Integrated Regional Vulnerability Assessment:

Metropolitan Sydney

Volume 1: Regional vulnerabilities

Towards a Resilient Sydney

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Published by:
Office of Environment and Heritage
59–61 Goulburn Street, Sydney
PO Box A290, Sydney South NSW 1232

Phone: +61 2 9995 5000 (switchboard)
Phone: 131 555 (environment information and publications requests)
Fax: +61 2 9995 5999
TTY users: phone 133 677, then ask for 131 555
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Preface

A key target of the NSW Government's ten year plan, *NSW 2021,* is to *minimise impacts of climate change in local communities*. Climate affects multiple systems and so risks from climate change require a systemic, coordinated response. This requires the input, agreement and collaboration of multiple stakeholders, across scales and across administrative responsibilities.

An Integrated Regional Vulnerability Assessment (IRVA) is a process developed by OEH to engage regional stakeholders, gain a holistic view and plan collaborative responses to the emerging risks from a changing climate. It produces a qualitative assessment of the influence of climate impacts on services and infrastructure for which state and local governments have a primary responsibility – such as public health, land-use planning, infrastructure and emergency services – and identifies factors that affect the vulnerability of those services. Using a participatory learning approach, an IRVA helps to develop relationships and networks within sectors and creates a sound knowledge and skill base from which regional managers and decision-makers can adapt government services, aware that action by one sector may have adverse consequences in another.

The Metropolitan Sydney IRVA report is a key output of the *Towards a Resilient Sydney* project, established to meet the actions in the *NSW 2021 Regional Action Plans* for Northern Beaches, Western Sydney – Blue Mountains, and South Western Sydney:

- develop improved information of climate risks for Sydney – see Metropolitan Sydney Climate change snapshot
- assess cross sectoral vulnerability to these risks, and
- identify responses and opportunities that assist local communities to improve resilience and minimise impacts.

This report outlines the outcomes of the IRVA process completed in the Metropolitan Sydney region of NSW in 2014. It describes the key areas of vulnerability to climate change identified by state and local government participants across an area of approximately 10,000 square kilometres, encompassing 41 local government areas and a population projected to grow to six million people by 2031. Detailed information on projected climate and socioeconomic changes for Sydney can be accessed from the *Towards a Resilient Sydney* webpage.

A global city, Sydney is a complex urban system that requires evidence-based responses that seek to emulate best practice adaptation. Developing a strong evidence base from local participants, identifying vulnerabilities, constraints, and prioritising climate change actions are vital steps towards minimising the impacts of climate change on Sydney's communities.

1 The IRVA process

The Integrated Regional Vulnerability Assessment (IRVA) of government service provision in the Metropolitan Sydney region draws on the Intergovernmental Panel on Climate Change definition of 'climate change vulnerability':

> *the degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes.*

'Vulnerability' is viewed as the state of susceptibility to harm from *exposure* and *sensitivity* to stresses associated with environmental and social change, and from the *absence of capacity to adapt* (see Figure 1). 'Adaptation' can result in outcomes that minimise this vulnerability, ranging from resilience (change to maintain existing system structure and function) to transition (incremental change through reform to existing governance arrangements) and transformation (fundamental change to the existing system).

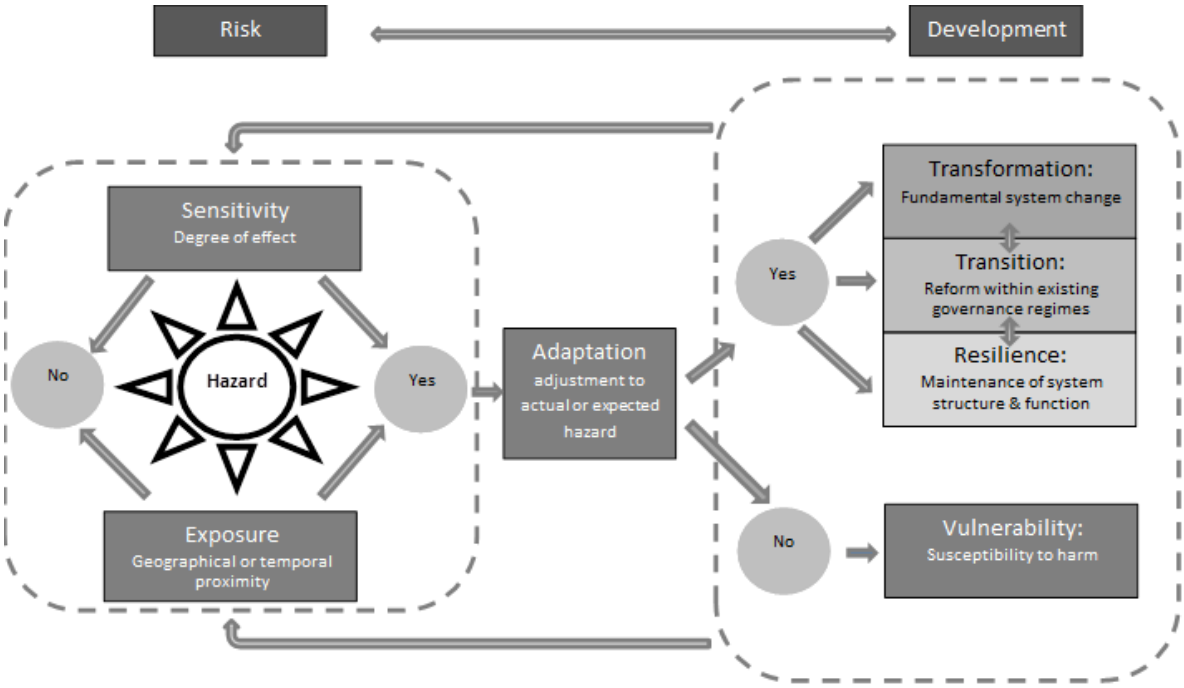

Figure 1: Vulnerability as conceptualised in the *Towards a Resilient Sydney* project, adapted from Pelling 2011[1]

Adaptive capacity is the ability to manage exposure and/or sensitivity to climate, which includes having and being able to deploy resources effectively in the pursuit of adaptation. Therefore adaptive capacity can provide a context to reduce and diminish vulnerability.

This report assesses the regional vulnerability and adaptive capacity of government operations and services in Metropolitan Sydney, a map of which is shown in Figure 2. The information in this report was collected at six workshops involving over 270 local government and state government participants operating across the region. A description of the sector workshops is provided in Table 1.

[1] Pelling, M 2011, *Adaptation to climate change: from resilience to transformation*, Routledge, London, UK.

Figure 2: Map of Metropolitan Sydney region showing local government areas

At the sector workshops, participants were presented with regional climate change and socioeconomic information to identify and discuss likely impacts on their sector and 'flow-on' consequences for other sectors. Participants were then asked to vote using electronic polling technology on a set of indicators, which either support or constrain the capacity of their communities and organisations to adapt to the impacts of climate change and variability. The indicators were grouped under the five capitals framework (i.e. human, social, natural, physical and financial) and the priority and importance of the indicators was recorded and presented in real time to the participants, which prompted collective consideration of the issues.

Participants were then divided into small working groups to discuss in detail the meaning of each indicator, potential constraints to adaptation, where and how such constraints may be overcome, and who should be involved in actions to build adaptive capacity. The full

discussion is recorded in *Integrated Regional Vulnerability Assessment: Metropolitan Sydney, Volume 2: Priority Sector Workshops – Summary Findings*.

Table 1: Sector workshops for Metropolitan Sydney IRVA

Sector workshop	Local government	State government
Human services	Community development and community services (child care, youth and senior services)	Education, health, senior, youth and child services, aged care, disability services, community services, health and education asset management and planning
Economy and industry	Economic development, tourism, risk and finance managers	Trade and Investment, Primary Industries, Tourism NSW, Sydney Ports, Small Business Commissioner, Renewable Energy Commissioner
Natural and cultural assets	Cultural Development and Heritage Officers, Environment Managers, Biodiversity Officers, Catchment Managers	Natural resource management, biodiversity, conservation, Aboriginal and historic heritage Officers
Emergency management	Emergency Management Officers	Emergency management services (fire, flood, heat, bushfire), infrastructure and utilities, public health/ disaster management
Built environment and infrastructure	Regional, subregional and local strategic planning, Infrastructure/ Asset Managers (traffic, stormwater, waste, etc.), Transport Planners	State significant and local development, urban renewal and greenfield development, neighbourhood and building design, peri-urban area, etc. Transport (rail, road, freight, port, ferry, buses), water (stormwater, sewer, water), energy, telecommunications, community infrastructure,

The results of the voting across the five sector workshops were aggregated to reveal a consistent set of indicators that affect the vulnerability of government services in the Metropolitan Sydney region. The aggregated results are shown in Table 2.

Table 2: Aggregated results of the Adaptive Capacity Indicator voting rounds across the five sector workshops

	Human services	Economy & industry	Natural & cultural assets	Emergency Management	Built environment & infrastructure
Human	**Risk Perception**	**Risk Perception**	**Risk Perception**	**Risk Perception**	**Risk Perception**
	Skills & knowledge	**Skills & knowledge**	**Skills & knowledge**	**Skills & knowledge**	**Skills & knowledge**
	Training	Innovation	Training	Training	Innovation
	Health	Workforce		Population change	Population change
Social	**Planning/engagement & consultation**	**Planning/engagement & consultation**	**Planning/engagement & consultation**	**Planning/engagement & consultation**	**Planning/engagement & consultation**
	Networks	**Resource sharing/ cooperation**	**Resource sharing/ cooperation**	**Resource sharing/ cooperation**	**Resource sharing/ cooperation**
	Legislation / policy	Legislation / policy	Legislation / policy	Legislation / policy	Community cohesion
			Social cohesion		Social values
Natural	**Water security / quality**	**Water security / quality**		**Water supply / quality**	**Water supply / quality**
	Food supply / security	**Food supply / security**	**Food supply / security**		**Food supply / security**
	Green space / urban heat islands	**Green space / reserves**	**Urban green space**		**Green space / reserves**
	Multiple events	Waste management	Connection to Country	Multiple events	Multiple events
				Flooding & inundation	
				Water catchments	
Physical	**Housing (homes)**	**Housing**	**Residential development**	**Residential development**	**Residential development**
	Energy	Energy	Energy	Roads & transport	Energy
	Infrastructure	Transport	Infrastructure	Telecommunications / IT	Roads & transport
	Services – health, education	Services – health, education			Water & sewage
		Telecommunications / IT			Plans
Financial	**Changing/competing priorities**	**Funding & budget priorities**	**Funding priorities & models**	**Funding priorities & models**	**Funding priorities & models**
	Sources of funding & models	**Sources of funding & models**	**Sources of funding**		
		Incentives/disincentives	Incentives	Incentives	Incentives
	Moral hazard	investment	Investment	Moral hazard	Investment
				Insurance	Moral hazard

Using a method known as thematic analysis, the records and data from the workshop activities were examined and scrutinised by the research team to understand the key themes and identify vulnerabilities of government services to climate change in Sydney. These vulnerabilities were then presented to an integration workshop, where participants from each sector came together to validate and prioritise the vulnerabilities and discuss actions that can be used to address them can contribute to regional adaptation. This was achieved through various engagement methods including World Café discussions, scenario options analysis, further interactive polling and the collaborative design of potential resilience projects. This report explains the components of these vulnerabilities, as told to us by the state and local government managers in this process.

Understanding vulnerability in the Sydney region is a critical step towards the development of effective adaptation strategies and programs. The regional vulnerabilities identified during the process highlight the ways in which the Sydney region is exposed and sensitive to climate change through its physical infrastructure, economy, natural and cultural assets and community knowledge, health and safety.

The vulnerability assessment process also explores the limits and behaviours of human systems, which inform the region's adaptive capacity, and how these systems interact dynamically with their physical context. Some areas of vulnerability are clearly driven by climate change impacts, whereas others are due to existing pressures or trends that are likely to inhibit adaptation in the future. In the latter instance, climate change creates a feedback loop whereby these trends increase or the pressure amplifies climate related vulnerability. If the root causes of vulnerability are understood and addressed, potential social, economic and environmental losses can be managed and minimised.

The following analysis is drawn from workshop participants' facilitated discussions and deliberations of the impacts and adaptive capacity issues of their region. Importantly the workshops also served to develop a shared understanding of the sources of regional vulnerability, constraints and opportunities for responding, and informed the identification of collective adaptation actions. A complete list of options to address the impacts and vulnerabilities in Sydney provided by the participants is included in Appendix A of this volume.

The six key vulnerabilities to the provision of government services that will be amplified by future changes to climate, were identified and ranked by the participants as:

- limited perception of climate risks
- insufficient consideration of climate change in planning processes
- an inability to direct funding to adaptation
- pressure from population growth on human settlements
- pressure on natural resource supply and security, and
- inadequate skills and knowledge to understand and respond to climate impacts.

2 Risk perception

Source of vulnerability

The limited ability to perceive and personalise climate change risk was identified as a key source of vulnerability within Metropolitan Sydney. Concerns about risk perception focused on:

- the availability and accessibility of information for learning about climate change risks, and
- the ability of individuals within the community, the business sector and government to personalise these risks, in order to adapt.

The time lag between spatial risk identification, and associated impacts, and the broad dissemination of this information limits understanding and interpretation of climate change hazards. This also results in a failure to recognise the potential consequences of inaction.

Societal disengagement with climate change issues leads to a lack of urgency about the effects of climate impacts on communities and within some service sectors of government. This is related to the challenges of connecting past experience of climate extremes with the need for change and adaptation planning. A reported reluctance in the business community to accept information about climate change from government, and a general lack of awareness of the importance of emergency management actions (in particular, the Prevent–Prepare–Respond–Recover cycle), has resulted in a lack of business resilience and continuity during emergency events.

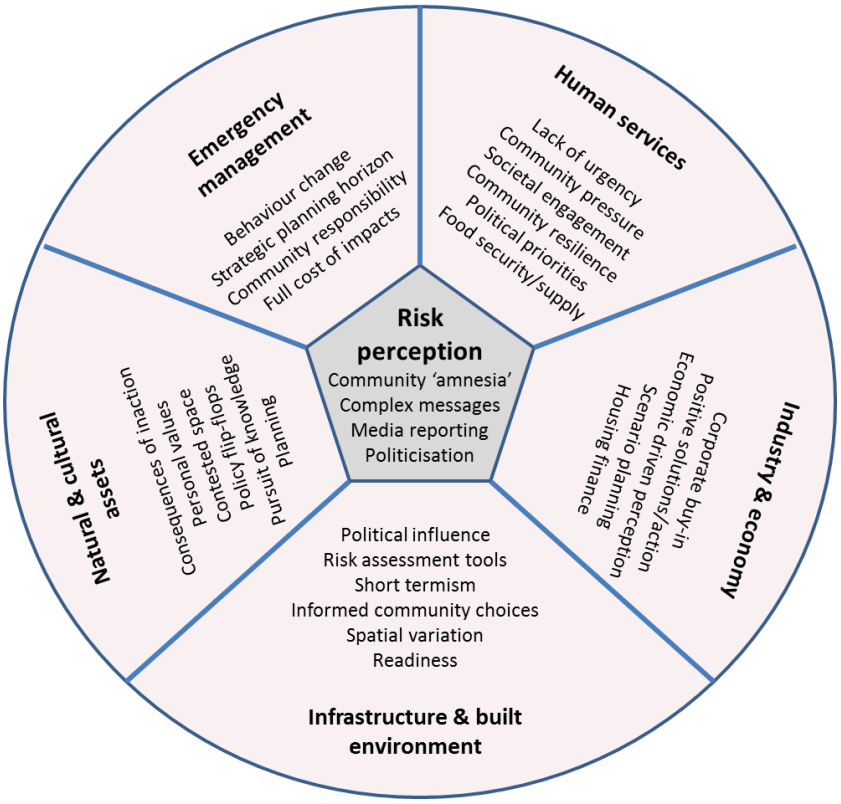

Figure 3: Factors associated with an increase in the vulnerability of government service delivery as a result of risk perception in Sydney, and sectoral-based perceptions of the issue

The inability of individuals to personalise risk was attributed to a focus on the short-term, cultural and socioeconomic variations in acceptance of risk among the Sydney population, poor comprehension of risk assessment terminology in public documents, and de-personalised and sensationalized reporting of extreme events by the media. For example, coastal communities of Sydney often perceive risk as affecting others, such as communities in the Pacific Islands that are forced to relocate due to sea level rise, but fail to notice impacts of climate change within the coastal areas of Sydney. Participants noted that because Western Sydney communities living in the Hawkesbury–Nepean floodplain have not experienced a major flood for many years, many do not perceive the significant flooding risks they face, especially in light of continued housing developments in flood zones.

It was also conveyed that communities have not understood or accepted that their behaviours contribute to climate change, or that their personal choices strongly influence their level of vulnerability to climate hazards. In addition, the scientific focus on global and national projections of climate change renders risk information inaccessible to people, makes local action on adaptation seem irrelevant, and limits the ability of the community to personalise climate change.

Constraints and opportunities

The perception of the risks posed by climate change does not always translate directly into risk management behaviour and adaptation due to a number of constraints. Four key constraints around risk perception are:

1. *Education: A* failure to empower the community to manage risks or to educate business owners using language they understand is constraining adaptation in Sydney. In particular, local government has not applied risk information from climate change risk assessments to educating senior managers and councillors about risks to local residents and critical infrastructure. Experiential case studies/stories that provide social, local and personal dimensions to community risk would help address this vulnerability.
2. *Communication:* The current focus on communicating risk and threats, rather than the opportunities of climate change adaptation, and accessing information that is balanced and credible (especially from the media) constrains communication of risk to communities and vulnerable sectors. Improving transparency in government communication, particularly in relation to flood risk in the Sydney Basin, and fostering a consistent use of risk terminology were perceived to support adaptation action. The use of trusted communication sources, for example organisations such as the Insurance Council of Australia, and the Red Cross and ensuring communication campaigns present consistent, clear messages and incorporate a range of adaptation responses could further improve the ability of the government to address this vulnerability.
3. *Involvement of business and industry:* The reported unwillingness of business owners to learn about and invest in improving their businesses by understanding the risks of climate change, and a failure of industry bodies to inform and distribute industry-specific information to promote climate adaptation, are constraints on the capacity of government to adapt service provision. Targeted engagement and an appropriate regulatory environment were identified as opportunities to assist business and industry better understand and respond to climate risks.
4. *Leadership:* All sector participants felt that leadership on climate change is lacking at all levels of government, and wanted government adaptation policies and programs to be evidence-based rather than shaped by public polling of climate change issues.


RISK
ACTION
NEED
RISKS
COMMUNITY
PERCEPTION
CHANGE
CLIMATE
PEOPLE
MANAGEMENT
MEDIA
POLITICAL
INDUSTRY
BUSINESS
INFORMATION
GOVERNMENT
COMMUNITY
PLANNING
ACTIONS
IMPACTS
RESPONSIBILITY
EDUCATION
LEVEL
TERM
LACK
NEEDED
POLICY
GOV'T
BUSINESS
STATE
BASED
COMMUNICATIONS
UNDERSTANDING
ENABLERS
CLEAR
RELIANCE
HAZARD
BUSINESSES
SYDNEY
PERSONAL
EDUCATE
BETTER
EXPERIENCE
HUMAN
WITHIN
SHORT
SEE
INFLUENCE
EDUCATION
SOCIAL
EVIDENCE
NEEDS
CONSTRAINTS
LIABILITY
MAKE
AGENCIES
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CCA
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TOOLS
SERVICES
CLIMATE
SECTOR
UNDERSTOOD
ISSUES
COMMUNITIES
LOCAL
REDUCE
EMERGENCY
COMMUNICATION
SHOW
FUTURE
FLOOD
RELATED
INDICATORS
KNOWLEDGE
WILL
LONG
CASE
HIGH
UNDERSTAND
EVENTS
LEADERSHIP
CHANGE
INVESTMENT
GREEN
COMBAT
TAKE
VALUES
LEADING

3 Planning – engagement and consultation

Source of vulnerability

Planning is a key lever for government to manage and increase Sydney's resilience and long-term liveability. The vulnerability identified within planning, in particular engagement and consultation processes, is closely linked to risk perception and human settlement vulnerabilities.

The participants noted that a wide range of planning can support climate change adaptation, including: land use, strategic, demographic profiling and population planning, place-making, service delivery planning and corporate/business planning.

It was felt that urban planning for Sydney's demographic changes and population growth has to date failed to incorporate comprehensive climate risk and hazard information, inhibiting the development of cohesive and resilient communities across the full spectrum of government services. This is partly attributable to the hazard information available, but also to the challenges of strategic planning across tiers of government and agency administrative functions. An historical lack of commitment and resourcing to bring the community into planning decisions has also played a part in this vulnerability.

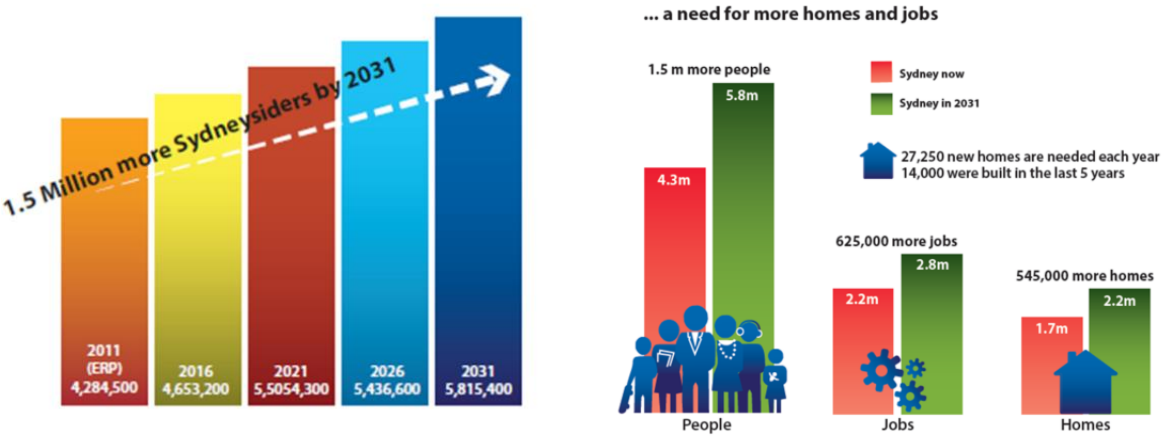


Figure 4: Projections presented to workshop participants by the NSW Department of Planning and Environment outlining the need for new homes and jobs to cope with Sydney's growing population

The reported absence of inclusive and transparent dialogue around planning for climate change at all scales, has led to unrealistic expectations of planning processes, a lack of ownership of planning outcomes and an inability to effectively implement management actions.

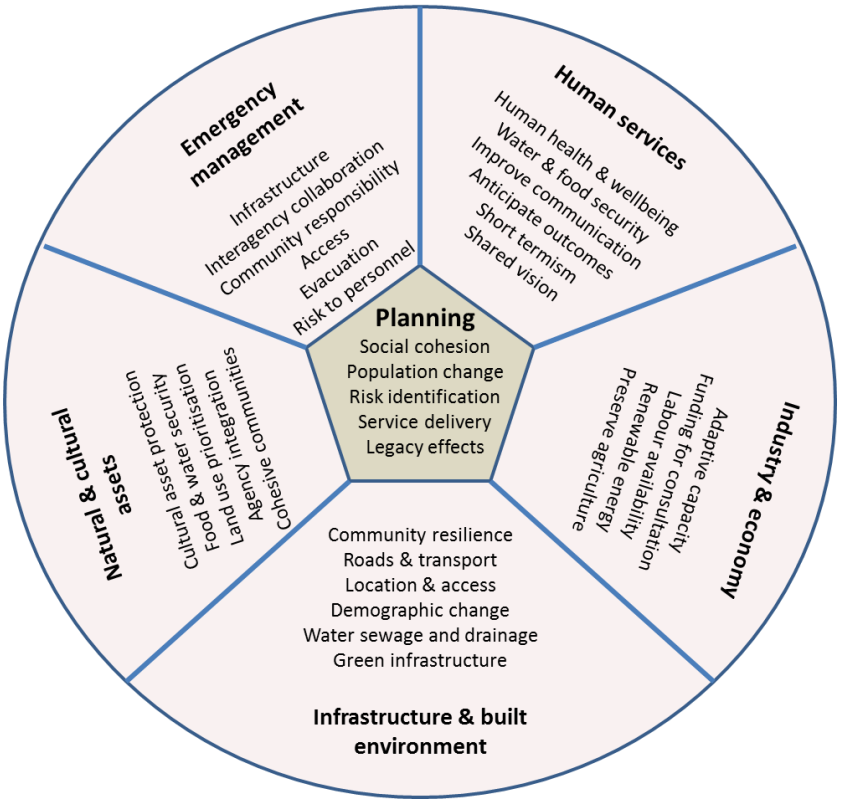


Figure 5: Factors associated with an increase in the vulnerability of government service delivery as a result of planning in Sydney, and sectoral-based perceptions of the issue

Constraints and opportunities

Factors affecting the capacity to adapt planning, consultation and engagement processes to incorporate climate change in the Metropolitan Sydney region fall into three categories:

1. *Resourcing*: Inadequate financial resources and a lack of professionally skilled personnel with experience in community engagement and consultation constrain government planning processes. To be effective, community engagement requires long lead times to plan, recruit participants, collate multiple perspectives and incorporate information into decision-making. Although time-consuming, a commitment to adequately resource consultation processes will be more productive than the decide–announce–defend approach often employed by government, but viewed unfavourably by the community.
2. *Political willingness*: An apprehension that community engagement may lead to politically unfavourable outcomes results in limited engagement processes which may also lead to over-consideration of the views of the 'squeaky wheels' (i.e. vested interests) within the community. Decisions informed by community values rather than along 'party lines' will help build a shared vision of the future and enable government to employ engagement and planning processes that meet community expectations.
3. *Cross-scale governance and alignment*: The lack of alignment in local, regional and state planning boundaries and inconsistency in planning regulations at local and state government levels are felt to be hampering efforts to minimise vulnerabilities through planning. One example of this was when the state government reversed its policy on sea level rise, but local government maintained the benchmarks. Entrenched

practices in many local government administrations and a general lack of multi-agency and multi-tier governance are also hindering effective integrated planning that would assist climate change adaptation.

In particular, the protection of non-economic values from strategic, natural assets (such as agricultural land) and integrated planning for transport that 'looks beyond road construction' were areas of concern raised by the participants for Sydney. Participants discussed examples that illustrate the difficulties in planning for government service provision in a changing climate, such as the long lead times required to identify climate impacts on water security planning, and how potential changes to future engineering standards to account for climate impacts may affect the design life of existing infrastructure in urban areas.

4 Funding – sources, priorities, models

Source of vulnerability

The complexity of adaptation governance, competition among pressing community needs for a limited pool of resources and reactive changes to address current concerns (e.g. drought versus flooding) contribute to this funding-related vulnerability. It was felt that the division of adaptation priorities among multiple funding sources and current unfavourable political ideologies constrain all tiers of government from funding adaptation action.

Additional factors that limit the funding available to support climate change adaptation actions include the abstract, long-term and ongoing nature of adaptation programs that do not easily fit the typically short-term (three-year) funding horizons of government, the lack of innovation in models used to fund adaptation, and public distrust of government funding programs because of past lapses of transparency and commitment to outcomes.

A range of potential funding sources were suggested to support adaptation depending on the type of action needed. These included crowd-sourcing, volunteer incentive payments, community co-contributions for small grant schemes, local environment levies, and developer contributions for local adaptation, through to subsidies for industry initiatives, bonds for major public infrastructure, tax rebates and philanthropy for broader scale adaptation measures.

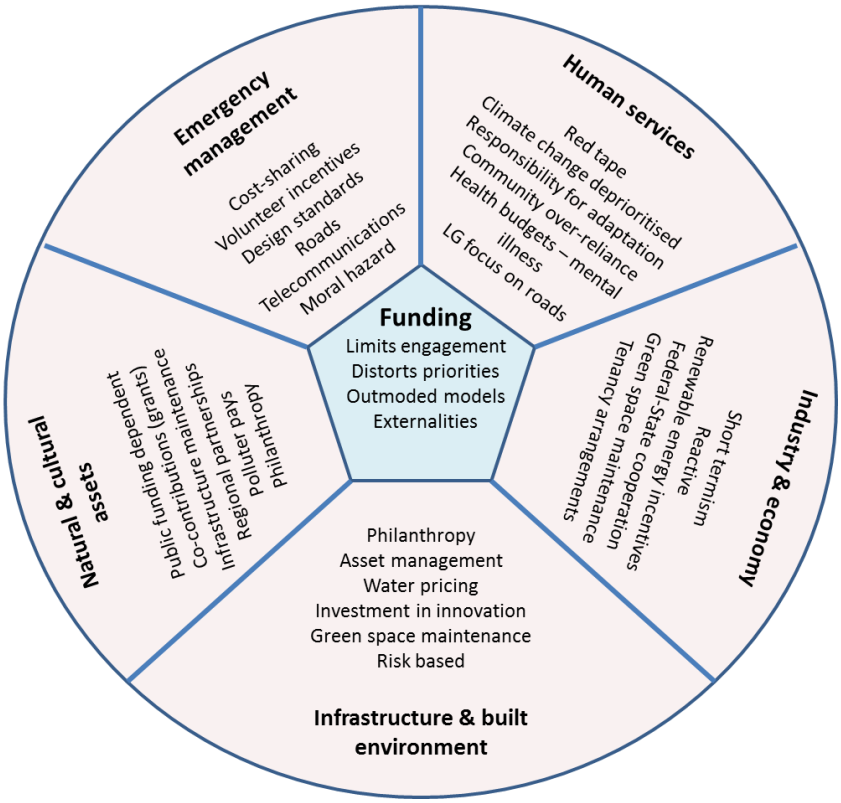


Figure 6: Factors associated with an increase in the vulnerability of government service delivery as a result of funding in Sydney, and sectoral-based perceptions of the issue

Constraints and opportunities

Factors affecting the capacity to adapt sources, priorities and models of funding to better target climate change vulnerabilities in the Metropolitan Sydney region fell into four categories:

1. *Cost adaptation measures:* While the participants viewed expenditure on adaptation as an investment in future community resilience, the perceived high upfront cost of infrastructure replacement, the politics of passing these costs onto the community (for example, where raised building standards increase housing replacement costs) and the uncertainty surrounding investment in new technologies, are currently constraining investment in adaptation. In addition, as adaptation is an iterative process, the ongoing costs associated with some adaptive responses (such as maintenance of urban green spaces) can be difficult to calculate and secure.

2. *Community input:* Lack of community input into funding processes and priorities results in a general lack of community involvement and 'buy-in' to government programs. It was further felt that industry lobbying, that promulgates climate change scepticism in pursuit of vested interests, is seen by the community as having undue influence over funding priorities.

   However, communities' limited perception of climate change risks means that actions identified by government, or even industry, as required to promote climate adaptation, may not align with community priorities. Given that the survival of many community-based organisations depends on availability of government funding, more dialogue and input about community priorities may better align funding to actions that build community adaptive capacity.

3. *Information and awareness:* Adaptation is constrained at the household scale by lack of recognition of the risks of climate change, lack of available information about how to adapt household finances for climate change and the capacity of local government to provide information or support on local adaptive measures to their communities. For businesses, a lack of awareness of funding opportunities especially among small to medium enterprises (such as federal incentive programs for solar panels and clean technology) limits adaptation.

4. *Policy:* There is a lack of clarity around which levels of government, agencies and funding streams are responsible for adaptation. This is compounded by a system of government that engenders short-term thinking due to election cycles, which creates difficulties in demonstrating return on investment from adaptation actions to funding bodies. It was also felt that government investment, and a political culture that panders to cost-of-living concerns, results in a difficult environment in which to develop effective climate adaptation policy, such as the over-reliance of the community on government assistance during extreme climatic events. The current bias towards replacement rather than betterment of vulnerable, public infrastructure assets (such as roads), is an example of a policy constraint that hampers service delivery adaptation by local government. Embedding climate change considerations across all government operations and processes and promoting risk-based approaches and cost benefit analyses could facilitate long-term and collaborative investment in adaptation.


FUNDING
PRIORITIES
FUNDING
COMMUNITY
COST
GOVERNMENT
INFRASTRUCTURE
MODELS
CHANGE
ADAPTATION
NEEDED
NEED
PLANNING
INVESTMENT
CONSTRAINTS
SUPPORT
PUBLIC
SECTOR
TRANSPARENCY
DELIVERY
INSURANCE
DEVELOPMENT
LEADERSHIP
TERM
CCA
INSURANCE
POLICY
MAINTENANCE
ACCESS
WATER
LEVEL
GREEN
CLIMATE
CLEAR
SUSTAINABILITY
COMMUNITIES
CHANGES
PRIORITY
EFFECTIVE
NEED
BASED
PROCESS
CROWD
SOURCES
AGENCIES
OUTCOMES
CONSULTATION
COMPETING
LEVY
BENEFITS
SHARING
GOVERNMENT
TAX
SPACES
SHORT
NEEDS
FUNDS
POLITICAL
FUND
CHANGE
CC
COST
COSTS
LACK
ROADS
SERVICES
ENGAGEMENT
MEDIA
VALUE
LESS
YEAR
GET
CHANGE
INCENTIVES
ACTION
LONG
LOCAL
FEDERAL
GOVT
INFORMATION
STATE
RESOURCES
DIFFERENT
PRIVATE
PROGRAM
COMMITMENT
INNOVATIVE
PROGRAMS
GRANT
ASSET
INDUSTRY
BETTER
MANAGEMENT
ISSUES
PEOPLE

5 Human settlements

Source of vulnerability

Sydney's rapid population growth has been accommodated over the past 100 years in residential settlements throughout the Sydney Basin, with a range of infrastructure, architectural styles and building materials to suit a relatively stable climate.

Concerns were raised however, that the planning, location and development of Sydney's human settlements has failed to ensure ease of access for emergency service workers to evacuate at-risk communities, minimise impacts on natural environments and optimise energy and water efficiency. Therefore government service delivery is already vulnerable to the style and spatial distribution of settlements. Responding to sectoral vulnerabilities is further constrained by limited local food and water supply, restricted workforce supply and movement, and limited provision of transport and health care infrastructure, particularly for the disadvantaged.

It was also discussed that much of Sydney's neighbourhoods and housing designs are not climate friendly by modern standards with respect to resource efficiency, thermal comfort, waste management and urban green space. For example, communities in Sydney's west and those in an east–west band of older established suburbs stretching from the Sydney CBD to Parramatta suffer most from extreme heat events. Suburbs established on the Hawkesbury–Nepean floodplain are also considered at risk from a greater incidence and intensity of storms and flooding in the future. There is a perception that adapting existing settlements for adverse climate impacts and future climate change by retrofitting buildings and improving drainage infrastructure is too costly and may occur too slowly to match the pace of climate change.

As Sydney's population is projected to continue growing and spreading, of equal concern is the lack of consideration of climate risk in the planning of new human settlements, particularly on Sydney's peri-urban fringe, with new settlements established in areas known to be vulnerable to flooding and bushfires. Some also felt that designs that are insensitive to climate have resulted in settlements that are homogeneous, rather than reflecting the identity and distinctiveness of their communities or environment. Though unsustainable, these settlements are surprisingly durable (because it was noted that housing remains in service for much longer than the intended design life-span). It was felt that there is no clear path for new technology that would improve the environmental performance of dwellings, to be adopted into standard housing models by the building industry.

Incorporation of features such as water sensitive urban design, renewable energy generation, passive cooling, green space, and on site waste management is not yet the norm for Sydney's building industry. It was felt that if planning, design and regulatory standards could go beyond the current requirements of BASIX[2], it would enhance the adaptability of housing for climate impacts. Also, while accommodating population growth in high-rise or high density development may improve affordability and resource efficiency, there is a perception that it comes at the expense of human wellbeing, sense of place and personal independence. The planning, location and development of Sydney's human settlements is a major factor contributing to the vulnerability of government service delivery in the Metropolitan Sydney region. Ease of access for emergency service workers, ability to evacuate at-risk communities, the impact of development on stressed natural environments and inherently poor energy and water efficiency contribute to this vulnerability. In addition, a lack of food and water supply and security, restricted workforce supply and movement, and limited provision of transport and health care infrastructure, particularly for the disadvantaged, is affecting government services through the style and spatial distribution of Sydney's human settlements.

[2] NSW Government Building Sustainability Index scheme

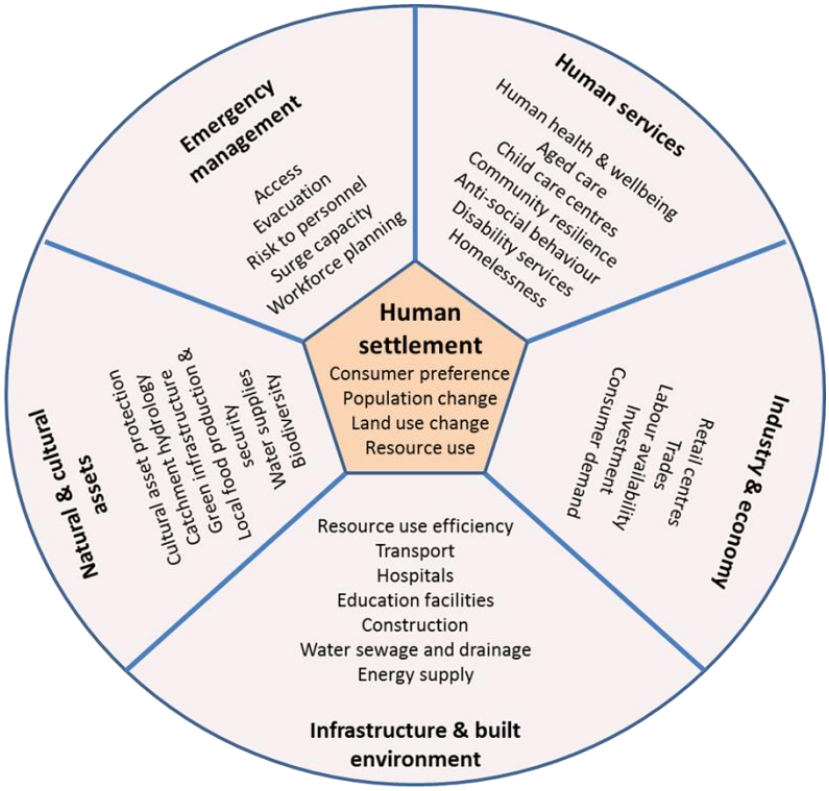


Figure 7: Factors associated with an increase in the vulnerability of government service delivery as a result of human settlement in Sydney, and sectoral-based perceptions of the issue

Constraints and opportunities

Factors affecting the capacity to adapt the spatial distribution and style of human settlements to climate change in the Metropolitan Sydney region fell into five categories:

1. *Affordability*: Sydney's poor housing affordability is driven by high and escalating property values, reliance of government revenue on stamp duty on the sale or transfer of land, and social stigma attached to public housing. These factors combine to ensure high consumer preference for low outlay, private dwellings, driving a market that does not reflect the long-term costs of running and maintaining buildings. Disclosing the climate vulnerability of different designs and materials may provide an opportunity to drive a market for greater housing resilience.
2. *Developer behaviour*: A focus on green-field development driven by developer monopolies and a focus on profits rather than sustainability and liveability limits options for locating and constructing new human settlements. Recognising and celebrating best practice siting and design of developments would increase consumer awareness and drive a commercial market for more resilient development options.
3. *Sustainability incentives*: Industry perceptions of additional costs of incorporating sustainability and resource efficiency in dwellings, coupled with a lack of political will to promote energy or water efficiency through incentives to developers, limit options available to house buyers. The lack of information on the economic advantages for property owners in improving environmental performance through innovative technologies such as alternative energy, green spaces and carbon offsetting constrains owners from improving building performance and limits interest and uptake of sustainability incentives. Assessing and communicating financial returns from sustainability measures to the property industry could address this.

4. *Policies and standards*: Existing building standards, local government planning rules on zoning and changes to zoning, and weak penalties for non-compliance with standards contribute to housing policies that do not adequately consider climate change, or learn from past extreme events or drive necessary adaptation. Limited understanding and acceptance in the community of the risks of climate change ensures there is little pressure placed on government to promote regulatory change. Furthermore, the lack of public transport options to new human settlements entrenches dependence on private vehicles for transport. Linking land-use policies and building standards may provide greater flexibility to address climate resilience and integrated planning issues.
5. *Consumer lifestyle preference*: Consumer marketing of large amounts of private space (block sizes) and cultural aspirations in Sydney in relation to house size ('McMansion' developments) perpetuates the geographic and design vulnerability of Sydney housing. Ensuring lifestyle values of 'safety, comfort and cost effectiveness' may promote better location, style and efficiency of housing.

6 Natural resource supply and security

Source of vulnerability

The supply of natural resources, particularly water, food and green space, is a source of vulnerability for Sydney's urban population facing climate change. Participants discussed the government's role in ensuring efficient, adequate and secure supplies of food and potable water in the Sydney basin. For water, vulnerability was attributed to limited water storage capacity relative to population growth, degradation of ecosystem services from natural water catchments and limited water recycling options in established suburbs. In addition, the potential for declining future water quality, exposure of water systems to biosecurity hazards and the need for water supply to maintain sewage treatment and disposal systems also contributed to vulnerability. Changes to climate were considered likely to compromise future service availability, particularly under extreme climate events, threaten equity of supply to disadvantaged communities, and limit security of supply for enhanced local food production. This in turn may further impact and degrade the resilience of Sydney's remnant ecosystems.

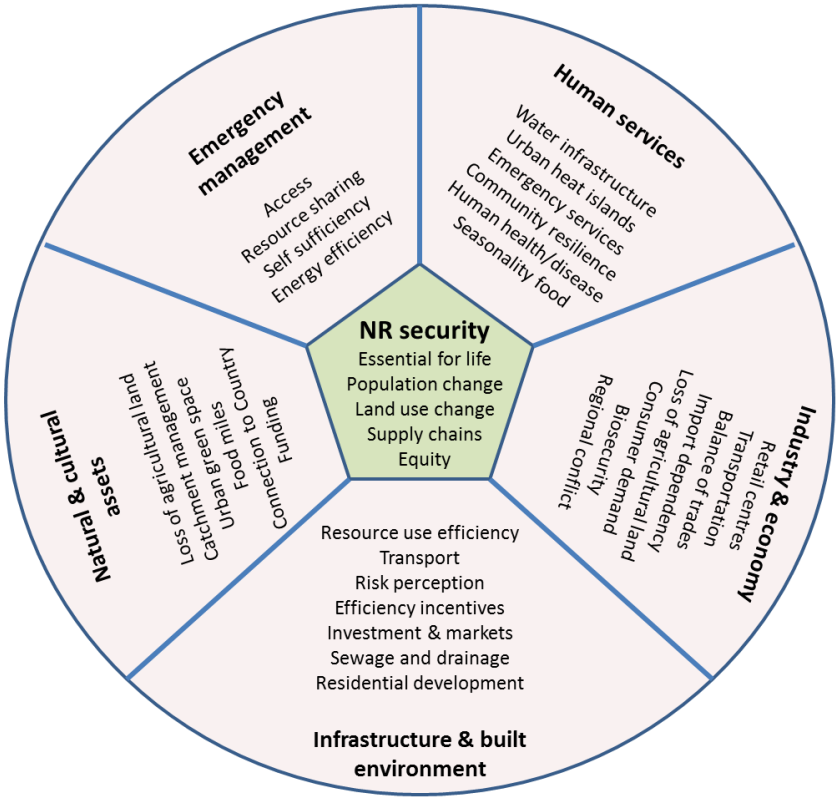


Figure 8: Factors associated with an increase in the vulnerability of government service delivery as a result of natural resource supply and security in Sydney, and sectoral-based perceptions of the issue

Sydney's food systems are vulnerable to future climate because of their reliance on extended supply chains, dependence on fragile interstate and overseas transport links to the city's centre, and the vulnerability of food imports to climate change, biosecurity and regional conflict. In Sydney, the dislocation of agricultural production from urban food consumers through the ongoing decline of commercial farming in the Sydney Basin

means local food production does not address this vulnerability. Conversion of farm land to urban development, the economics of agricultural production on small, often fragmented parcels of land and limited access to affordable water resources for local food production, contribute to food system vulnerability. Other factors that were indirectly linked to food security include the diversion of Australian food production for overseas consumption through foreign ownership of land, loss of availability of some seasonal foods, disposal of food waste, the administration of food safety and changes in consumer preferences through concerns about animal welfare, food-miles, over-consumption and human health impacts (such as obesity, diabetes). The importance of urban green space, which can promote cultural connections to natural resources and urban food (at a small scale), while also addressing urban heat impacts projected to significantly increase with climate change, was also discussed in this context.

In addition, both water and food systems are heavily dependent on energy for transport, processing and distribution. Energy generation, distribution and access are in turn vulnerable to future resource availability and regulatory approaches to reduce carbon emissions.

Constraints and opportunities

Factors affecting the capacity to adapt water and food supply and security to climate change in the Metropolitan Sydney region fell into six categories:

1. *Value of water and food:* Consumers fail to value secure water and food supplies because of pricing that does not adequately account for the environmental costs of production. For water, low pricing fails to drive improvements in resource efficiency, while for food, consumers are unaware of the intrinsic value of local agricultural land. Inadequate returns to local food producers mean many farmers in the Sydney area grow non-food crops, such as turf, which provide a better livelihood. Commercial interests in water businesses and contractual arrangements around desalination limit action to explore and encourage alternative water sources, such as recycling.
2. *Community attitudes:* The perceived security of water and food supply, community resistance to water recycling, the preference of some consumers for bottled water over tap-water, the low cost of imported food relative to local production, and a lack of diversity in food marketing through supermarket chains result in limited public support for actions to protect catchments and local food production. Poor public perception of farming as an occupation ensures that it is not seen as a viable career choice for school leavers with significant declines in university enrolments in the Metropolitan Sydney region and fears of a loss of skilled professionals. Addressing issues related to the cost of investment, security of tenure and the need for minor infrastructure could facilitate moves towards establishment of community gardens for novel local food production systems, and build shared community values.
3. *Climate variability:* The highly variable nature of Sydney's climate leads to a 'stop–start' policy cycle in government. Water efficiency and recycling initiatives and interest in localised food production are closely linked to scarcity, as occurs during droughts; however, interest wanes once the drought breaks and supplies of water and food prices return to 'normal'. Embedding climate change consideration across agency portfolios and policies may even out the cycle of addressing individual risks.
4. *Technology:* Much of the centralised network that supplies water to Sydney was designed and constructed over 100 years ago. The development and adoption of technology that reduces reliance on infrastructure (often described as 'prone to failure'), decentralises and localises water systems, enhances water efficiency through recycling and innovative storage solutions, and decouples food production from an increasingly variable climate, are all opportunities to enhance adaptive responses to climate change.

5. *Land use planning*: Pressure to accommodate population growth fuelled by expectations of a continually expanding urban footprint, has resulted in the inability of agricultural production to compete with residential development as a viable land use in the Sydney Basin. Over time, decisions have failed to preserve agricultural land and natural ('green') infrastructure in urban areas for water catchments, placing limits on local food production and creating inequities in water sharing between human and biodiversity/environmental needs. This has determined Sydney's reliance on imported food resources, and increased our vulnerability to climate change. Some progress towards improvements in water efficiency are evident in newer 'master-plan' suburbs where recycled water is used for non-potable uses (e.g. toilet flushing); however, trade policies that fail to protect Australian food producers from cheap imports, and state and local scale policies that fail to foster Sydney's local agricultural industries will see food system vulnerability persist. Incorporating green spaces into planning and design codes could improve the adaptive capacity of Sydney land use.
6. *Urban green space:* Currently the ecosystem and social co-benefits provided through urban vegetation and green open space are not quantified or valued. This means protecting, increasing and utilising urban green space is not being prioritised to address climate change vulnerabilities. Ensuring that Sydney's communities have sufficient access to urban green space can promote active living and health benefits, psychological welfare, and social and cultural connections. At a more practical level urban vegetation can minimise heat impacts, regulate storm water and runoff, improve air quality and improve biodiversity. Ensuring equitable access, proximity and quality for urban green space will build value and provide numerous liveability benefits.

7 Skills and knowledge

Source of vulnerability

Lack of community knowledge about adaptation limits awareness and capacity to respond to climate change. Open and flexible approaches to learning and capacity building, imparting positive skills, co-development of solutions, effective communication and social network creation are not currently evident in government-sponsored approaches to adaptation. A pressing need for policy makers to recognise communities (in particular, Indigenous communities) as knowledge holders and partners in the formulation of effective adaptation actions was identified by the participants.

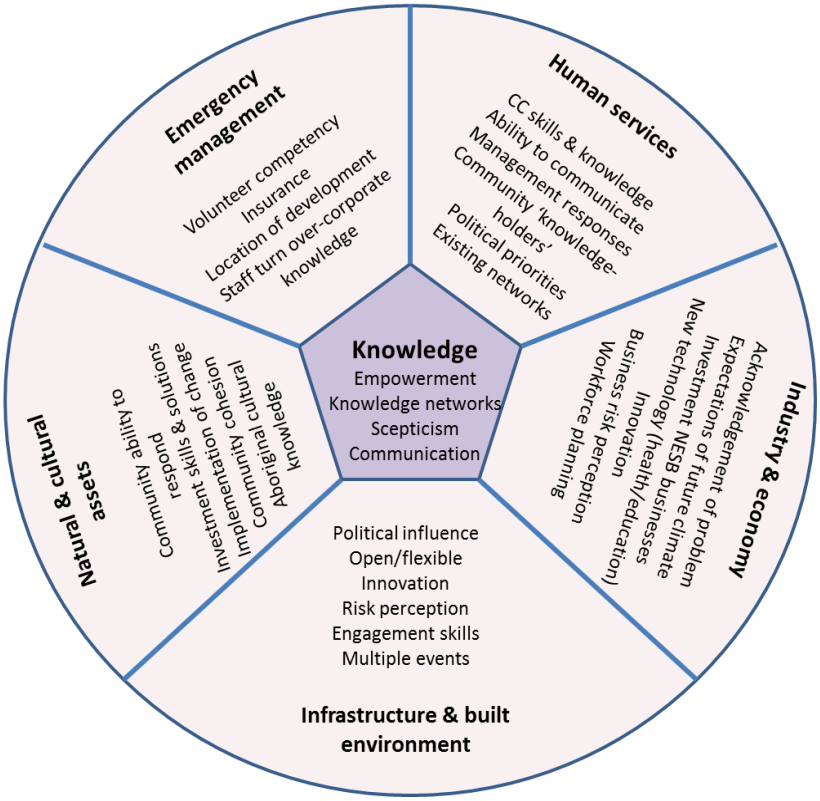


Figure 9: Factors associated with an increase in the vulnerability of government service delivery as a result of skills and knowledge in Sydney, and sectoral-based perceptions of the issue

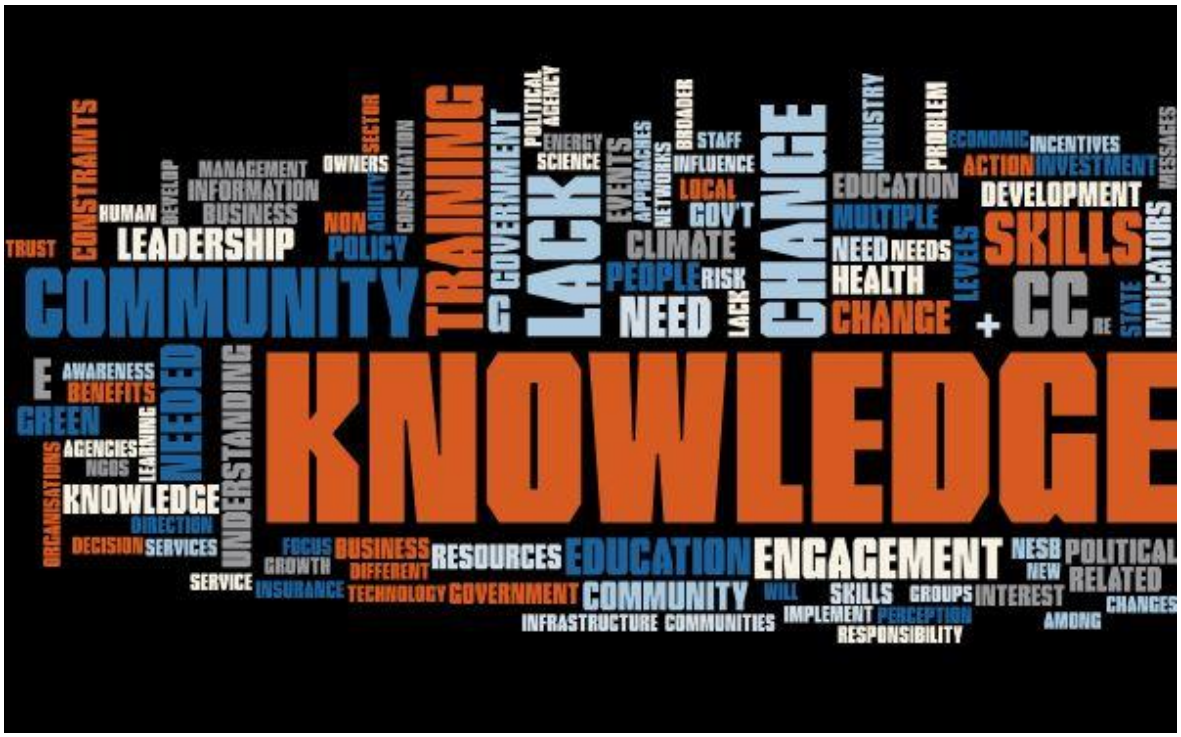
Constraints and opportunities

Factors affecting the capacity to adapt skills and knowledge to climate change in the Metropolitan Sydney region fell into three categories:

1. *Climate change scepticism:* 'Nonsense conspiracy theories', exploitation by vested interests in the media, industry and a perceived lack of consensus on climate change science appear to constrain government leadership on climate adaptation, and climate action in general.
2. *Skills gaps:* High staff turnover is leading to loss of corporate knowledge, less regional experience and declining social networks in some sectors of government. This is limiting the ability of government to use the local knowledge and skills of the

community, and is conflated by a lack of trust in non-scientific knowledge. The advent of citizen science offers a way to bring community skills and participation into the mix. There is also a pressing need in the existing public sector skills set for training in management of multiple, concurrent extreme events. For the human services sector in particular, a lack of skills and knowledge to plan and prepare for climate change was identified. Servicing already vulnerable populations is reportedly made more difficult because they are generally unaware of climate change and often unable to respond through adaptation.

3. *Community knowledge*: The pressure for government adaptation responses is limited by inadequate skills and knowledge to understand and respond to climate impacts and a lack of recognition of transferable knowledge and skills held within local communities (for example through various volunteering organisations). Community attitudes influence political priorities so if the community does not sense the urgency of the risk posed by climate change there may not be sufficient pressure placed on the government to take adaptation action. A combination of increasing awareness, and building capacity to prepare and respond can contribute to reducing the degree of exposure to the regional vulnerabilities.



8 Suggested actions

In excess of 200 suggestions to remove constraints to adaptation associated with specific aspects of vulnerability were collected from the activities and discussions during the five sector workshops (Figure 10). Some of these actions have been referenced above, and the complete list of actions can be found in Volume 2 of this report.

Actions varied considerably in their scope, scale and feasibility. The greatest number of suggested actions was related to changes to policy and addressed constraints on funding, planning, resource supply and security, and human settlement. These actions included mandating energy and water efficiency standards for buildings, improvements to policy coordination between the state and Federal governments, the development of guiding principles for effective community engagement on planning issues, and changes to local government planning to permit verge plantings.

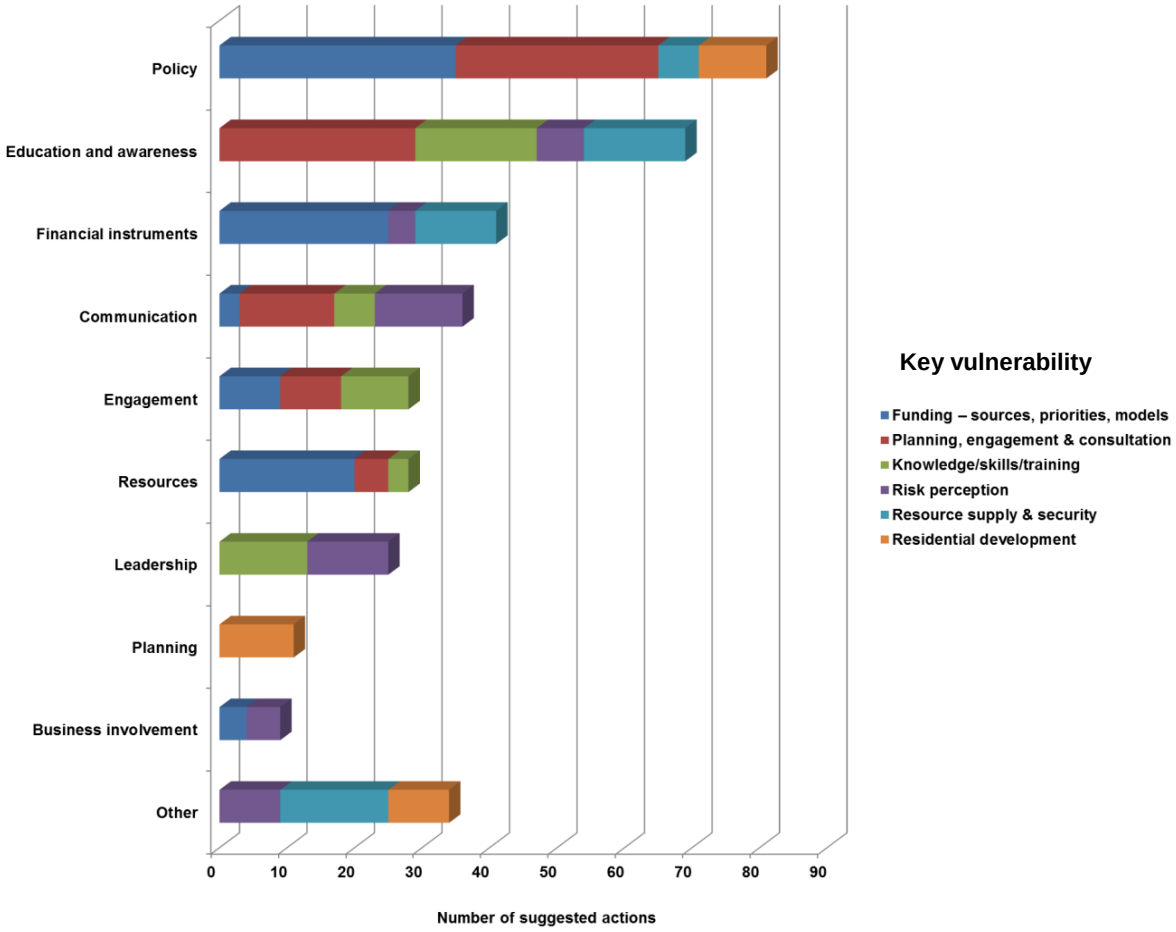


Figure 10: The number of potential actions suggested to address constraints on adaptation to climate change in Sydney
Note: Actions were pooled from all sector workshops and grouped into broad categories. Within categories, the number of actions associated with each key vulnerability is shown as a stacked bar.

The second largest category, *Education and awareness*, included actions related to planning, knowledge–skills–training, risk perception and resource supply and security. This category included improved public access to climate risk information, establishing a dialogue between the community and policy-makers on climate change, creation of links

between urban consumers and the peri-urban farming community to promote the value of localism in food production, and greater investment in raising awareness of climate adaptation with non-English speaking background (NESB) communities.

While most categories of actions addressed multiple vulnerabilities, some, such as leadership, planning, and business involvement, were associated with only one or two. For example, the category *Business involvement* contained fewer than 10 actions and included greater participation of industry bodies in distributing industry specific information (such as business or sector planning 'templates') and increased reflection of climate change risk in insurance premiums. These actions address vulnerabilities of funding and risk perception.

Potential cross-government adaptation projects

During the final integration workshop, discussion on the key vulnerabilities and potential responses led to the development a series of cross-government projects to minimise impacts and increase resilience in the Metropolitan Sydney region. For each project an indicative time frame, collaborative arrangements, potential sources of funding and aligned government processes were also identified. The list of project titles is outlined in Table 3.

The energy in the room during this exercise was extremely positive, indicating a collective sense that adaptation is as much about capturing opportunities as it is about moderating harm. While this list is by no means exhaustive, it represents the extensive scope for addressing Sydney's climate change vulnerabilities, especially through opportunities afforded by the opening of policy-change windows, which are known to occur following extreme climate events.

Table 3: Adaptation projects emerging from a synthesis of the constraints to adaptation across the range of key vulnerabilities and developed by *Towards a Resilient Sydney* participants

1. **Cooling the West** – coordinated planting and vegetation planning in Western Sydney to address urban heat islands and other heat impacts
2. **Preparing and responding to extreme events** – linking state and local emergency management and community services to meet community response needs
3. **Combined asset management systems resilience** – increasing redundancy/resilience of critical infrastructure, e.g. water supply contamination for fire/storm event
4. **Cost–benefit analysis of refitting key utility services** – applied assessment of increased power reliability, improved safety, improved noise management and amenity benefits of undergrounding transmission wires
5. **Cross Sydney civic engagement process** – to create grass roots understanding of need for climate change actions
6. **Social activation precinct** – a resilient, low income and cohesive greenfield development
7. **Agri-business park** – to promote food production, rural processing and local employment in a changing climate
8. **Community owned solar farms on CBD buildings** – virtual community owned electricity network
9. **Creative industries communicating climate change** – to foster emotional responses to climate change through collaborative art projects
10. **Disaster PPRR for non-English speaking background business owners** – to ensure NESB businesses remain viable and rapidly re-establish services following extreme climate events through a place-based, multi-language adaptation program

Appendix A: Actions to address vulnerabilities identified by the Metropolitan Sydney IRVA

During the sector workshops the participants were asked to suggest actions or measures that would address the vulnerabilities, or constraints to adaptive capacity, that were being discussed. The following list details a range of potential actions, which are drawn from the complete list included in Volume 2.

The actions in this list are ideas generated by the participants during the IRVA process and may not represent or reflect the view of the NSW Government.

Risk perception

- Use community champions to explain risks
- Agree across agencies on terminology
- Use the information from council risk assessments to educate senior managers about risks to residents and infrastructure
- Appoint people to deal with resilience in LG (specialised role)
- Publish flood mapping for Sydney, to overcome the fear/reluctance of what the evidence shows
- Develop a business/sector 'template' so that industry bodies can inform/distribute industry-specific information for implementation by individual businesses
- Establish community insurance (state government) fund to take risk off local government
- Direct education/empowerment to the community to manage and deal with risk
- Tailor council risk information from assessments to educate senior managers about risks to residents and infrastructure

Planning, engagement and consultation

- Sharing good engagement/collaboration outcomes through a website recording examples of current actions, shared experience and outcomes
- Undertake voluntary community 'disaster exercises'
- Avoid promoting fear of climate change, as it can paralyse action
- Take advantage of existing/new technology for looking after and/or checking on vulnerable members of the community
- Provide feedback on consultation Make planning for climate change a regulatory requirement
- Set enforceable guidelines and information requirements for consultation processes

Funding – sources, priorities, models

- Explore crowd source funding
- State and Federal governments need to allocate funding for infrastructure improvements – recognising that investments may be heterogeneous across areas

- Improve funding arrangements between state/local/Commonwealth to maintain roads – identify critical roads and prioritise funding accordingly
- Government procurement requirements should specify climate change adaptation
- Business tax concessions for climate change adaptation
- Green spaces and reserves need more innovative asset management – cost sharing
- Calculate water costs on delivery cost, otherwise water is too cheap and not valued
- Broader levy for emergency services or exemption from levy if you have insurance
- Superannuation funds could be invested in adaptation

Human settlements

- Incorporate green space in development designs
- Include strategic urban design in planning processes
- Consider risk in land-use planning regulations
- Incorporate flood mitigation guidelines in existing plans
- Create communal space in residential development
- Green space funding particularly in urban areas
- Improve/increase BASIX requirements
- Enable community use in 'Part 3A development'

Natural resource supply and security (food, water and urban green space)

- Promote and support restaurants driving local food ideas – Hawkesbury Harvest supporting Sydney's local food producers; farmers markets (e.g. Penrith area)
- Identify and raise awareness of Aboriginal food/medicine sources
- Create links between urban consumers and the peri-urban farm community
- Incorporate food production into public spaces, e.g. macadamias and mangoes as street trees, bee hives
- Connection tor Country – urban green space for cultural connections
- Incentives to take unused urban land and convert into community gardens
- Community insurance (state government) fund to take risk off local government
- Separate critical from discretionary water use and apply appropriate use benchmarks
- Explore innovative solutions to water storage (e.g. underground water storage)
- Better match crop requirements with climate to improve food security
- Change local government planning to permit verge plantings and identify appropriate land opportunities
- Tree protection orders for urban green space
- Localise energy and water supply to reduce reliance on infrastructure

Knowledge/skills/training

- Need for better/clearer communication of evidence-based policy development
- More joint ventures with neighbouring countries and knowledge exchange, looking outwards to consider/talk about what is happening overseas, e.g. Cyclone Sandy in the US
- Web database of case studies/top priorities of other LGs/agencies to help share info/skills – peer-to-peer learning
- Investment into knowledge of climate adaptation methods for non-English speaking background (NESB) business owners
- Creating projects with cross-department involvement – practically applied training
- Government mentoring programs, e.g. industry mentoring
- Sharing of knowledge about CC through engagement with local families
- Sporting groups – could engage non-engaged groups, e.g. recreational fishers
- Greater emphasis on participatory processes