The Towards a Resilient Sydney project: from Collective Assessment to Strategic Frameworks

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Abstract:
At SOAC 2013, we presented on the Towards a Resilient Sydney (TARS) project, a partnership between the NSW environment and planning agencies to assess the regional vulnerability of government services to climate change and identify responses and opportunities to adapt (Lee et al 2013).

Now two years later we reflect on the results of this participatory learning process, which engaged over 270 government participants, from 31 Metropolitan Local Government Areas, 37 State agencies and 7 Commonwealth agencies. We will report on how the process sought to improve resilience and minimise impacts in local communities by: building adaptive capacity; influencing decision making; and promoting collective actions. The paper explores key questions of how qualitative evidence and collective outputs are interpreted and implemented, and how strategic frameworks can account for and foster "on ground" adaptation action.

Introduction
There is increasing global focus and support for pursuing resilience for our cities and urban populations with a number of international organisations having established major programmes. Examples include The United Nations Office for Disaster Risk Reduction's (UNISDR) Making Cities Resilient programme; the International Council for Local Environmental Initiatives'(ICLEI) Annual Global Forum on Urban Resilience and Adaptation; the C40 Cities Climate Leadership Group's (C40) program focusing on emissions and climate risk reduction; and recently the philanthropic US based organisation, the Rockefeller Foundation's, launch of the 100 Resilient Cities project. There are, however, diverse views on what resilience in a city actually means, or how to recognise it.
In 2011, the NSW Environment and Planning agencies established the *Towards a Resilient Sydney* project to meet deliverables in three Metropolitan Action Plans, to the NSW State Plan (Northern Beaches, Western Sydney - Blue Mountains and South Western Sydney) to: develop improved information of climate risks for Sydney; assess cross sectoral vulnerability to these risks; and identify responses and opportunities that assist local communities to improve resilience and minimise impacts.

The Towards a Resilient Sydney (TARS) project employs a systems thinking approach to understanding Sydney's resilience to climate change. The city is viewed as a social-ecological system with the ability to absorb disturbances as well as the capacity to self-organise for adaptation to emerging circumstances (e.g. Carpenter et al., 2001; Berkes et al., 2003; Folke, 2006). We established five objectives for the project that would collectively and progressively enable resilience in metropolitan Sydney, including:

1. Establish a credible evidence basis;
2. Create a knowledge bank for climate adaptation to be accessed by multiple users;
3. Develop endorsed project outcomes with ownership by agencies and local government;
4. Build capacity across government to deliver best practice adaptation; and
5. Outline mechanisms for decision making and implementation, which can attract and allocate resources.

Governments have a number of roles to play in responding to the threat posed by climate change. These roles encompass government's need to adapt its own programs and activities, to regulate to reduce community vulnerability and to build the adaptive capacity of the community to facilitate adaptive responses (Brooks et al 2009). With these needs in mind, a steering group was formed with related functions across agencies, and across scales, to guide project development. Led by the Climate Change Impacts and Adaptation team, Regional Operations Group, Office of Environment and Heritage (OEH), the group included the Urban Strategies Team in Department of Planning and Environment (DPE), the Metropolitan Team in the Environment Protection Authority (EPA), as well as local government partners, Sydney Coastal Councils Group (SCCG), and the Western Sydney Regional Organization of Council (WSROC). Researchers from the Adaptive Communities Node of the Institute for Sustainable Futures (ISF), a partner organisation in the NSW Adaptation Research Hub, provided opportunities for co-learning among government decision makers and adaptation

practitioners. Interagency oversight was provided through regular presentations to the Department of Premier and Cabinet's Regional Leadership Groups (Sydney East and Greater Western Sydney).

TARS is part of an ongoing, state wide, stakeholder led process to inform and enable local and regional adaptation planning and implementation. This overarching multiregional program demonstrates many of the components that Smith et al (2009) recommend to underpin government adaptation effort. These features include political leadership and institutional organization; stakeholder involvement; climate change information and appropriate use of decision analysis techniques; explicit consideration of barriers to adaptation; funding for adaptation; technology development and its diffusion; and adaptation research Jacobs et al (2015). This paper will discuss the five TARS subprojects, in the context of the statewide adaptation program, then outline some challenges in presenting qualitative evidence and fostering collective actions and finally discuss some current and future actions for Metropolitan Sydney on its journey towards resilience.

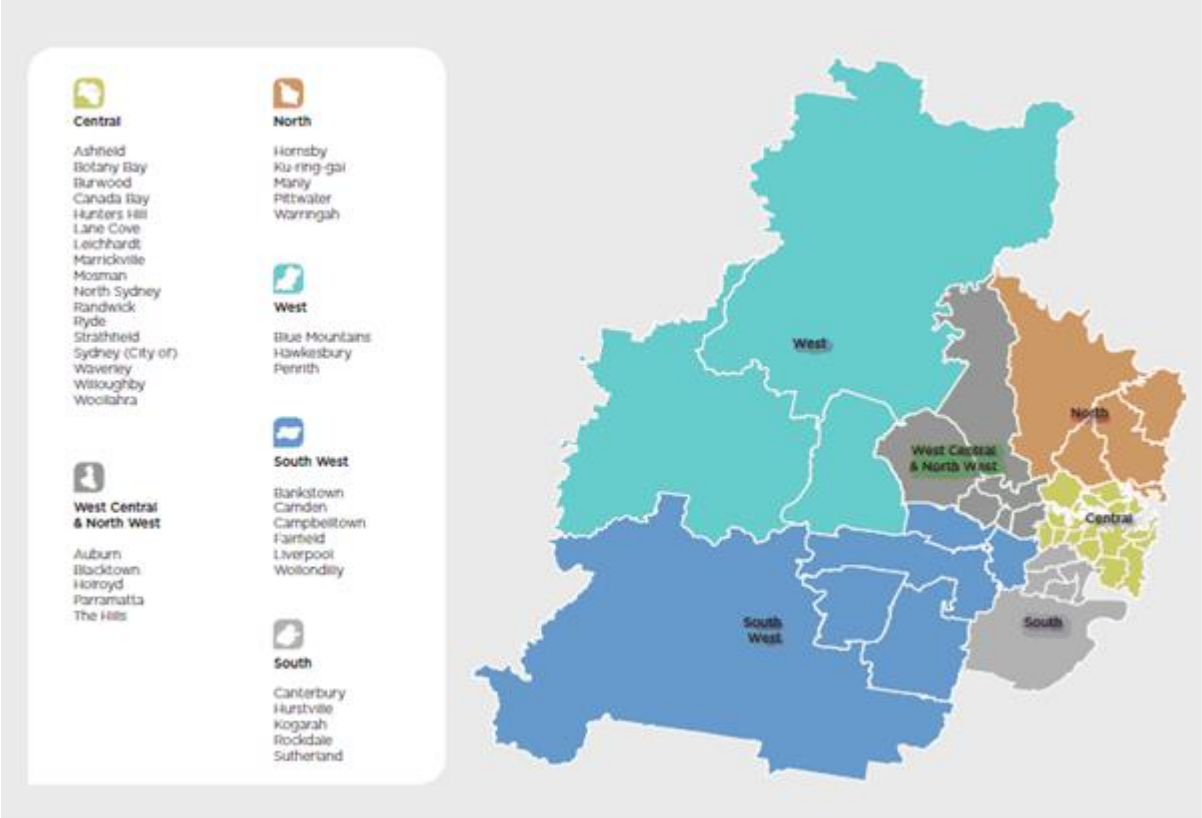

Figure1 – The Towards a Resilient Sydney study area encompassing 41 Local Government Areas in six subregions

Sub Project 1 - Taking Stock

Cities are centres of political and economic power, have highly concentrated populations and complex infrastructure systems and are often in coastal locations. As the impact of Hurricane Sandy on New York or the floods in Brisbane show, cities can be vulnerable to extreme weather events which have widespread and lasting impacts on buildings, neighbourhoods, infrastructure and communities. However, they are also vulnerable to impacts of gradual climate change (such as rising urban heat), especially as changes approach thresholds beyond which the change is unmanageable (WRI 2011, IPCC 2007). Cities also face additional challenges due to high rates of population increase, putting pressure on existing infrastructure and services even in the absence of climate change impacts (Matthews 2011).

Not surprisingly, the extent to which a city is affected by climate change depends on a wide range of variables, including its location, such as coastal or riverine cities, or its economic dependence on climate-sensitive resources such as agriculture, forestry, water-intensive industries or tourism. However, settlements often have high potential for adaptation, if given access to financial and other resources, and the competence and capacity of a range of individuals and organisations to identify and implement change (IPCC 2007, 2014).

When we began scoping this project in 2010,"resilient cities" had less profile and fewer global networks than today. However, with 55% of the world's population already urbanised, (this figure is likely to reach up to 75% in the next 30 or 35 years (UN Habitat, 2012)) measures to enable resilience of cities have been identified as an area of critical focus for sustainable global growth. Appraising contemporary theory and practice around adaptation planning at the city scale was the agreed first step. Accordingly, we conducted a desktop review into global best practice which resulted in the *Towards a Resilient Sydney Adaptation Review Paper* covering a range of cities throughout the world, from Copenhagen, London, and Toronto, to Ku-ring-gai, Melbourne and Parramatta, in Australia. This document provides an overview of relevant climate change adaptation approaches covering frameworks, guidelines, strategies and plans, both global and local, to determine current understanding of best practice for adaptation planning and implementation as well as reference material and guidance during the development of TARS.

In addition to the review paper, an Adaptation Planning Best Practice Checklist was produced and distributed via the NSW Local Government Adaptive Capacity program. See www.climatechange.environment.nsw.gov.au/Adapting-to-climate-change/Local-government. This served to assist the development of risk assessments and adaptation strategies required under the 2011-12 Waste and Sustainability Improvement Payment Program, through the *NSW Protection of the Environment Operations (Waste) Regulation 2005.*

The review process emphasised challenges to effective planning and implementation of city adaptation, including:

- the timescales and inherent uncertainties in the process
- the time and challenges involved in effective stakeholder engagement
- cooperating across disciplines, scales and functional area responsibilities
- the long-term perspective of management, inconsistent with political cycles and
- the difficulties in choosing an appropriate climate scenario.

Sub Project 2 - A Future Sydney Climate storyline

Developing the best climatic change impact information was the second TARS subproject. Information on climate impacts was considered essential to guide a deeper understanding of Sydney's vulnerability to climate change.

At the time, OEH had initiated work with the Climate Change Research Centre-University of New South Wales to develop high resolution climate change projections for the State, in response to the need by regional decision makers and impact assessment researchers for local scale climate change information. Known as the NSW and ACT Regional Climate Modelling (NARCliM) Project, this research partnership was funded by government end users of climate data, including Sydney Water, Sydney Catchment Authority, Hunter Water, NSW Department of Transport, NSW Department of Primary Industries, NSW Office of Water and the Australian Capital Territory Government. NARCliM has produced an ensemble of robust regional climate projections for south-eastern Australia down to a 10km-grid resolution that can be used to plan for the range of likely future changes in climate (Evans et al 2014). The NARCliM projections and products were launched in December 2014 and can be found online at www.climatechange.environment.nsw.gov.au .

However, in 2013 the full NARCliM dataset was not yet available. In addition, because the TARS project team were interested in understanding the specific climate impacts on Sydney, such as urban heat (Argueso et al 2013,Yang et al 2015 a &b), climate projections and impact information were required at a finer scale than would be available through NARCliM. OEH and UNSW then developed a pilot study to deliver dynamically downscaled climate change data to 2km (urban relevant scale) for Sydney out to 2050. The Global Climate Model CSIRO Mk3.0 was downscaled using the Weather Research and Forecasting Model (WRF) with a single, representative emissions scenario (the IPCC high emissions scenario A2).

The model also included a "future land use" layer, used to determine the impact of changes in land use on the climate of Sydney's urban environment. The future layer was derived from NSW statewide land use data and incorporated areas of planned urban expansion from the planning department.

The Sydney pilot study was the first time this fine-scale climate data had been used for impact assessments and product development. The lessons learnt from data anomalies and difficulties in processing and delivering the pilot data were used to ensure effective quality assurance processes were integrated into the larger NARCLiM Project.

The 2km climate projections were analysed by OEH Science staff to determine potential impacts on biodiversity, coastal systems, water, soils, fire weather, heat and air quality. Given the pilot study used projections from a single global climate model and a single regional climate model, the results presented only one possible future, and possessed a large band of uncertainty regarding the magnitude of projected changes, and hence were not suitable for detailed adaptation planning. The projections and impact assessments were synthesised into a booklet called the Sydney Climate Storyline, and provided a single potential future for Sydney for use in discussions around high level vulnerabilities and impacts.

Even though the Sydney Climate Storyline provided to the TARS participants was a one-case scenario, it has been found to be consistent with the climate and impact information now available through the more robust NARCLIM data set for Sydney which shows:

- Sydney is projected to become hotter, with higher maximum and minimum temperatures projected across the region in all seasons. The greatest increases in minimum temperatures are projected to occur in the west and southwest of the city;
- The number of warm days is projected to increase over all of Sydney and the number of heat waves expected to increase; Increases in mean daily Forest Fire Danger Index (FFDI) are projected during Spring particularly east of the Blue Mountains;
- Exposure to coastal hazards is expected to increase in the future scenarios, due to the increased landward reach of beach erosion and oceanic inundation associated with a projected rise in mean sea levels. This has the potential to cause impacts in Sydney due to the concentration of population, buildings and infrastructure in close proximity to dynamic coastal environments; and
- Rainfall is projected to decrease in spring and winter and increase in summer and autumn, but continue to be highly variable.

Sub Project 3 - Assessing the Future Social Context of Sydney

Climate change is expected to have social as well as bio-physical impacts. While the Sydney Climate Storyline provided a picture of possible impacts on the natural capital of Sydney, it was recognized that exploring other key drivers of change for Sydney such as population growth, would be also be essential to understanding interactions with climate vulnerabilities. Likely future scenarios for social, human, economic and physical capital were compiled as a key input into the TARS project.

With over 4 million people, Sydney accounts for approximately 60% of the State population and features significant cultural and ethnic diversity, with 36% of the population born overseas. Sydney accounts for almost one-fifth of the national total annual output of goods and services and represents over two-thirds of the estimated Gross State Product of NSW (NSW Government 2014).

The then Department of Planning and Infrastructure (now Department of Planning and Environment) developed a socio-economic profile, outlining the social and economic characteristics of Sydney at a variety of geographic and time scales. The profile data was primarily based on the Census of Population and Housing (ABS 2011), Department of Planning & Infrastructure Preliminary population projections (2013), ABS General Social Survey (2010) and Regional Development Australia Economic Baseline Assessment for Sydney (2013).

The profile outlined population projections for Sydney being driven by both natural increase and net migration in equal measure. In the next 20 years, Sydney will be home to another 1.6 million people; more than half settling in Western Sydney. This growing population, including more than 1 million people over the age of 65 years and almost the same number under the age of 15 years, will require over 600,000 new homes and almost 700,000 new jobs. The population density is expected to rise from 410 to around 550 people/km^2 by 2031.

The profile also provided insights into human capital, outlining a diverse employment base including, health care (11%), professional, scientific and technical services (10%), retail trade (10%) and manufacturing (9%). The importance of financial and professional services to the $306 billion Gross Regional Product, is underpinned by access to educational opportunities (from primary to tertiary) with increasing levels of students and, on average, 55% of residents with tertiary qualifications.

Social capital measures were provided to understand people's capacity to participate in networks, and sources of support. These measures included changing address rates (14% changed in the last 1 year

and 37% changing in last five years), English language proficiency (poor in 14% of the population), volunteering rates (15%) and levels of trust (51% felt that most people in Sydney were trustworthy).

Financial capital and access was explored through the participation rate and the size of the working age population, which has stayed relatively steady from 2006 to 2011 at approximately 66%. However an ageing population will place increased pressure on health and community service provision. In addition, the proportion of workers employed close to where they live is particularly low in some areas of Sydney. Mortgage and rental payments, which are higher than the State average, impact Sydney residents' cost of living and disposable income, contributing to housing stress in certain parts of Sydney and affecting vulnerability and ability to adapt.

Physical capital was explored through measures of infrastructure contributing to livelihoods: including housing stock, transport and fuel, internet connection and social infrastructure, such as hospitals, schools and libraries. As densities in Sydney increase to accommodate growth house size tenure is changing, which is impacts on the suitability of existing infrastructure for changing demographics and modes of living.

This information provided insight into the implications for planning for geographically and culturally differentiated social contexts for resilience, and was presented alongside the climate projections, to inform the discussions and deliberations in Sub project 5 – the Integrated Regional Vulnerability Assessment – or IRVA.

Sub project 4 - Capturing and Mobilising Adaptation Research for Sydney

TARS provided an opportunity to draw on Sydney's large network of sophisticated research agencies and their expert knowledge and skills to support and inform effective city adaptation planning. In May 2012, OEH commissioned a series of research reviews across eight key themes in order to better understand existing and emerging Australian and international research, and to identify where research gaps or opportunities may exist that could be filled to support adaptation responses in Sydney.

Sector	Lead researcher
Economy and industry	Bill Pritchard, University of Sydney
Natural assets	Jennifer Hearn, Office of Environment and Heritage
Human health	Hilary Bambrick, University of Western Sydney
Cultural assets	Susan McIntyre-Tamwoy, James Cook University
Settlements and communities	Michael Neuman, University of New South Wales
Buildings and neighbourhoods	Michael Neuman, University of New South Wales
Emergency management	Neil Dufty, Molino Stewart
Infrastructure	Ron Cox, University of New South Wales

Each research leader approached their topic with different methodologies, reflecting the nature of the respective sector. For example, the infrastructure review drew heavily from interviews with infrastructure operators while the cultural assets review conducted a comprehensive literature review from both Australian and international sources. However, all reviews provided relevant and comparable insights for Sydney, in terms of geography, population, current climate or/and culture.

An Urban Adaptation Research Synthesis was produced which analysed the reviews and identified research opportunities to produce a list of cross-disciplinary themes which would support adaptation across Sydney's multiple sectors. Cross-cutting research themes include:

- Fostering adaptive urban design
- Utilising land use planning mechanisms
- Opportunities for data sharing and downscaling
- Improving cross government coordination
- Identification of vulnerable communities, populations and infrastructure
- Promoting best practice in local government

- Securing water quality and supplies
- Exploring the role of the private sector in urban adaptation
- Understanding infrastructure interdependencies
- Improving community connectedness

Figure 2 – Cross sectoral research themes from the Urban Adaptation Research Synthesis

This subproject provided rigour and transdisciplinary inputs into enhance adaptation knowledge, and provided a direction for priority research. The exercise also served to inform the establishment in August 2013 of the NSW Adaptation Research Hub, a collaborative research hub funded by OEH with in-kind contributions from research nodes hosted by research providers, which explores adaptation responses under the statewide priority themes of Coastal Processes, Biodiversity and Adaptive Communities. www.climatechange.environment.nsw.gov.au/Adapting-to-climate-change/Adaptation-Research-Hub/

Sub Project 5 - Getting a handle on vulnerability

Armed with detailed best practice, climatic, socio-economic and research community information, we conducted an Integrated Regional Vulnerability Assessment (IRVA) of Metropolitan Sydney. This process (Jacobs et al 2014a) draws on contemporary practices in vulnerability assessment to identify exposure and sensitivity of region scale social, economic and biophysical systems to the impacts of climate change, the direct and flow-on effects of these impacts on government service delivery and the adaptive capacity of local government administrations and state government agencies to continue to service the community. The IRVA process:

- employs a systems thinking approach that acknowledges communities exist within human–natural (or social-ecological) systems (Carpenter et al., 2001; Berkes et al., 2003; Folke, 2006) and encourages a plural-conditional approach to adaptation policy development (Stirling 2010)
- makes extensive use of participatory engagement in which stakeholders co-create an understanding of vulnerability through their knowledge (often tacit) of the region
- focuses on developing an understanding of the constraints to adaptation, and on identifying opportunities for building adaptive capacity so communities can deal better with climate shocks regardless of their nature or timing,

- identifies opportunities for collective action that operate across scales, sectors and disciplines, and encourages regional decision makers to seek collaborative projects to address complex vulnerability drivers, or apply regional capacities; and
- supports qualitative analysis wherever possible with quantitative information (the regional climate projections and socioeconomic profile), which acknowledges that societal interactions are complex and contradictory in nature, and not amenable to external, expert-led, reductionist approaches to problem analysis.

In late 2013 a series of workshops was conducted with representatives from Sydney's government service providers in five key sectors: human services, economy and industry, emergency management, built environment and infrastructure, and natural and cultural assets. After absorbing Sydney's changing climatic and socio-economic context (provided by subprojects 2 and 3), participants identified the vulnerability of services for which they share administrative responsibility, such as public health, land-use planning, interconnecting infrastructure and emergency services, and the factors affecting the vulnerability of those services. A final workshop to integrate sector findings was held in March 2014 involving 70 participants from across each of the sectors, where a thematic assessment of the cross-sectoral vulnerability was tested and validated. For Sydney key climate change vulnerabilities are:

- limited perception of climate risks
- insufficient consideration of climate change in planning processes
- challenges in directing 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 (Jacobs et al 2014b).

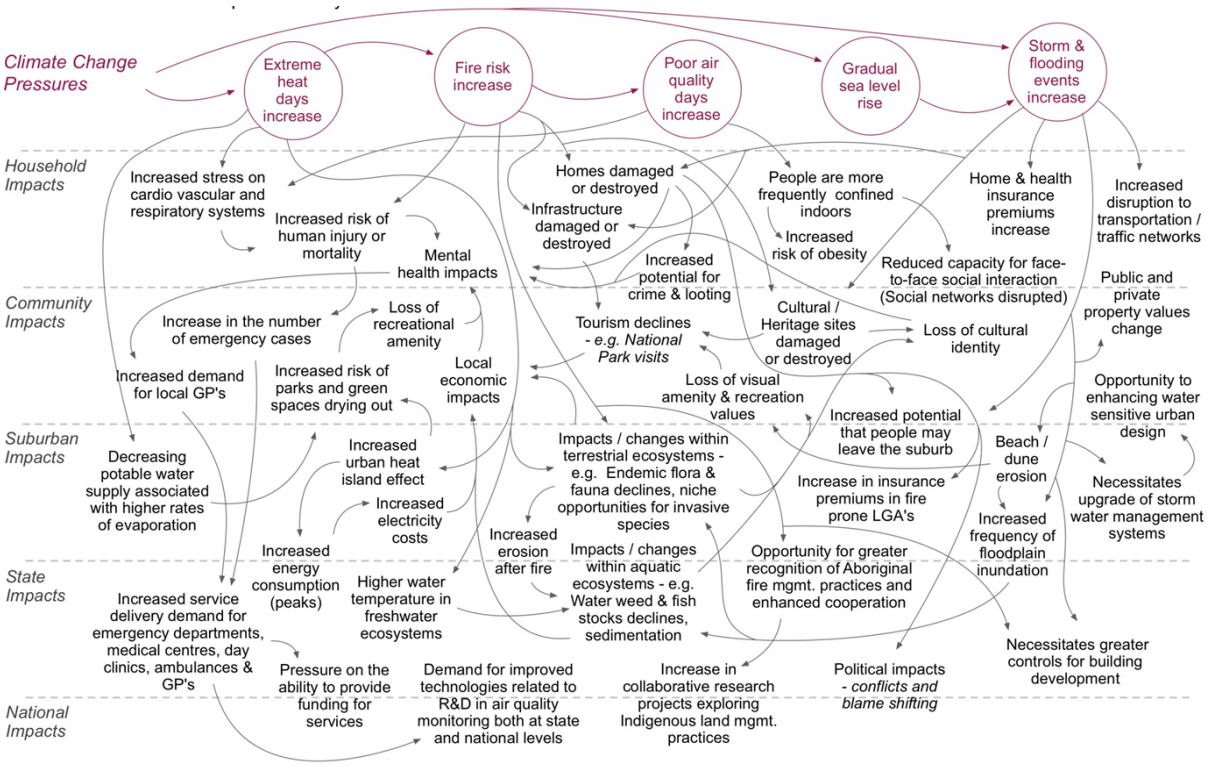

Figure 3: Impact pathways generated through a participatory workshop with the government service providers in the natural and cultural assets sector of the Greater Sydney Region in the Sydney IRVA.

The participants were engaged in a participatory learning journey using a suite of approaches including World Café discussions, scenario options analysis and real time interactive polling. Relationships and networks within sectors developed and the collective knowledge and skill base of participants was used to plan collaborative adaptation responses to the emerging risks, cognisant that

action by one sector may have adverse consequences in another. A list of cross-government adaptation projects collaboratively designed in the final IRVA workshop included:

- Cooling the West – coordinated planting and vegetation planning in Western Sydney to address urban heat islands and other heat impacts
- Preparing and responding to extreme events – linking state and local emergency management and community services to meet community response needs
- Combined asset management systems resilience – increasing redundancy/resilience of critical infrastructure, e.g. water supply contamination for fire/storm event
- Cross-Sydney civic engagement process – to create grass roots understanding of need for climate change actions
- Social activation precinct – a resilient, low income and cohesive greenfield development
- Agri-business park – to promote food production, rural processing and local employment in a changing climate
- Community owned solar farms on CBD buildings – virtual community-owned electricity network
- Creative industries communicating climate change – to foster emotional responses to climate change through collaborative art projects
- Disaster planning for non-English speaking background business owners – to ensure local businesses remain viable and rapidly re-establish services following extreme climate events through a place-based, multi-language adaptation program.

A project evaluation was undertaken to assess the suitability of the IRVA for facilitating a coordinated approach to increasing Sydney's resilience. Through structured interviews and analysis of the workshop evaluation forms, we confirmed a high level of enjoyment and value in the process and an appetite for further engagement. While participants reported enhanced understanding and changed attitudes following the workshop process, there was a reported inability to share their knowledge within their organisation, potentially limiting the influence of the project on regional decision making, other than via direct participation. Evaluation by the steering committee found that strong engagement and cross-sector involvement had resulted in more awareness and greater recognition of the need for resilience planning and concerning specific climate issues, such as increasing urban heat. They felt that while adaptive capacity was growing, further knowledge delivery was required to promote application of the now established knowledge bank on adaptation (project objective 2).

Challenges of presenting qualitative and collective evidence

The findings of the IRVA process were qualitative (descriptive), relying on the thematic analysis of workshop information and outputs as raw data, rather than the quantitative (mathematical) measurements relied on in conventional research. It is often asserted that participatory methods involve only subjective observations so that findings are 'informal' and 'qualitative', implying poorer quality or second-rate work, or that rigour and accuracy are assumed to be in contradiction with participatory research (Pretty and Vodouhê 1997). However, reliance on tacit knowledge is necessary to understand impacts and adaptive responses in a local context because the data required to support quantitative modeling at that scale is not available (Campbell et al 2001).

The participants reported explicit value in exploring vulnerability through shared operational experiences, rather than theoretical perspectives, as it underpinned their learning experience. This experience in turn is more likely to trigger local adaptation action than top down data driven assessment (Jacobs et al 2015). From a central agency perspective, the process and the findings are highly valued, and four more State Planning Regions have invited OEH to lead and deliver regional vulnerability and adaptation processes in the coming year.

However, because vulnerability is understood as the "susceptibility to be harmed" (Adger 2006), the findings highlight issues that may be viewed as negative. Also collective findings from a cross disciplinary process are extensive, wide-ranging, and not directly attributable to individuals or organisations. These issues create difficulties in applying findings to specific administrative responsibilities and roles. Also where findings express views not aligned with established policies or existing strategic documents, we have noted reticence and delay in their acceptance.

Whether or not the views in the findings are "correct" is a matter of perspective, perception and power and does not change the fact that they exist. To be useful for policy information should be relevant, salient and legitimate (Cash et al 2003). Well-designed participatory processes help to achieve these

outcomes. Policy makers need to be receptive to 'feedback from local voices' (Wallington and Lawrence 2009) and accept that a broad range of factors will constrain or enable adaptation, in order to identify and implement appropriate actions or policies in response. Acknowledging and sharing findings is critical when seeking to catalyse on-the-ground actions by regional participants.

Using strategic frameworks to foster "on ground" adaptation actions

At the finalisation of the five subprojects, the objective to outline mechanisms for decision making and implementation remained unfulfilled. While some steering committee members favoured an endorsed government framework of roles and responsibilities, others felt that the project had demonstrated that normalising adaptation issues into day to day to decision making in areas like conservation planning, emergency management, regional development, and strategic planning was the best approach for linking current imperatives and existing challenges with future changes in climate (Dovers 2009). Based on the project outputs and findings, key project partners developed a framework of principles which could be used to guide decisions and appraise actions that build Sydney's capacity for resilience into the future, including:

- **Evidence-based decisions** - Actions and decisions are based on the best available evidence.
- **Subsidiarity** - Local decision makers identify appropriate adaptation actions that meet community needs, and regional strategies, practices, investments and programs support the effectiveness and efficiency of regional adaptation.
- **Cooperation and partnership** – Cross scale coordination and sharing skills, knowledge and resources will boost opportunities to foster multidisciplinary approaches and programs, build capacity for action and influence practice.
- **Ecologically sustainable development** - Community resilience is increased by promoting resource efficiency and intergenerational equity.

Despite the challenges in finalising reports, the project and related actions were included in the leading strategic planning document of the region – *A Plan for Growing Sydney (DPE 2014),* thereby embedding the evidence base into strategic and sub-regional (spatial) planning in relation to the following actions:

- 4.3.1 – Apply the Urban Green Cover Technical Guidelines
- 3.2.1 – Create the Sydney Green Grid of interlinked, multi-purpose open and green spaces
- 3.2.2 – Investigate options for Bush land Renewal
- 4.1.1 – Protect and deliver a network of high conservation value land by investing in green corridors and protecting native vegetation and biodiversity
- 4.1.2 – Prepare a strategic framework for Metropolitan Rural Area to enhance and protect the broad range of environmental economic and social assets of this area.
- 4.2.1 – Provide local councils and communities with tools and information to shape local responses to natural hazards

The findings of the project, along with integrated vulnerability assessments in other NSW regions, served to demonstrate the ongoing financial and technical capacity needs in NSW local government sector in relation to adaptation. A $1 million Building Resilience to Climate Change contestable grants scheme was established in August 2014 to address these shortfalls. Funded by OEH and the NSW Environmental Trust, and administered by Local Government NSW, this program has funded four metropolitan Sydney-based projects, involving 13 local government areas, three state agencies, universities and private and community organisations.

- **Mapping Sydney's 'food sheds' in peri-urban and regional centres in Western Sydney**, to build the capacity to adapt Sydney's food supply to a changing climate.
- **Adapt Roads Pilot** establishing a tool to assess and quantify the resilience of council road and water infrastructure networks to current and future climate impacts and natural hazards, to help council properly plan infrastructure investment.
- **Mapping Inner-west and Western Sydney Hotspots** to mitigate localised heat and reduce community vulnerability in Western Sydney.
- **Thermal mapping of heat islands across southern Sydney councils** to support implementation of adaptive responses for public and private assets

In addition, the high quality of stakeholder engagement and the newly formed cross-scale networks provided a comprehensive foundation for pursuing opportunistic adaptation projects, such as:

- **Urban greening masterclasses and release of Urban Green Cover Technical Guidelines**: A series of peer to peer forums to exchange local government case studies of urban greening

implementation, complemented by a handbook on how to increase vegetated, reflective and permeable surfaces in urban environments to adapt communities to urban heat.

- **Minimising the impacts of Extreme Heat: a guide for NSW Local Government** Guidance on respective roles of State and local government in responding to extreme heat, including via the NSW Heatwave Sub Plan, developed through the State Emergency Management Committee Climate Change Working group with project partners including: NSW Health, NSW Police, State Emergency Service, two Local Health Districts, Local Government NSW, Environmental Health Australia (NSW), Australian Red Cross (NSW), and Sydney councils.
- **Northern Beaches Flood and Coastal Storm Historic Photograph Exhibition** to raise awareness, and workshops to build community resilience through household emergency response plans, funded through the Community Resilience Innovation Program for $25,000.
- **Revegetation for multiple benefits in the Cumberland Conservation Corridor.** Greater Sydney Local Land Services successfully bid for $800,000 for tree planting in Western Sydney across three local government areas under the Commonwealth's 20 Million trees funding grants, providing long term urban heat, air quality and biodiversity benefits.
- **The City of Sydney's successful admission into the Rockefeller 100 Resilient Cities program** in December 2014. The Mayor has committed to represent and involve the entire Metropolitan region in his process and will soon appoint a Chief Resilience Officer to lead resilience planning for Sydney region. OEH is continuing to liaise with the City and this process to ensure best use of the project's evidence base and outputs, as this global implementation process proceeds.

Conclusion

Through five distinct subprojects, the TARS project sought to build capacity and collective learning to produce a robust and enduring response platform to the threats, risks and opportunities for Sydney into the future.

While the existence of individual actions cannot be attributed to one government process, the project has provided an important opportunity to integrate adaptation responses in Sydney's metropolitan planning and to implement cross-scale projects and initiatives.

Adaptation requires a broad range of actors and skills sets employed in iterative processes, so while we have started this process in Sydney we are aware it requires ongoing adaptive responses.

The breadth, complexity and timeframe of the project, was difficult to manage at times, but was appropriate to assess the unique geographical, environmental, economic and social circumstances in Metropolitan Sydney. Early planning and preparation can help identify and capture opportunities to minimise long-term economic, social and environmental costs to Sydney's communities.

Importantly the Towards a Resilient Sydney outcomes demonstrate that stakeholders are intelligent, responsible agents who are willing to act in the collective interest when institutional arrangements foster learning, allow co-design of institutional conditions and value reciprocity (Collins and Ison 2009).

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