Australian governments and businesses underinvest in resilience for new and replacement infrastructure. The case studies in chapter three showed that inconsistent approaches to considering resilience (including consideration at the discretion of private businesses or only in line with minimum building codes or land planning requirements) can have major economic and social implications when natural disasters occur. Along with the high-level analysis in chapter four, the case studies suggest that investment decisions would often change if disaster resilience were considered during the planning process.

A key opportunity to improve resilience is at the beginning of new infrastructure projects, specifically the CBA process used to assess options. While resilience should be part of infrastructure CBA (alongside other community costs and benefits), the inclusion of natural disaster risks and options for resilience appears to be lacking or incomplete in most cases. There are various reasons why.

This report has revealed systematic limitations that impede decision-makers from assessing options for greater resilience, in terms of their capacity and incentives. The limitations include:

- Limited references, if any, to disaster resilience in existing guidelines for CBA of planned infrastructure. Also, there is no guidance on 'how' natural disaster risks can be appropriately considered in a CBA framework
- Significant data requirements for assessing disaster risks, and options for resilience, with the expertise required for such analysis often dispersed across multiple agencies
- Limited references to resilience in tertiary education beyond its inclusion in building codes and regulations. This potentially limits technical capacity to identify disaster risks and propose innovative options for resilience
- Complex cross-jurisdictional mechanisms for approving projects, funding and owning of infrastructure
- Government appraisal mechanisms providing no requirements for project proposals to assess disaster risks or take action to mitigate these through evaluating resilience options.

5. Practical guidance for decision-makers

Moving towards a system in which resilience is considered up-front in the project proposal and decision-making processes for major infrastructure investments will be a long-term process and will require commitment from both industry and government. As illustrated in Figure 5.1, it will require effective coordination of data, research and decision-making processes between a broad range of end-users with a wide range of roles, responsibilities and objectives.

To support this shift, this report recommends the adoption of:

- **Practical guidance** for practitioners to demonstrate how resilience can be integrated into the CBA process for proposed infrastructure
- **A set of five principles** to help decision-makers (at all levels of government and in industry) to comprehensively integrate disaster resilience in the infrastructure planning, appraisal and approval processes.

Box 11: An appetite for change?

This report reinforces growing recognition of Australia's critical need to safeguard infrastructure.

In May 2015, Infrastructure Australia released the first *Australian Infrastructure Audit* report. It found that maintenance and resilience were major themes, and that 'Enhancing the resilience of assets will become more important for infrastructure providers as extreme weather events become increasingly likely to threaten certain assets'. The report found that:

- The number and intensity of extreme weather events are increasingly likely to threaten critical infrastructure. Repairing these assets, and enhancing their resilience, will require an increase in maintenance expenditure
- Infrastructure operations can be disrupted by a range of hazards, including natural disasters. It is critical to ensure infrastructure can continue operating through minor disruptions, and recover quickly from major disruptions.

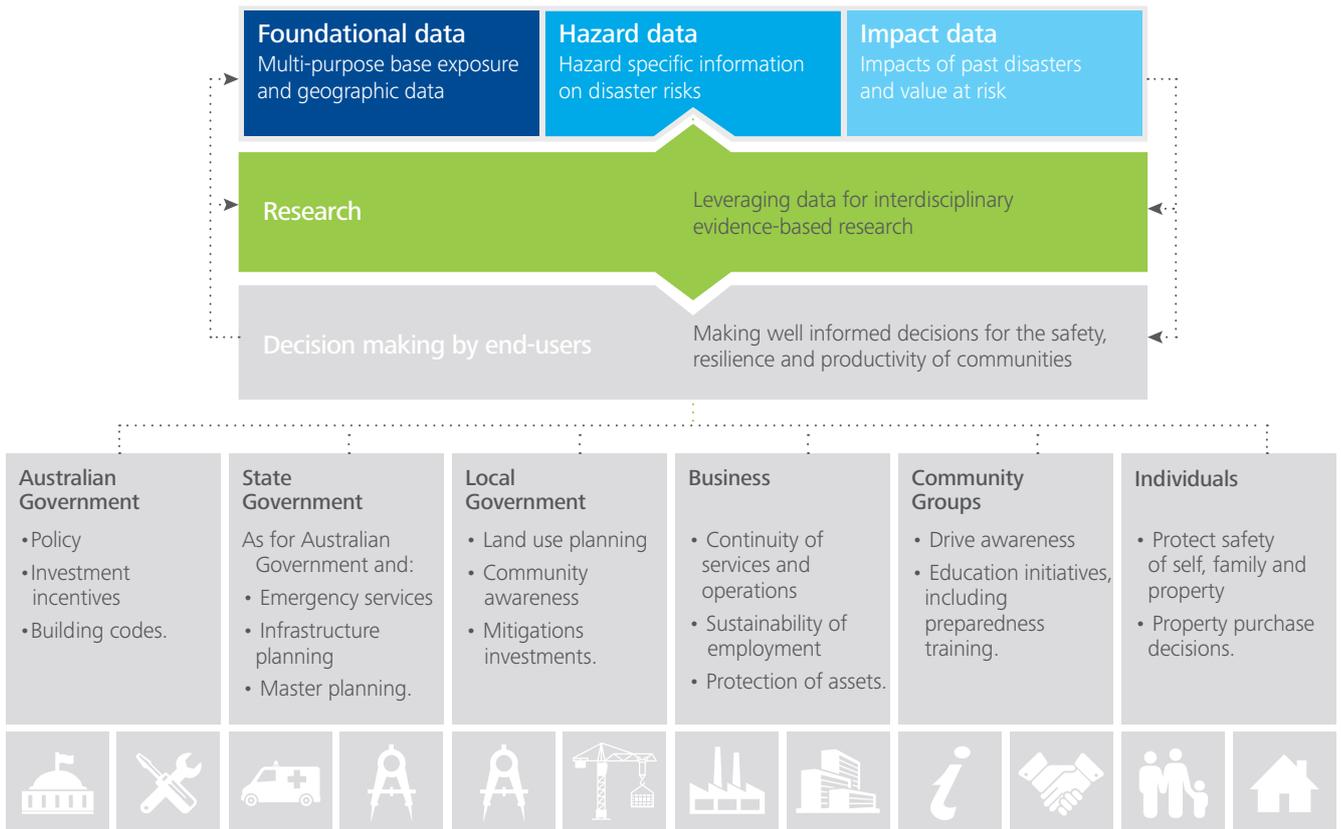
Further, it argued that all parts of the infrastructure sector require some level of reform.



Panoramic view of damage caused by the Black Saturday bushfires in Buxton, near the Acheron River Bridge, six months after the fires, Victoria. (Mike Keating / Newspix)

5. Practical guidance for decision-makers

Figure 5.1: Inputs for decision-making on infrastructure investments



Source: Australian Business Roundtable for Disaster Resilience & Safer Communities (2014)

5.1 Guidance for practitioners

This section outlines the steps required to integrate resilience into a CBA assessment process. These steps are designed to be integrated with existing guidelines and CBA methodologies issued by the various jurisdictions governing infrastructure investment decisions, such as Infrastructure Australia's *Reform and Investment Framework – Templates for Use by Proponents* and similar frameworks or manuals released by state governments (see Table 2.2). The steps reveal how disaster risks and options to improve resilience can be assessed for proposed infrastructure.

5.1.1 Integrating resilience into CBAs for proposed infrastructure

Proposed infrastructure is usually well scoped before a detailed CBA is undertaken. The objectives and requirements for the infrastructure – in terms of type, location, function, timing and main benefits – are described and construction costs are roughly estimated. The CBA process is then used to conduct a detailed appraisal of project options that can best meet these requirements.

Acknowledging disaster resilience does not significantly change the CBA process that is applied to an infrastructure project. The overall approach to CBA remains the same, comparing one or more project options to a base case option, which is often defined as 'business-as-usual'.

5. Practical guidance for decision-makers

Disaster resilience can be included in CBA as an additional benefit. This benefit is estimated for each project option in the CBA and then aggregated with other benefits and compared with costs. To add resilience benefits, natural disaster hazards need to be identified, and the potential savings (in terms of direct and indirect avoided disaster costs) need to be identified for each option.

A simple CBA process is defined in Table 5.1. Three additional steps for practitioners to integrate disaster resilience into CBAs have been highlighted.

Table 5.1: Adapting infrastructure CBA processes

Steps	Description
1. Profile infrastructure requirements	Predetermined objectives and scope of the proposed infrastructure project (e.g. function, location, estimated budget and timing)
2. Specify a base case	Usually a business-as-usual option
3. Assess disaster hazards	Determine the potential disaster hazards and their probability of occurrence
4. Identify project options	Develop a series of options for infrastructure
4a. Identify resilient project options	Include options for infrastructure with greater resilience to natural disasters
5. Estimate the costs and benefits of each option	Estimate the costs and benefits of each project in present value terms
5a. Estimate resilience benefits	Include 'avoided disaster costs' as a measure of resilience benefits
6. Identify preferred option	Compare costs and benefits to identify a preferred option

5.1.1.1 Assess disaster hazards

Hazard assessment requires information about the nature and likelihood of major hazards with the potential to affect proposed infrastructure. Some key examples in Australia include:

- Tropical cyclones
- Floods
- Severe storms
- Bushfires
- Earthquakes
- Tsunamis
- Sea level rise.

Hazard assessment should identify all characteristics that may influence the physical infrastructure and the service it provides, including the timing, frequency, duration and intensity of hazard events. For CBA, this information should be used to determine a probability weighting for a hazard event based on the likelihood of the event exceeding a certain intensity in a given year. Characterising hazards in this way is typically data-intensive.

For example, bushfire hazards can be influenced by weather conditions (such as wind, temperature and humidity), prevalence of drought and fuel load (such as vegetation density and type) and landscape topography, among other factors. Bushfire hazard assessment therefore relies on complex geospatial modelling to establish the probability of an event occurring at a certain intensity.

Appendix F provides further details on best practices for hazard assessment.

5. Practical guidance for decision-makers

5.1.1.2 Identify resilient project options

Where disaster hazards are identified, practitioners should scope potential options to strengthen resilience. These may include options to reduce the costs associated with disasters by:

- **Reducing the infrastructure’s exposure to disaster hazards:** For example, relocating infrastructure away from areas susceptible to hazards, such as roads in areas less prone to flooding
- **Reducing the infrastructure’s vulnerability to disaster hazards:** For example, changing infrastructure design or materials to reduce the severity of impacts, such as shifting transmission lines underground in areas prone to bushfires
- **Reduce the impact of disaster hazards on infrastructure:** For example, introducing early warning, evacuation and/or contingency systems for emergency responses during service losses, such as informing customers of expected network outages.

During this step, a range of resilience options may be qualitatively scoped with viable options then specified for detailed CBA.

5.1.1.3 Estimate resilience benefits

For each project option, a potentially large set of costs and benefits should be quantified. In addition to these, the resilience benefits of each option should be estimated. The total resilience benefits of each project option can be estimated in terms of the total avoided disaster costs. That is:

$$\text{Resilience benefit} = \text{Avoided disaster cost} = \text{Base case disaster cost} - \text{Project option disaster cost}$$

Disaster costs include both the direct impacts of infrastructure damage (replacement costs) and the indirect impacts of infrastructure damage (including the economic cost of social impacts associated with service outage). These are likely to vary in the base case and for each infrastructure option. A summary of potential benefits is included in Table 5.2, with further detail for each component described in Appendix G.

As disaster costs only arise when a natural disaster occurs, resilience benefits depend on the probability of a disaster occurring. As such, estimated disaster costs are multiplied by the probability weighting of each hazard to estimate an annual average cost. These costs are then discounted (as per other costs and benefits) to estimate resilience benefits in present value terms.

For disasters expected to occur very infrequently, such as a one-in-100-year flood, the estimated resilience benefits will be smaller when averaged on a per-year basis. Reliable hazard assessment is therefore essential to ensure resilience benefits are not overstated.

For infrastructure project appraisal, disaster costs that are common between project options need not be estimated as they have no bearing on which is the most beneficial. That is, the broad costs associated with natural disasters (such as loss of property, loss of livestock and death) need not be estimated unless they are a direct consequence of infrastructure damage.¹¹

A detailed approach to monetising resilience benefits is in Appendix G, including an example of how this could be incorporated into Infrastructure Australia’s Template for Stage 7 (Transport Infrastructure).

Table 5.2: Disaster cost components

	Avoided disaster costs
Direct impacts	• Avoided infrastructure damage
Indirect impacts	• Avoided household costs • Avoided commercial costs • Avoided emergency response costs • Avoided social costs (such as inconvenience and stress)

Source: Deloitte Access Economics (2016)

11. For cases where overall natural disaster impacts are relevant, such as in comparing policy options for disaster resilience, a detailed methodology for CBA is included in *Building our Nation’s Resilience to Natural Disasters*.

5. Practical guidance for decision-makers

5.2 Principles for infrastructure planning

In addition to practical steps for measuring resilience, broader institutional change is needed to embed resilience into infrastructure planning and investment decisions. The following five principles have been developed to facilitate this change. In light of the high cost of natural disasters to the economy, proactively integrating resilience by adopting these principles can reduce costs as well as the broader socioeconomic impacts of natural disasters.

Infrastructure Australia has observed that while the main focus is still on economic considerations, there is an emerging trend where project proposals are placing focus on resilience issues too. This needs to be encouraged and supported by adopting the principles outlined here.

The principles can be applied across the breadth of jurisdictions involved in planning and appraising new infrastructure, as well as the private sector. The capacity to embed resilience can vary substantially between agencies however, potentially limiting their ability to maximise public net benefits. Each agency must review how the principles can be applied to their existing systems, as well as the roles they can play in contributing to greater cross-jurisdictional consistency.

The principles aim to change the way new infrastructure is planned and approved by businesses and governments by establishing appropriate frameworks, incentives and capabilities to include resilience in decision-making.

Figure 5.2: Principles for resilience in infrastructure planning



5. Practical guidance for decision-makers

Principle 1: Identify disaster risks

A risk assessment process can help to determine at the outset if proposed infrastructure has any exposure to natural disaster risks, including bushfires, floods, storm surges, cyclones and earthquakes.

Government and business decision-makers should integrate a risk assessment requirement into infrastructure project proposals to ensure disaster exposure, asset vulnerabilities and, in turn, opportunities for hazard prevention or mitigation are identified.

More broadly, they should prioritise risk assessment in long-term strategic planning for infrastructure, particularly given the interdependency between assets and the need for a holistic perspective.

Assessing disaster risks involves identifying the likelihood of all hazards with the potential to affect infrastructure, the economy, people and/or the environment. The risk assessment should identify vulnerabilities that would make the proposed infrastructure more susceptible to damage from a disaster. Further, risk assessments should consider both direct impacts on infrastructure and indirect impacts such as delays, business interruption, financial losses, loss of customers and social impacts such as stress.

Principle 2: Apply robust methodologies for CBAs

Decision-makers need a robust and consistent methodology to analyse disaster risks and ensure infrastructure projects with the greatest community benefits are delivered.

Most jurisdictions use CBA to identify net benefits to the broader community, alongside other planning tools. However, resilience is treated inconsistently and, in most cases, inadequately within these CBAs.

CBA frameworks and guidelines should be updated to include resilience, following a common methodology. This will facilitate best practice approaches across all types of major infrastructure investments, regardless of their ownership.

Deloitte Access Economics has reviewed the information, data and analysis and developed a practical approach for practitioners to measure resilience (see section 5.1).

Principle 3: Coordinate, centralise and make available critical data and information

Assessing disaster risks and options for resilient infrastructure is a data-intensive process. Practitioners evaluating resilience require accessible and relevant data to undertake analysis and make optimal investment decisions. This includes:

- **Foundational data** on demographics, topography and weather
- **Hazard data** on disaster types and their likelihood to occur
- **Impact data** on potential and historical impacts.

As revealed in *Building an Open Platform for Natural Disaster Resilience Decisions*, the data currently available is dispersed between local, state and federal agencies and the private sector.

A number of proposals have recently emerged that look to improve the availability of data to simplify decision-making. The National Open Platform for Natural Disaster Information proposed by the Roundtable and supported by the Productivity Commission (2014) can support data sharing between agencies and practitioners, as well as ensure relevant information is available to end-users. Also, in December 2015, the Australian Government released a *Public Data Policy Statement*, committing to make non-sensitive data collected by government 'open by default'. The Public Sector Data Management Project acknowledges that 'By making the most of its data, the Commonwealth could grow the digital economy and improve people's lives by transforming how policies and services are delivered'.

It is likely that a number of stakeholders will remain responsible for governing data collection and managing accessibility. For example, while commercial interests should be protected to encourage continued broadening of data collection, agencies should consider options for greater collaboration, transparency and accessibility.

5. Practical guidance for decision-makers

Principle 4: Strengthen approval processes

Without incorporating a mandatory checkpoint to assess disaster risk and evaluate resilience options incentives to prioritise resilience are likely to remain inadequate. In particular, practitioners may not fully scope resilience options or undertake the extra steps to assess resilience costs and benefits in economic terms. Policy change or introduction of funding mechanisms could ensure the positive externalities associated with resilience are considered and, where appropriate, pursued, even though the benefits might accrue to other stakeholders.

Decision-makers should consider implementing mechanisms to ensure resilience is considered in economic assessment and project prioritisation processes. At a minimum, funding applications should disclose the identified disaster risks and how they influence proposed infrastructure. Where high-risk hazards are identified, jurisdictions should include further checkpoints in their appraisal processes. These can serve to ensure mitigation options are identified and the benefits of resilience (in terms of avoided disaster costs) are quantified in the economic assessment processes (including CBA).

Principle 5: Embed ongoing monitoring of resilience

The vulnerability of infrastructure to natural disasters is expected to change as it ages and through climate variability and population demographics. Further, changes in knowledge, information or data availability may influence our understanding of the nature of hazards or the susceptibility of infrastructure.

For these reasons, decision-makers should make provisions to regularly monitor infrastructure resilience, alongside planned maintenance. Responsibility for monitoring resilience should be clearly delegated when a project is approved.

People trapped on the Carpendale side of Lockyer Creek survey damage to the bridge after floodwaters from Toowoomba in Queensland caused flash flooding between Helidon and Grantham, after heavy rains caused widespread flooding across the region. (Aaron Francis / Newspix)



A chinook helicopter with supplies flies over houses affected by flood waters on January 6, 2011 in Rockhampton, Australia. Floodwaters peaked at 9.2 metres in the central Queensland city, preventing residents from returning to their homes. The Queensland flood crisis resulted in ten deaths and affected more than 200,000 people across an area as large as France and Germany combined. (Jonathan Wood / Getty Images)

