North Coast Enabling Regional Adaptation

North Coast region report

Acknowledgements

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Report overview

This report contains a collective understanding of the likely vulnerability to climate change of the North Coast region and aims to stimulate action to plan adaptation. It documents regional challenges and actions identified by local decision-makers as critical to their community's prosperity and endurance. Local councils and state agencies will need to continue to collaborate and look for opportunities and policy windows to enable transformation of the nine systems identified in this report.

To address the region's vulnerability to climate change, regional administrators, businesses and communities can begin by pursuing the following opportunities and be on the lookout for new ideas as well:

- **Understand regional vulnerability** – Table 3 in Chapter 3 of the report outlines the exposure and sensitivity of the region to climate and other regional drivers of change. It provides a lens through which the specific attributes of the region can be viewed as a means of addressing threats (adaptive capacity). It can also help to identify what attributes are absent or negative, highlighting which adaptive responses will be constrained, leaving the region vulnerable.

- **Understand the flow-on impacts of climate shocks and stressors across the community** – The impact chains in Figure 16 in Chapter 4 show how climate variability and extreme events will affect food and agriculture in the region and illustrate the complexity of consequences from the four main climate drivers that were identified.

- **Assess climate change adaptation progress in the region** – The survey results in Chapter 6 outline the key climate risks and the status of adaptation currently underway. This provides a benchmark against which future action can be measured.

- **Embed the transition models into regional and local strategic plans** – The nine transition models in Chapter 2 look at key regional systems that will need to be significantly different in the future due to climate change, and other specific regional drivers of change. Identifying actions in the transition pathways during project and program development will aid cross-sectoral adaptation and support regional efforts to transform to a desirable future. This can be achieved through strategic planning or operational opportunities at a regional and local level.

- **Seek funding to activate transition pathways** –The assessment method used to identify the regional vulnerabilities is a peer reviewed methodology, meaning it provides a robust and scientifically rigorous way to prioritise adaptation projects and responses. It provides a sound evidence base to support adaptation projects and justify subsequent investment.

- **Communicate the expected physical changes** – Table 2 and Appendix A summarise the changes to climate variables that can be expected in the future and also the likely impacts across different sectors. Community education and staff training will help the whole region to increase its preparedness.

- **Leverage existing cross-jurisdictional leadership groups** – These groups are central to coordinating and driving climate change adaptation in the North Coast region and are a valuable resource to help build momentum.

- **High priority pilot projects** –Table 4 in Chapter 5 lists 29 potential pilot projects identified by workshop participants that could be developed as first step actions from a range of transition pathways.

Collaborative and proactive action by administrators, businesses and communities is the key to minimising the impacts of climate change on the local economy and environment of the North Coast. This report is designed to facilitate that action and enable transition for the region.

1.   Introduction

The climate is changing and global modelling indicates that further change is already locked in. As a result there is a growing risk of climate related impacts on our state's natural, social and economic systems. Regional administrators, businesses and communities need to identify their strengths and weaknesses in the face of climate impacts – deciding how they will act together to minimise the impact of climate change on their local economy, environment and society.

Climate affects multiple systems and so risks from climate require a systemic, coordinated response. From a practical perspective, this requires input, agreement and collaboration of multiple stakeholders, amongst whom there may be no history of cooperation. In partnership with leading researchers, the Office of Environment and Heritage (OEH) has developed and delivered processes that enable regional scale consideration of climate projections and investigation of related impacts.

The North Coast Enabling Regional Adaptation (NERA) project builds on local knowledge to understand climate vulnerabilities in the North Coast region and identify opportunities to respond, enabling regional decision-makers to enhance government service delivery and planning at a regional and subregional scale.

The NERA project provides a structured process for participation by representatives of NSW Government agencies, local government and key regional stakeholders, using their tacit local knowledge to identify and capture opportunities to build regional resilience. By enabling participatory learning, the Enabling Regional Adaptation (ERA) process develops new and expanded professional networks which can be mobilised to respond to climate change. This operational knowledge of how regional systems interact informs the development of adaptation responses that are sensitive to the reality of local systems.

The NERA project has sought to:

- provide a credible evidence base for Government adaptation planning by developing a regional understanding of the impacts of projected climate change and vulnerability to the expected impacts for the North Coast region
- build on the capacity of regional decision-makers to undertake adaptation action by improved understanding of regional climate change impacts, adaptive capacity, vulnerability and adaptation options, and
- strengthen relationships between sectors across local and state government in the North Coast, with a view to capturing opportunities for regional climate change adaptation projects.

This report presents the output from a series of workshops held in the North Coast region during 2018. Workshop participants developed transition pathways for key regional systems, to build resilience to climate extremes and minimise impacts on their local communities.

The report also outlines the workshop process, and potential projects to activate the transition pathways and strengthen key regional systems in the North Coast, and support improved government service planning and delivery now and into the future. The final chapter of the report gives proactive ways to turn the report's findings into action.

2. What needs to change in the North Coast region?

2.1 Identification of vulnerable regional systems

The state's regions are subject to a broad range of drivers of change (economic, technological, social and environmental). Regions such as the North Coast are made up of many component parts (or systems) that all contribute to how the region currently functions (business-as-usual) and its trajectory of future development. A region's resilience in response to drivers of change relies on its capacity to adapt. For temporary drivers (such as fluctuations in agricultural commodity prices), basic alterations to business-as-usual may be an adequate response; however, for persistent and disruptive drivers such as climate change, more fundamental and transformative change may be required to adapt regional systems.

For the North Coast, nine regional systems were identified as particularly vulnerable and in need of change to ensure effective ongoing government service planning and delivery:

- Settlements and land-use planning
- Resilient communities
- Cultural heritage
- Biodiversity
- Emergency management
- Food and agriculture
- Infrastructure and water
- Energy
- Tourism.

2.2 Transition models for key regional systems

For each of the key regional systems identified, a change model was developed to describe:

1. the regional system (or set its boundaries)
2. the most important drivers acting on the system, which currently may not be climate related; however, the impacts of non-climate drivers will likely be amplified by climate change
3. business-as-usual (or the way the system currently operates)
4. a series of transition pathways that emerge from business-as-usual in response to the need for change
5. a desirable future system, transformed by progress along the transition pathways.

Settlements & land-use planning

The settlements and land-use planning system for the North Coast was defined for the region as the implementation of informed land-use and settlement frameworks to deliver vibrant, liveable, resilient, sustainable and functional communities (Figure 1).

Settlements & Land Use Planning
Definition: Implementing informed land use & settlement frameworks to deliver vibrant, liveable, resilient, sustainable and functional communities
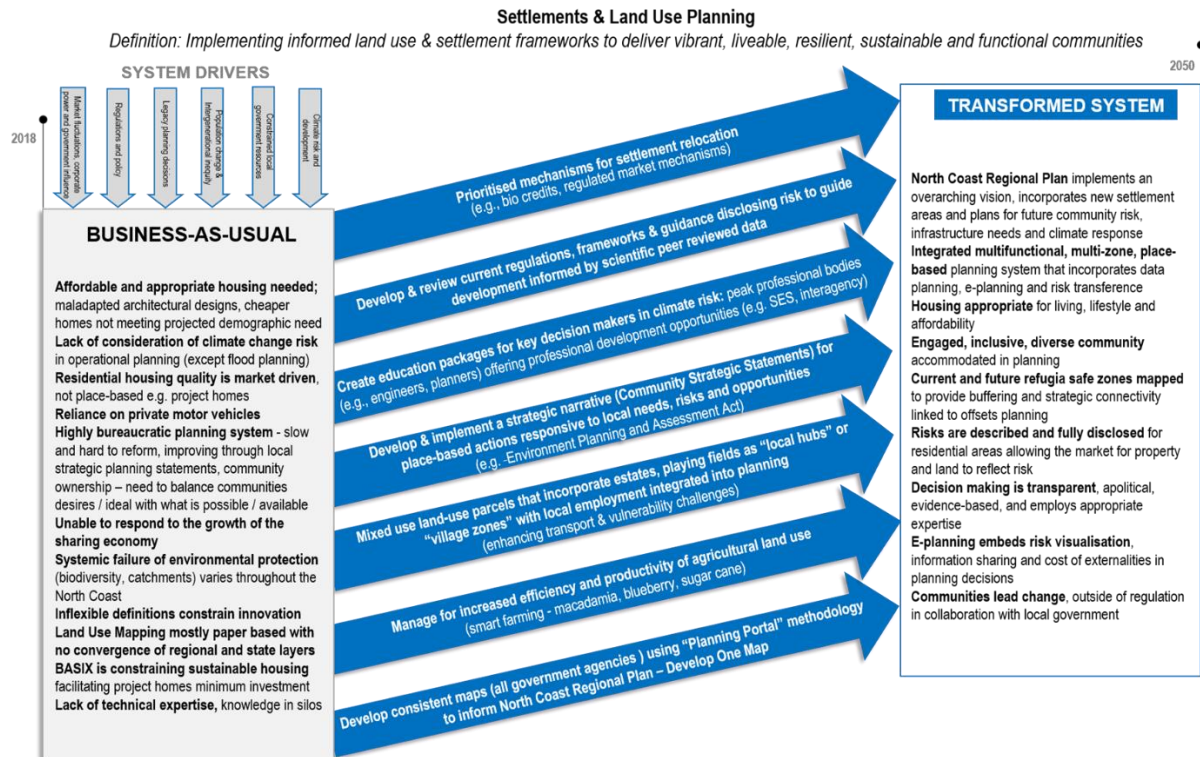
Figure 1:   Change model for settlements and land-use planning

In the North Coast region settlements and land-use planning are influenced by a range drivers including regulation and policy, climate risk and new developments, constrained local government resources, population growth, demographic change and intergenerational inequities. Furthermore, legacy planning decisions act to exacerbate some planning risks.

The North Coast region needs affordable and appropriate housing but currently maladapted architectural designs and 'cheaper' homes are unlikely to meet the needs of projected population growth and demographic change. There is a lack of consideration of climate change risk in operational planning (except for floods). Residential housing quality is market driven, not place-based, meaning that economic factors such as short-term affordability determine the standard housing models available as project homes in residential developments. The Building Sustainability Index (BASIX) currently constrains the implementation of sustainable housing options and further facilitates project home developments with minimum investment. In addition, planning is heavily predicated on reliance on private motor vehicles, leading to a lack of consideration of other transport options. The planning system is currently highly bureaucratic and has so far been unable to respond to the growth of the sharing economy. The system is slow and difficult to reform with inflexible definitions constraining innovation; however, some improvement is evident through local strategic planning statements and greater community ownership. Land-use mapping remains mostly paper-based with no convergence of regional and state planning layers. There is evidence of a systemic failure of environmental protection (biodiversity, catchments) with some variation throughout the North Coast. Many of these issues are compounded by a lack of technical expertise in the region with existing knowledge locked within silos.

Pathways to a desirable transformed system recognise the need for mechanisms that allow settlement relocation (e.g. biodiversity credits, regulated market mechanisms). Such mechanisms would be supported by the review and remaking of regulations, frameworks and guidance materials informed by scientific peer-reviewed data that disclose climate risk in order to guide development. Furthermore, peak professional bodies (e.g. engineers, planners) should be encouraged to offer professional development opportunities (e.g. to SES, interagency) and disseminate targeted education packages to inform key decision-makers about climate risk. Place-based actions on climate impacts require support from a strategic narrative (such as Community Strategic Statements) that are responsive to local needs, risks and opportunities (e.g. under the *Environmental Planning and Assessment Act 1979*). There is a need for planning on the North Coast to accommodate mixed use land-use parcels that incorporate estates and playing fields as 'local hubs' or 'village zones' with local employment opportunities. Agricultural land use needs to be managed for improved efficiency and productivity, for example through smart farming of crops such as macadamia, blueberry and sugar cane. The transition would be strongly supported by the development of a North Coast Regional Plan that makes use of consistent maps, across the range of government agencies, using 'Planning Portal' methodology.

The transformed system envisions an overarching North Coast Regional Plan that incorporates new settlement areas and considers future community risk, infrastructure needs and climate responses. This plan integrates a multifunctional, multizone, place-based planning system that embeds data planning, e-planning and risk transference. Housing is appropriate for living, lifestyle and affordability and an engaged, inclusive, diverse community is accommodated within planning processes. Current and future safe zones have been mapped to provide buffering and strategic connectivity linked to offsets planning. Risks are clearly described and fully disclosed for residential areas ensuring the market for property and land reflects risk. Decision-making is transparent, apolitical, evidence-based, and employs appropriate expertise. E-planning embeds risk visualisation, information sharing and the costs of externalities in planning decisions. Communities now lead change, outside of regulation, in collaboration with local government.

Resilient communities

Resilient communities for the North Coast are defined as diverse, healthy, inclusive, well-prepared and connected (Figure 2). Regional drivers of the current system include a lack of housing affordability, cultural change, population and demographic change (including an ageing population), inadequate planning and decision-making, changing community risks, communities with transient lifestyles and varying service delivery expectations, and extreme event impacts.
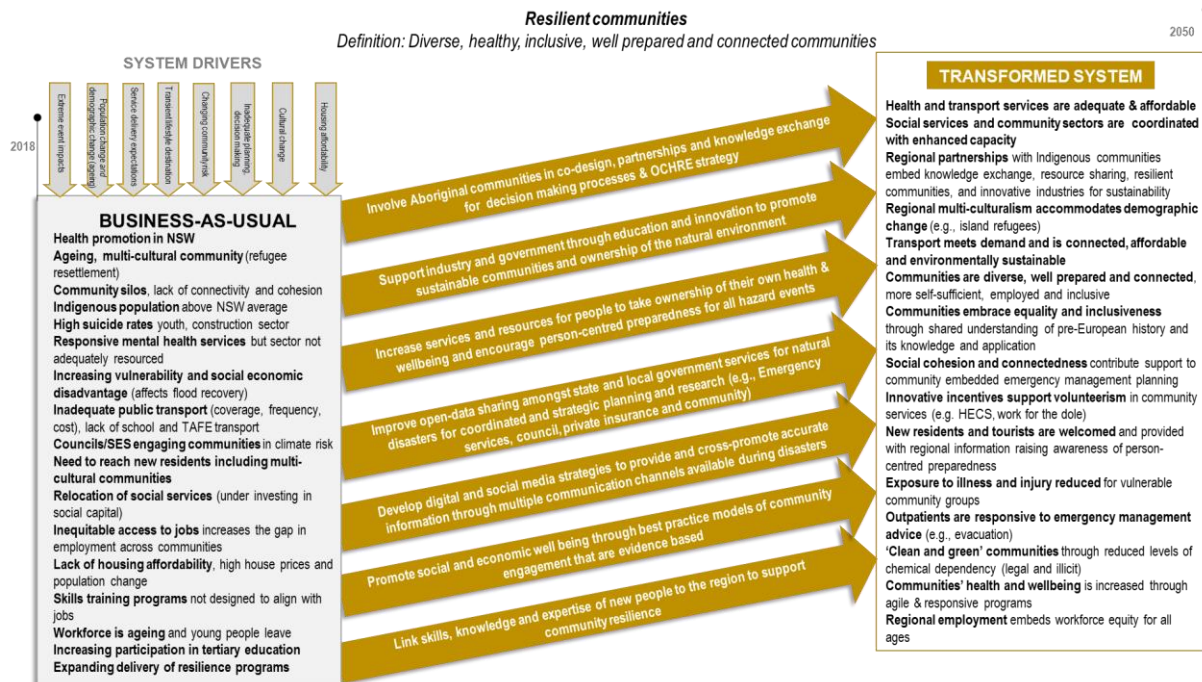
Figure 2:   Change model for resilient communities

The NSW Government actively promotes health and healthy lifestyles to communities throughout the state. The North Coast has a diverse population that is ageing and multicultural. The proportion of Indigenous people making up the North Coast population is above the NSW average; however, communities tend to operate within social groups, which leads to a lack of connectivity and cohesion among groups. Suicide rates are relatively high, particularly among both youth and the construction sector (which is often composed of a short-term workforce). Mental health services are responsive; however, the sector is not adequately resourced. Vulnerability to climate impacts and social and economic disadvantage are increasing, which affects community recovery from natural hazards such as floods. Public transport systems are inadequate in terms of coverage, frequency and cost, and there are insufficient connections to schools and TAFE.

Councils and the State Emergency Service (SES) are engaging communities in climate risk and are expanding delivery of resilience programs, yet there is a need to reach new residents including multicultural and transient communities. The region has experienced changes to social services, which has led to under investing in social capital. Job access is inequitable, which in turn increases the gap in employment across communities. Housing affordability is relatively poor with high house prices, and population change (more affluent 'sea-changers') driving up market prices. The workforce is ageing and young people leave the region for education and work. There is an increasing participation in tertiary education; however, current skills training programs are not well aligned with job opportunities.

Transition pathways identified a need to further involve Aboriginal communities in co-design, partnerships and knowledge exchange for decision-making processes, such as through the *OCHRE* Plan (NSW Aboriginal Affairs). Education and innovation are needed to promote sustainable communities and ownership of the natural environment, with support from industry and government. Communities are encouraged to take individual 'ownership' of their health and wellbeing and to be prepared for hazard events through enhanced services and resources. Improved open-data sharing among state and local government services for natural disasters would allow for coordinated and strategic planning and research. Furthermore, development of digital and social media strategies would provide and cross-promote accurate information on natural hazards through multiple communication channels during hazard events. Adoption of best practice models of community engagement that are evidence-based promote social and economic wellbeing and assist in the development of more resilient communities. In addition, communities could be strengthened by enlisting the skills, knowledge and expertise of new people to the region in support of community resilience.

The transformation to resilient communities envisions adequate and affordable health and transport services. Transport meets demand and is connected, affordable and environmentally sustainable. Social services and community sectors are well coordinated with enhanced capacity. Regional partnerships with Indigenous communities embed knowledge exchange, resource sharing, resilience, and innovative industries for sustainability. The region's multiculturalism accommodates demographic change (e.g. climate refugees). New residents and tourists are welcomed and provided with regional information, raising awareness of person-centred preparedness that encourages community diversity, connectedness, self-sufficiency, and employment. North Coast communities embrace equality and inclusiveness through a shared understanding of pre-European history and application of Indigenous knowledge. Emergency management planning is embedded in communities through greater social cohesion.

Regional employment is high and is equitable for all age groups and demographics. Innovative incentives support volunteerism in community services (e.g. HECS-HELP discounts for volunteers and/or work for the dole initiatives). Exposure to illness and injury is reduced for vulnerable community groups, particularly after extreme events. Outpatients are responsive to emergency management advice ensuring timely action on evacuations and access to medication. The health and wellbeing of communities is increased through agile and responsive programs which lead to 'clean and green' communities with reduced levels of chemical dependency (both legal and illicit).

Cultural heritage

The cultural heritage system of the North Coast is defined as encompassing Aboriginal cultural heritage values, material and living culture and the re-introduction of cultural practices (Figure 3). This system is driven by population growth and urban development pressure, current legislation, policy and regulations, cultural stories and connectivity, Indigenous knowledge of culture and assets, as well as climate change.

Cultural heritage in the North Coast region is characterised by loss of cultural connections to landscapes and loss of cultural sites within landscapes. There continue to be awareness raising and education programs about Aboriginal cultural heritage and cultural practices. There are systemic difficulties engaging with Aboriginal communities and the Registered Aboriginal Party process, and knowledge management and access are not well connected. Leadership within government often has limited knowledge of culture. Local government development application and planning processes insufficiently recognise cultural values, and Aboriginal community engagement is often ad hoc. Aboriginal cultural heritage legislation protects places and objects, but not intangible values, with limited mapping of cultural heritage sites. Cultural heritage management through conservation programs and repatriation is continuing but needs strengthening.
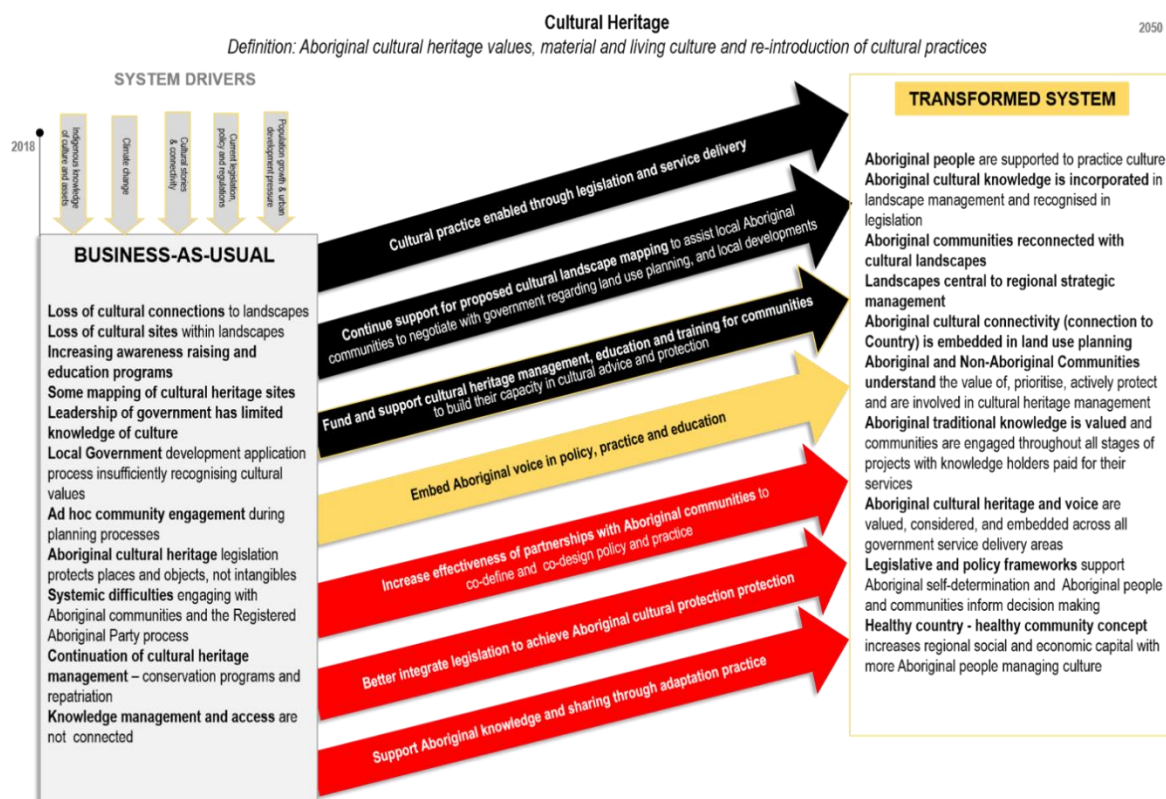
Figure 3:   Change model for cultural heritage

The pathways to a transformed system call for cultural practice to be enabled through legislation and service delivery. Continued support for proposed cultural landscape mapping would assist local Aboriginal communities to negotiate with government regarding land-use planning and local developments. Adequate funding and support for communities for cultural heritage management, education and training would build their capacity in cultural advice and protection. Aboriginal voices should be embedded in policy, practice and education. More effective partnerships with Aboriginal communities would facilitate co-definition and co-design of policy and practice, and better integration with legislation to achieve Aboriginal cultural heritage protection. Additional support for Aboriginal knowledge sharing through adaptation practice would also support the transition to the transformed system.

In a transformed system, Aboriginal cultural heritage and voices are valued, considered, and embedded across all government service delivery areas. Aboriginal people are supported to practise culture, with Aboriginal cultural knowledge and connection to Country incorporated in landscape management and recognised in legislation. Aboriginal communities are reconnected with cultural landscapes, which are central to regional strategic management. Aboriginal and non-Aboriginal communities understand the value of, prioritise, actively protect and are involved in cultural heritage management. Aboriginal traditional knowledge is valued and communities are engaged throughout all stages of projects with knowledge holders appropriately remunerated for their services. Legislative and policy frameworks support Aboriginal self-determination and Aboriginal people and communities inform decision-making. The concept of 'healthy country – healthy community' increases regional social, natural and economic capital with more Aboriginal people intimately involved in managing culture.

Biodiversity

The North Coast biodiversity system was defined as liveable, healthy, adaptive and resilient (Figure 4). The current system drivers include political interest and conservatism, population increases, land-use change, failure of existing strategy, policy and practice, economics, environmental loss and decline, and extreme events including social, national and climatic.

The North Coast is one of the most biologically diverse regions of New South Wales but is increasingly vulnerable to threats from weeds and pests. Responsibilities for biodiversity are fragmented with government under-resourced and with insufficient investment in environmental assets. These issues are compounded by thinly spread implementation of funding across agencies and communities. The planning system is uncoordinated with regional variations in land management objectives and legacy problems (from 'pre-landscape thinking'). The current system has no regional plan to deliver environmental outcomes, weak legislation and a lack of leadership compounded by economic tensions with agriculture. The marine and terrestrial environments are managed by different agencies with varying objectives (e.g. ideological tension between fisheries and native fish conservation). While the region's coastal geography requires specialised management, currently there is a lack of information sharing and strategic use of information.

There is an increasing recognition of the need for corridor connectivity, rehabilitation and restoration (trees and coast), and a current focus on management of threatened species. Within the North Coast, tourism often has negative impacts on the biodiversity of the region (which is a primary tourist attraction). The general public and communities of the North Coast are engaged and participate in supporting conservation of biodiversity assets; however, despite this the region is experiencing ongoing loss of biodiversity with flow-on effects to ecosystem services. Complications in management occur as threatened species and endangered ecological communities sometimes exist on private property and therefore are outside the reserve system.

The transition pathways to a transformed biodiversity system for the North Coast call for strengthening of land protection through a compulsory state of the environment repository for values mapping of biodiversity, native vegetation regulation, and development of a single information source: a 'One map' concept. A monitoring and evaluation framework should be implemented with Integrated Planning and Reporting (IP&R) framework strategies using a range of mechanisms that promote the retention, restoration and enhancement of biodiversity and ecosystems. A strengthened focus on landscapes rather than species to prioritise high conservation areas (e.g. Marine Estate Management and the *Saving Our Species* program) would aid in working towards the transformed system, as well as the

increased use of information and technology for management (e.g. 3D mapping, drones). Recognition of the socioeconomic value of biodiversity could be increased through education programs. Improved understanding is needed of critical thresholds for the supply of ecosystem services to the region. Existing engagement programs for biodiversity would benefit from further engagement with the community on planning and collaborative delivery of biodiversity conservation.
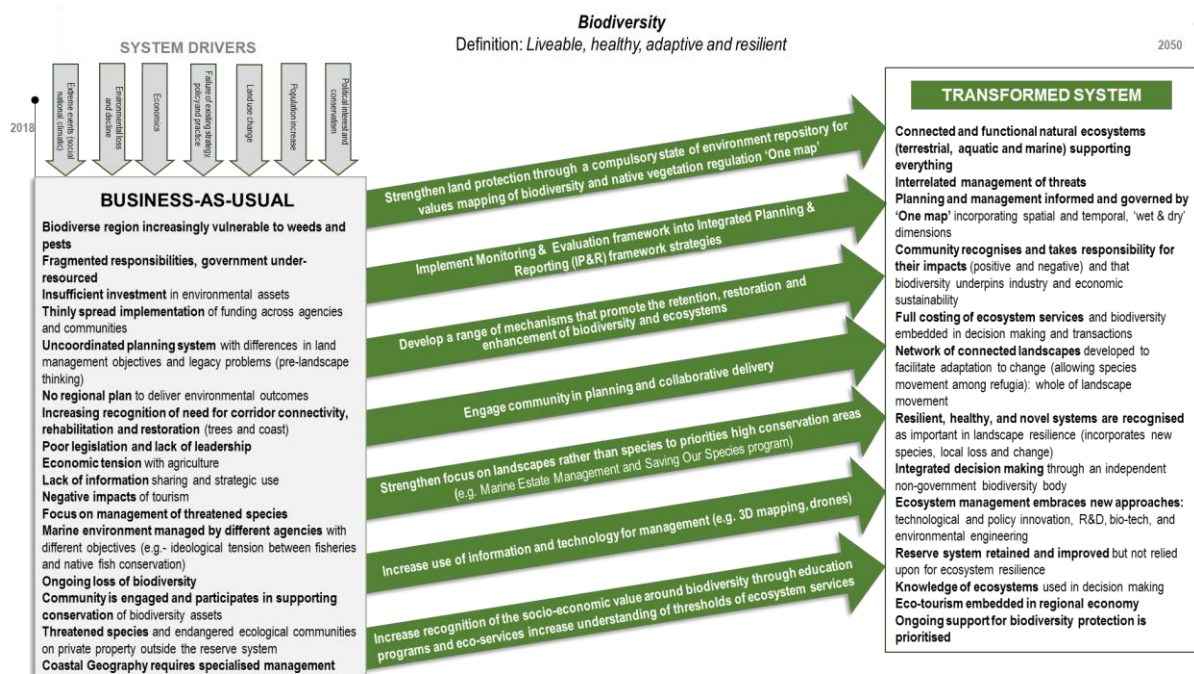
Figure 4: Change model for biodiversity

A transformed system for biodiversity encompasses connected and functional natural ecosystems (terrestrial, aquatic and marine) 'supporting everything'. Management of threats is deeply interrelated and needs to be considered holistically. Planning and management are informed and governed by 'One map', which incorporates spatial and temporal and 'wet & dry' dimensions. Full costing of ecosystem services and biodiversity is embedded in decision-making and transactions. A network of connected landscapes facilitates adaptation to change allowing species movement among refugia throughout the entire landscape. Resilient, healthy, and novel systems are recognised as important for landscape resilience and incorporate new species, local losses and species change.

Integrated decision-making takes place through an independent, non-government biodiversity body. Ecosystem management embraces new approaches to technological and policy innovation, research and development, bio-technology use, and environmental engineering. The reserve system is retained and improved but not relied upon for ecosystem resilience. Knowledge of ecosystems is used in decision-making and ongoing support for biodiversity protection is prioritised. Ecotourism is embedded in the economy of the North Coast, which benefits the biodiversity system. Finally, the community recognises and takes responsibility for their impacts (positive and negative) and understands that biodiversity underpins industry and economic sustainability.

Emergency management

Emergency management was defined as all-hazards planning for emergency management events: prevention, preparedness, response and recovery with climate change considerations (Figure 5).

Emergency management is influenced by a range of complex drivers that include local and state government legislation and regulations, shifting political cycles, insurance costs, ageing infrastructure and a lack of resources (including funding). Demographic change within the region, a lack of local knowledge as well as community expectations about rescue during events (rather than preparedness) puts strain on emergency management staff.

Figure 5:   Change model for emergency management

Currently, there is increasing residual risk within the North Coast region and emergency management is not coping. Within the State Emergency Service (SES) organisational structures are undergoing change, and there is a need to grow the volunteer workforce supporting both the SES and Rural Fire Service operations. Agency planning is largely siloed and emergency management isn't always involved as much as they could be. In particular, land-use planning committees are not influenced by emergency management committees, which leads to building in areas subject to flooding.

The emergency management system operates under an adaptive management paradigm (staff debrief after events to share learning). The system relies heavily on under-resourced local government for local emergency management. There is some surge capacity; however, it comes at a high cost and from out-of-region. State emergency planning is currently disconnected from local arrangements.

Within the current system asset protection predominates activities. There are high expectations from some sectors of the community and limited planning to service aged care facilities and at-risk groups, including mental health and retirement living. Vulnerable communities and the homeless are given limited consideration despite these groups being least able to adapt. After an event, there is often community trauma; however, the community recovery from trauma is not the core business of the sector. An outdated flood warning system, based on river level alerts, hampers emergency response. The current annual funding model for hazard mitigation and maintenance has little consideration for actual

requirements and the declining resource base, which perpetuates community dependence rather than resilience.

Transition pathways in emergency management focus on organisational change and the operating context of service delivery. For organisational change, there is a need to ensure that planning and processes for emergency management consider climate change risks, develop all hazard risk maps that are open and accessible to everyone, and implement systems for retention and transfer of information, learning and knowledge. Externally, policy development is required that ensures emergency management agencies are consulted in land-use planning decisions, and that funding is increased for local government to purchase and repurpose land and relocate communities from high-risk sites to safer alternatives. Improved funding from the federal and state governments is needed to promote technology innovation, enhance disaster preparedness and prevention, and for consistent regional approaches to information delivery and technology adoption. Community self-reliance would be improved through education and local community capacity building for all-hazards risk management, and through new models of volunteerism (e.g. community hubs – community-led responses to disasters).

A transformed emergency management system envisions a proactive emergency management sector, engaged in a more coordinated research program that addresses on-ground needs and implementation (e.g. Bushfire and Natural Hazards Cooperative Research Centre). Warning systems are consistent across hazard types and government levels, and include compulsory risk notification prior to land/property purchases. Emergency management data is free and open access. Visitors (including non-English speaking) to the region are aware and prepared for emergencies, and communities are self-reliant and resilient, accepting personal responsibility for disaster mitigation and preparedness. Emergency management is embedded in planning with land use predicated on hazard risk, and processes to assist relocation accepted by the community. Real time information is provided to communities for improved decision-making and delivered through technical innovation. Insurance premiums now reflect disaster preparedness and prevention, adjusting premiums for community adaptation to mitigate risks. Legal liability for land-use decisions is managed through appropriate advice to decision-makers. Disaster prevention structures (e.g. levees) are adequately funded and maintained in alignment with climate projections. Infrastructure betterment is embedded in renewal following disasters. Flexible and improved processes of human resource management recognise and reduce fatigue in emergency management staff and volunteers, and enhance the resource base across emergency management services. Planning to manage risk of emergencies and business continuity are continuously reviewed and updated, and target high-risk infrastructure, such as aged care facilities.

Food and agriculture

Food and agriculture on the North Coast is defined as a diverse system incorporating food, fibre, energy, fisheries and forestry production and processing (Figure 6). Currently the system is influenced by a conservative producer base, a market that is unsupportive of environmental innovation, climate change and extreme events, population growth and turnover, biosecurity issues and threats (such as pests and weeds), environmental regulation and red tape, land-use conflict and increasing land prices, social norms and consumer preferences as well as the increasing cost of production.

The current system is heavily impacted by rising costs and lack of support for 'floodplain' agriculture. The region's climate is diverse, which leads to regionally diverse production systems and a large number of individual enterprises. Some sectors are connected into extension networks (e.g. dairy industry), however others are disconnected (e.g. beef), or have independent contact within their sector (i.e. fish co-ops operating as social hubs).

For the food and agricultural sector, state legislation limits water security and capture for horticulture, and there are disincentives aimed at keeping runoff from farms from entering fisheries. Unregulated rivers with limited water sharing plans lead to over extraction in some locations, un-metered use, and a lack of regulation to address this issue. Industry demographics are shifting and are influenced by uncertainty, lifestyle and changing regulation, as well as an emerging 'cottage' industry sector (speciality items, cheese, gin, organic vegetables). Residential development in the region encroaches on agricultural areas. In common with other regions in New South Wales, farmers' terms of trade are declining as supermarket chains limit prices paid for produce (e.g. dairy), and emerging biosecurity issues (pests, diseases) increase expenditure on pest control. The spatial relocation of some horticultural production within the region (e.g. blueberries and macadamias) is causing environmental and social issues leading to land-use and community conflict. In particular, macadamia trees planted on the floodplain cause tension around existing land use and raise property prices, affecting neighbours. For livestock production, heat stress is an increasing problem and changes in pasture composition (e.g. the mix of C3/C4 grasses and legumes) affects forage quality. A reform process for fisheries has seen recent changes in the sector that impacts catch.

Pathways towards a transformed system include the development of a strategic focus for the region that promotes the wide diversity of produce. The North Coast has a significant point of difference to other regions with a 'liquorice all-sorts' offering of produce. Climate change adaptation requires support from NSW Government programs for North Coast agriculture. Consultation processes around land-use planning to promote long-term sustainable productivity need improvement and implementation, to include environmental management plans and local communities-of-practice supported by appropriate training. Regional infrastructure is needed to support existing and future industries at all scales (e.g. from food hubs to cottages). Agricultural cooperative models should be explored and low-cost and innovative ways to promote resource sustainability and efficiency (water, fertiliser, drainage, soil, vegetation and energy) need to be investigated. Social licence to operate would be supported through research and data collection, and industry engagement in reporting improvement in environmental performance and animal welfare. Agritourism (particularly horticulture) should be valued as intrinsic to regional tourism promotion (e.g. forestry, fishing, blueberry 'footprints', gin distillery in Dorrigo). Understanding the relationship between primary production and the viability of the regional economy would be promoted by a community education program.

Food and Agriculture
Definition: diverse system incorporating food, fibre, energy, fisheries and forestry production and processing
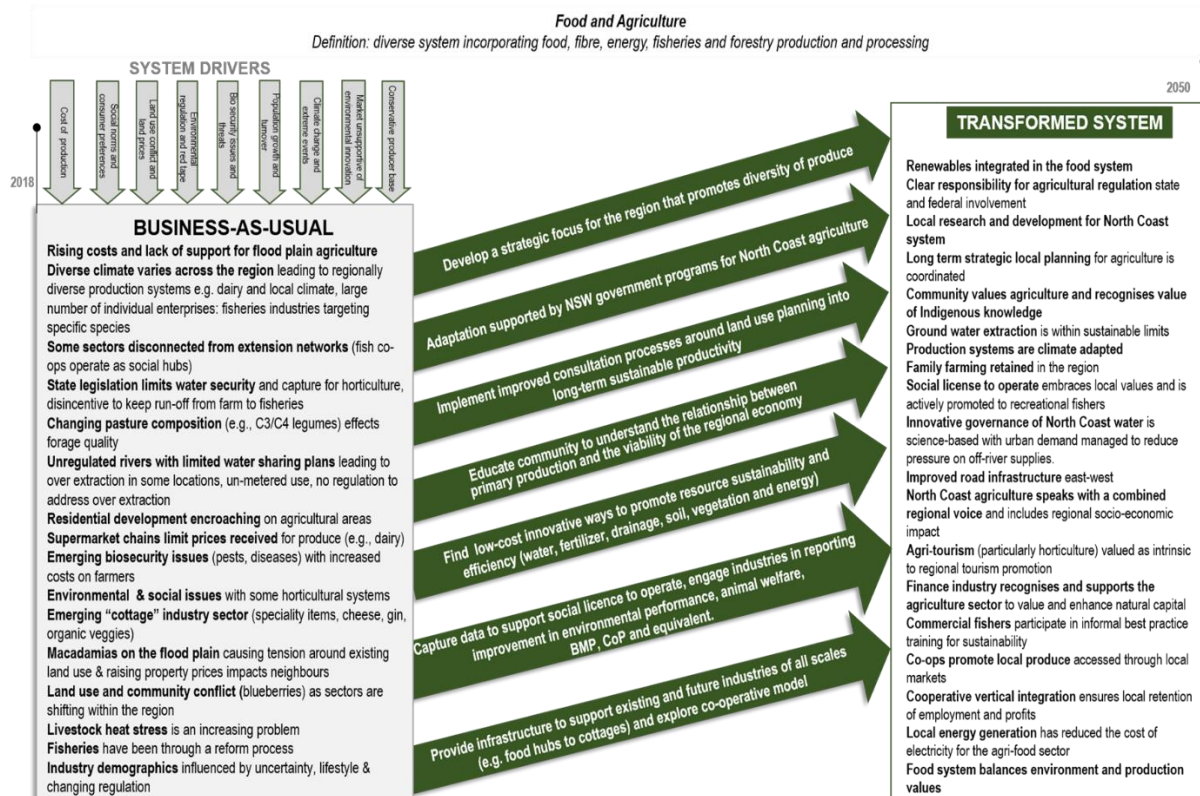
Figure 6:   Change model for food and agricultural

A transformed food and agriculture system features coordinated planning for agriculture that is long-term, strategic and local. The food system balances environment and production values and integrates renewable energy (e.g. solar pumps, recycled water where possible). Responsibility and involvement of the state and federal governments for agricultural regulation is clear. The community values agriculture and local Indigenous knowledge. Local research and development for North Coast primary production systems is reinvigorated to offset the loss of regional capacity over recent years. Production systems are climate adapted and ground water extraction operates within sustainable limits. Innovative governance arrangements for North Coast water are science-based with urban demand managed to reduce pressure on off-river supplies. Family farming has been retained in the region and social licence to operate embraces local values, and is actively promoted to recreational fishers. Commercial fishers actively participate in informal best practice training for sustainability. North Coast food and agriculture speaks with a combined regional voice that recognises regional socioeconomic impacts. Cooperatives promote local produce accessed through local markets, and are vertically integrated to ensure local retention of employment and profits.

East-to-west road infrastructure is improved and supports agritourism (particularly horticulture) to enhance its intrinsic value to regional tourism promotion. Local energy generation reduces the cost of electricity for the agri-food sector and the finance industry recognises and supports the sector-based initiatives to conserve and improve regional natural capital.

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Infrastructure and water

The infrastructure and water system is defined succinctly as critical-infrastructure-service (Figure 7). Factors that currently influence the region include funding, population increase and change, cultural change, technological innovation (e.g. automation), regulatory frameworks, policy, pricing, and climate change.
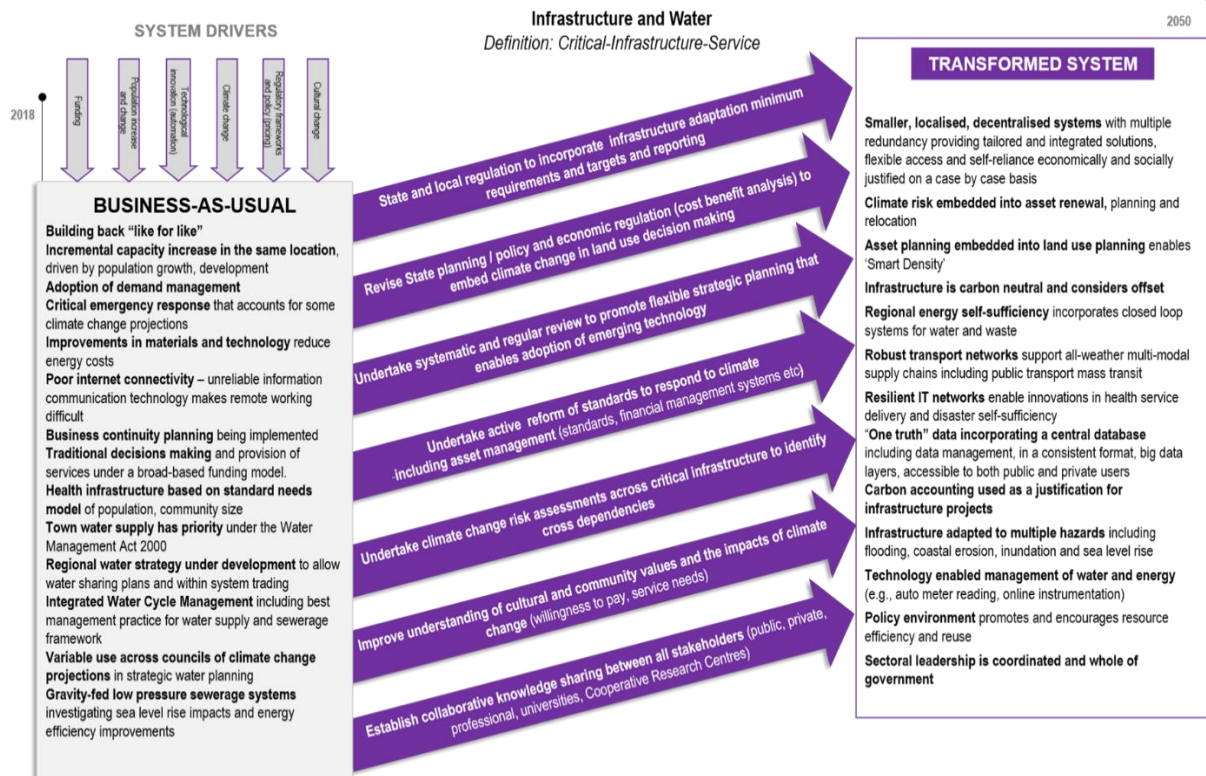
Figure 7:   Change model for infrastructure and water

The current system focuses on rebuilding 'like for like' infrastructure during development or after disaster events. Rebuilding following disasters is often constrained by funding models that do not allow for improvements, exacerbating vulnerability. Often infrastructure capacity at a location increases only incrementally, driven by population growth, and supported through the adoption of demand management in energy and water systems; however, the need for augmentation of infrastructure is anticipated as climate risks escalate.

Regional communities are growing, and the influx of holiday season tourists and holiday rental properties can place significant pressure on local infrastructure. For potable water, town supplies have priority under the *Water Management Act 2000* and there is a regional water strategy under development to allow water sharing plans and within system trading in water resources. Integrated Water Cycle Management supports a framework for best management practice in water supply and sewerage services, and councils are at different stages of incorporating climate change projections in strategic water planning. Currently, sewerage systems in the region are gravity-fed and low pressure, and the impacts of sea level rise and improvements in energy efficiency are under investigation to ensure safety and security of services.

Climate change projections are accounted for in critical emergency response by infrastructure managers; however, this is not applied consistently across all assets and locations in the region. There have been improvements in materials and technology to reduce energy costs. Remote working, while becoming increasingly popular and desirable, is constrained by poor and unreliable internet connectivity. Business continuity planning is

being implemented; however, there is room for improvement, particularly within government. Decisions about energy and water service delivery are made primarily under a traditional broad-based funding model rather than incorporating up-to-date information, particularly about climate change. For example, health infrastructure in the region is often under stress as it is based on standard needs modelling of population and community size.

Transition pathways focused on reforming and improving regulations, standards and frameworks. Minimum requirements, targets and reporting for infrastructure adaptation should be incorporated into state and local regulation. State planning, policy and economic regulation (cost–benefit analysis) should be revised to embed climate change in land-use decision-making and the siting of infrastructure. Systematic and regular review of policy and active reform of standards (standards, financial management systems, etc.) would promote flexible strategic planning that enables adoption of emerging technology to respond to climate change. Climate change risk assessments across critical infrastructure would allow identification of cross-dependencies and improve the understanding of cultural and community values regarding climate change impacts. This will include willingness-to-pay and regional service needs. Establishment of collaborative knowledge sharing among stakeholders, including public, private, professional, universities and Cooperative Research Centres, is required to achieve system transformation.

Under a transformed system for infrastructure, water systems are smaller, localised and decentralised with multiple redundancies providing tailored and integrated solutions, flexible access and self-reliance economically and socially. Climate risk is embedded into asset renewal, planning and relocation, and asset planning is embedded into land-use planning to enable 'Smart Density' development. Carbon accounting is used to justify infrastructure projects. Infrastructure is carbon neutral and considers offsets where 'net zero' emissions are problematic (e.g. airports). Regional energy self-sufficiency is incorporated in closed loop systems for water and waste. Management of water and energy is technology-enabled (e.g. auto meter reading, online instrumentation). A robust transport network supports all-weather, multimodal supply chains including mass transit public transport (e.g. rail). Resilient IT networks enable adoption of innovations in health service delivery, disaster self-sufficiency, and remote working. 'One truth' data is incorporated into a central database with data layers managed in a consistent format that is accessible to both public and private users. Infrastructure is adapted to multiple hazards including flooding, coastal erosion, inundation and sea level rise. The policy environment promotes and encourages resource efficiency and reuse with sectoral leadership coordinated across whole-of-government.

Energy

The North Coast energy system was defined as ensuring the security and provision of reliable and dispatchable 'base load' power, or 'energy in the face of climate change' (Figure 8).
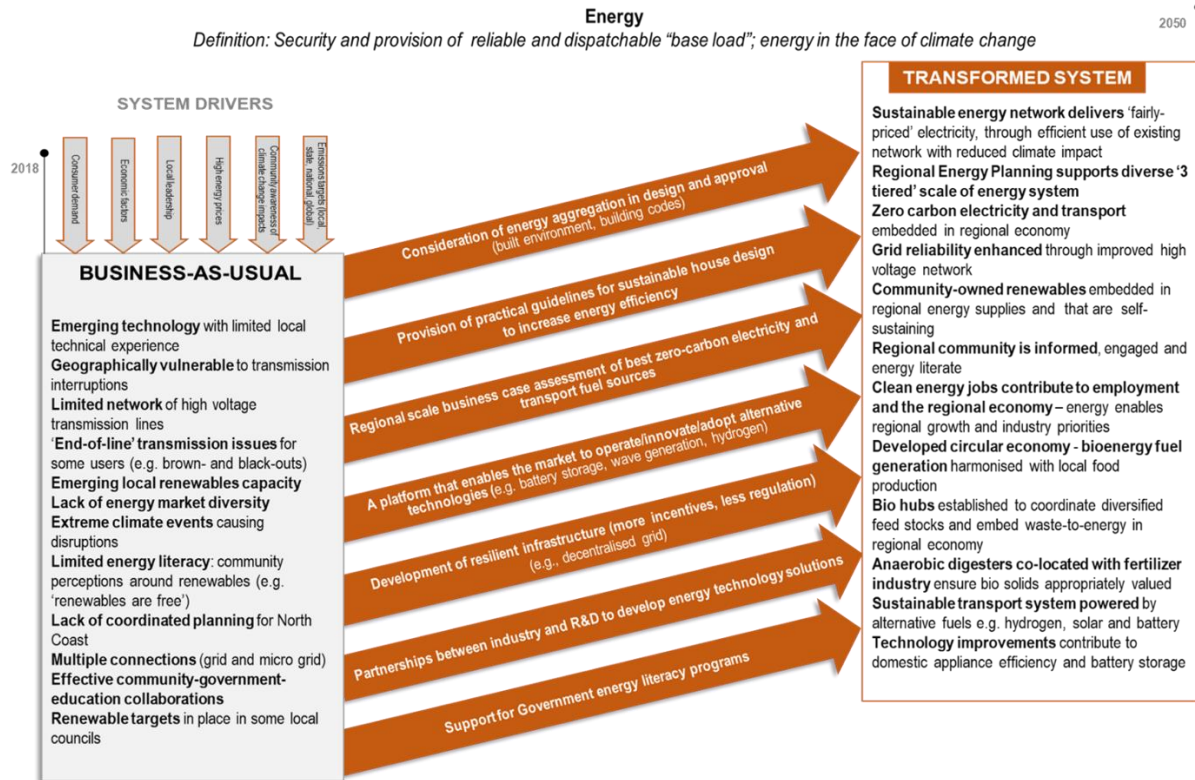
Figure 8:   Change model for energy

The energy system is viewed as already in transition, with change being driven by emissions targets (including local, state, federal and global targets), an increasing community awareness of climate change impacts, local leadership, and a range of economic factors that includes relatively high and rising energy prices and consumer demand.

The region's energy system has access to emerging technology; however, its optimal implementation is currently constrained by limited local technical experience. The region is geographically vulnerable to transmission interruptions due to extreme weather events, because of a limited network of high voltage transmission lines with 'end-of-line' issues for some users (e.g. causing brown- and black-outs). Energy planning, including micro-grids and decentralised energy, is becoming more prominent but there is a lack of energy market diversity, which may change over time through the expansion of local renewables capacity. Limited energy literacy among consumers can cause confusion and sub-optimal decision-making. For example, community perceptions that 'renewables are free' makes the case for investment in network infrastructure (e.g. poles and wires) problematic. Community–government–education collaborations are currently in place to improve community understanding of the energy system. Renewable targets are in place in some local councils; however, there is a lack of coordinated planning for North Coast region.

Transition pathways call for consideration of energy aggregation in both design and approval (both the built environment and building codes). To achieve the desired transformed future, practical guidelines are required for sustainable house design to support increased energy efficiency. Technology adoption would be enabled through a region-scale business case to assess best sources of zero carbon electricity and transport fuels, and an information-sharing platform to enable the market to assess alternative technologies such as battery storage,

wave generation, decentralised grids and hydrogen. More incentives and less regulation would aid in the development of more resilient infrastructure. In addition, partnerships between industry and research and development would aid in development of innovative energy technology solutions. The community would be supported in the transition to a more resilient energy system through ongoing government programs to improve energy literacy.

Transformation in the region's energy system envisages a sustainable energy network that delivers 'fairly-priced' electricity, through an efficient use of the existing network coupled to reduced climate impacts. Regional Energy Planning supports a diverse energy system that operates at multiple scales. Zero carbon electricity and transport are embedded in the regional economy. Grid reliability has been enhanced through an improved high voltage network and decentralised energy system. The regional community is informed, engaged and energy literate, and community-owned renewables are embedded in regional energy supplies that are self-sustaining. Clean energy jobs contribute to employment and the regional economy where energy enables regional growth and industry priorities. The region supports a thriving circular economy. Bioenergy fuel generation is harmonised with local food production, and bio-hubs coordinate diversified feed stocks and embed waste-to-energy in the regional economy. Anaerobic digesters are co-located with the fertiliser industry to ensure bio-solids are appropriately valued. The regional transport system is sustainable and powered by alternative fuels (e.g. hydrogen, solar and battery). Improvements in technology have contributed to the efficiency of domestic appliances and enhanced battery storage.

Tourism

Regional tourism is defined as sustainable, dispersed, unique and experiential (Figure 9). The natural environment and regional culture and lifestyles are major attractions for visitation. The key drivers on the system include changing demographics and an increasing population, and disruptions caused by weather and climate change. The effectiveness of tourism marketing and the Pacific Highway upgrade, which is improving travel times to North Coast destinations and weather-performance of the highway, are also influencing tourism.

The existing tourism system currently highlights 'Hero Destinations' (e.g. Byron Bay, Coffs Harbour and Port Macquarie) which attract local, state and international visitors. The whole region incorporates a diverse sector, attracting holiday makers, south east Queensland day-trippers, grey nomads, caravan and camping, conferences and events (e.g. foodies, markets, sports, etc.), and health and wellbeing activities. The majority of visitors to the North Coast are independent travellers (rather than on pre-packaged tours). The North Coast's natural environment, national parks and Indigenous culture, attract significant numbers of visitors to the region. Increasingly, events and festivals focused on music (e.g. Splendour in the Grass, Falls, Blues Fest), art, culture, food (e.g. Eat the Street Lismore, Food and Wine Festival Ballina), sporting (e.g. triathlons, bike road racing) and business events are drawcards to the region. Popular local festivals include Beef Week, which recently welcomed the Tropical Fruits Gay and Lesbian Festival, car rally events, and Grafton's traditional Jacaranda Festival. However, the growth in tourism demand has led to some infrastructure failures in some locations (e.g. sewerage, transport), which can be exacerbated by overcrowding in some popular centres (such as Byron Bay).

Transition pathways include creating a visionary strategy supported by data-informed marketing decisions for enhancing 'Hero Destinations' that would enable visitors to have holidays that are experience- and place-based. This strategy should be linked to a regional tourist dispersal plan to surrounding towns with local attractions, and matched investment in infrastructure to cope with increased visitation (e.g. waste management of sewage and

landfill, water and protection of natural environments). The region needs to explore alternative sources of investment (e.g. offsetting programs, funding through nature-based tourism) that are secure and would reduce reliance on short-term government grants. Regional transport planning should integrate technology and innovation in transport options and enhanced public transport. Further exploration of additional product offerings is required that builds on regional strengths, exploits opportunities for finance, and encourages entrepreneurial spirit. Investment is required at both a local and regional scale in sustainable tourism education and business development platforms (e.g. online tutorials, certified courses, YouTube videos, on the job training) linked to networks to promote entrepreneurship and mentoring.
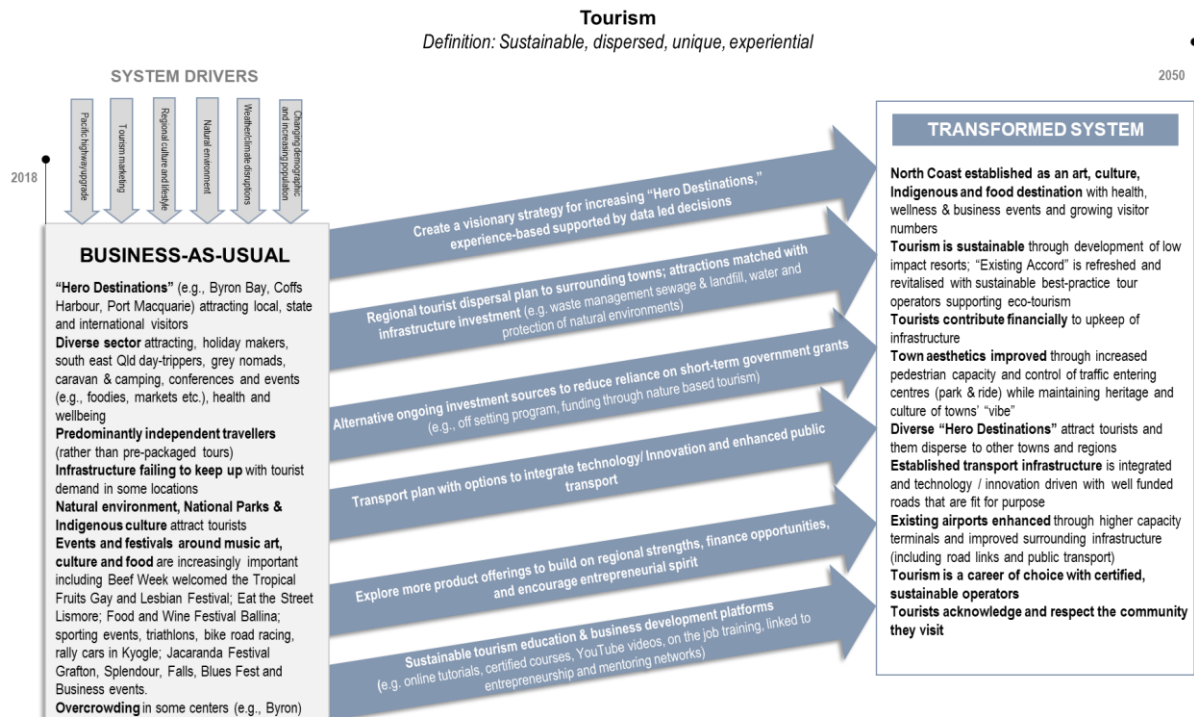
Figure 9: Change model for tourism

The transformed system sees the North Coast established as an arts, culture, Indigenous-experience and food destination with a diverse range of health, wellness and business events and growing visitor numbers. Tourism will be sustainable through development of low impact resorts. The 'Existing Accord' has been refreshed and revitalised with tour operators supporting ecotourism through widespread adoption of sustainable best practices normalised as the industry standard. Tourists will contribute financially to the upkeep of regional infrastructure. Town aesthetics have been improved through increased pedestrian capacity and better control of traffic entering town centres (e.g. through park and ride) while maintaining heritage and cultural values of a town's unique 'vibe'. Diverse 'Hero Destinations' attract tourists who are then dispersed to local attractions throughout the region. Established transport infrastructure that is integrated and technology-/ innovation-driven, with well-funded roads that are fit for purpose. Higher capacity terminals and improved surrounding infrastructure (including road links and public transport) are features of the North Coast's airports. Tourism is a career of choice with certified, sustainable operators supporting additional jobs that encourage young people to stay in the region. Finally, in a transformed system, tourists will acknowledge and respect the communities they visit.

3. How is the North Coast vulnerable to climate change?

In partnership with regional decision-makers, the ERA process considers the climate vulnerability of regional communities in the context of biophysical impacts and socioeconomic change, with a focus on government service planning and delivery. By drawing on regionally specific data and local knowledge under the five capitals framework, an integrated understanding is developed of the relationships within key systems, and desirable adaptive responses and futures are identified.

3.1 Social and economic

People

The North Coast region encompasses the traditional lands of the Bundjalung, Gumbayngirr, Dunghutti, Nganyaywana, Biripi and Yaegl peoples.

The region consists of multiple language groups and incorporates all or part of 22 Local Aboriginal Land Councils. Based on 2016 Census data, the Indigenous population of the region is estimated to be 25,000 people or 5% of the total population (ABS 2016a).

In the region there are a large number of cultural heritage sites and 16 Aboriginal Places identified under and protected by provisions of the *National Parks and Wildlife Act 1974*. There are four Indigenous Protection Areas (Ngunya Jargoon, Minyumai, Dorodong, Gumma) in the region which are recognised by the Australian Government as an important part of the National Reserve System.

The region's total population in 2016 was 502,460 (ABS 2016b). Figure 10 provides a comparison of populations within each local government area (LGA) ranging from 91,380 people in the Tweed Shire LGA to 8929 in the Kyogle LGA.
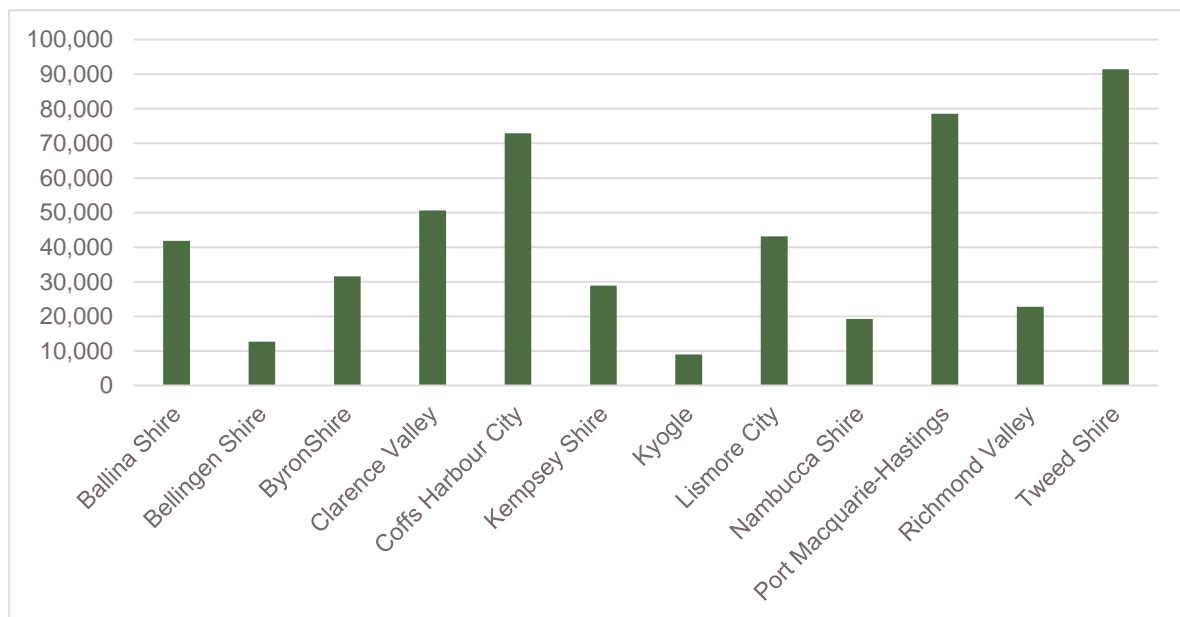
Figure 10:   Local government area population statistics from 2016
Source: Department of Planning and Environment (2016)

The population of the North Coast region is projected to grow by 14% over the next 17 years (to 2036). The proportions across the age profiles (from 2016 to 2036) are projected to change, with the number of young people (less than 15 years old) declining by 1%, people of working age (15–64) also declining by 7%, and people 65 or older growing by 9%. This will see the proportion of people aged 65 years or older grow from 22% to 31% of the total population by 2036 (Department of Planning and Environment 2016).

The workforce participation rate for the region in 2016 was 55.5% (NSW 65.7%) and the working age population (i.e. those aged 15–64) of the region comprised 70.7% (NSW 74.2%) of the total population (Department of Jobs and Small Business 2017).

The region generally has both a younger and an older population compared to New South Wales as a whole, with a pronounced difference in the working age population (Figure 11). The region has higher dependency ratios than the state overall, meaning that a smaller proportion of its working age population is supporting a higher proportion of people deemed not to be in the workforce.
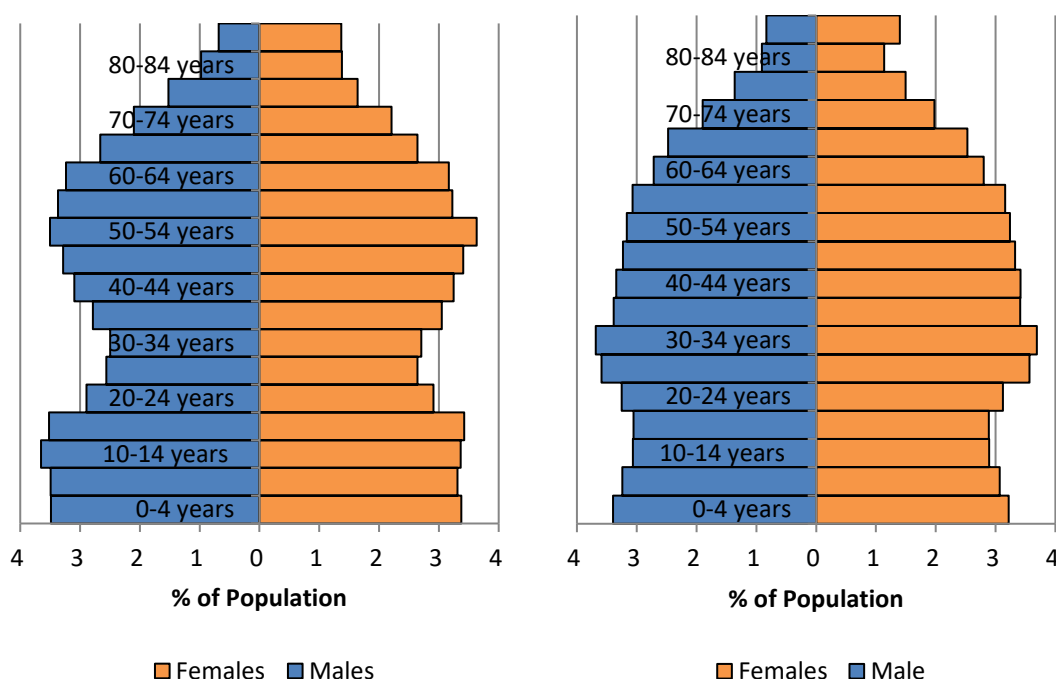
Figure 11: Age distribution in the North Coast region (left) compared to New South Wales (right) Source: Australian Bureau of Statistics (2016b)

Stakeholders from the region expressed the greater importance of social relationships and bonds, family links, groups, support networks and influences over political decisions. Some key points when assessing social capital for the region include:

- 92% of the region has a well-developed proficiency in English speaking compared to 1% not well or not at all, among non-English speaking background people (ABS 2016b)
- 65% of the region is families, with the highest proportion of families classed as coupled families with no children (44%), followed by coupled families with children under 15 years (25%) (ABS 2016c)
- 16% of the population in 2016 was involved in volunteer activity (ABS 2016a)
- being able to contact family and friends not living in the same household can enhance a person's feelings of connectedness to the wider community and can build social resilience. Based on the 2014 General social survey (ABS 2015) most households have face-to-face contact with family or friends living outside of the household at least once a week or every day (Figure 12).
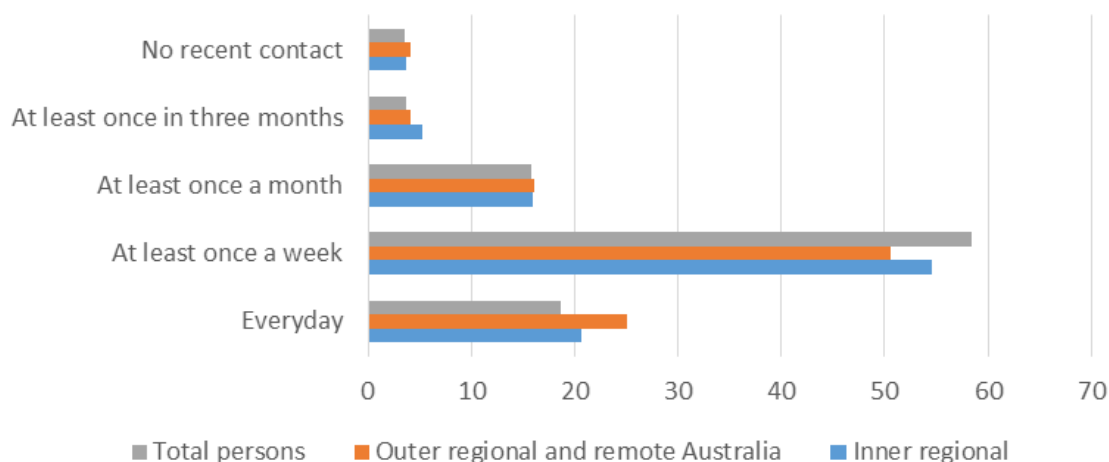
Figure 12: **Frequency of face-to-face contact with family or friends living outside the household** Source: Australian Bureau of Statistics (2015)

Human capital considers the skills, health and education of individuals that contribute to the productivity of labour and physical capability to respond to climate. Based on 2016 Census data key attributes of human capital for the region are:

- compared to the whole of New South Wales, people living in the region were much less likely to have completed Year 12 education and more likely to have left school before or directly after Year 10; 46% of people had certificate level and 22% of people had a post-secondary schooling qualification above certificate level (ABS 2016c)

- 88.2% of people living in the region spoke English at home compared with 4.1% who spoke another language (ABS 2016c)

- compared to the whole of New South Wales, the workforce had an under-representation of professionals and community and personal service workers and an over-representation of labourers (ABS 2016c)

- 6.8% of the region requires assistance with core activities, higher compared to the whole of New South Wales (5.4%) (ABS 2016b)

- in 2017, the incidence of obesity was higher than for New South Wales as a whole (NSW Health 2018)

- four local government areas were ranked in the top 20 for socioeconomic disadvantage in New South Wales based on the ABS Socio-Economic Indexes for Areas (SEIFA; ABS 2016a).

Economy

- The regional output for North Coast region is valued at $14.3 billion with over 40,000 businesses and supporting over 186,700 jobs. Industry is quite diverse, with the major employment sectors being health care and social assistance, retail trade, education and training, accommodation and food services, and construction. The construction sector is the region's largest industry, with a 16.9% share of regional output and 9.3% of employment (Table 1).

- Manufacturing is very significant in the region with an output of over $6 billion in 2016 and 5.2% of employment. Health care and social assistance is another of the largest sectors, with increased demand from a growing and ageing population likely to drive continued growth in this sector. The education and training sector, which is anchored by Southern Cross University and North Coast TAFE, contributes around 4.9% to regional output and 9.9% of employment. The region's visitor economy contributes around $2.8 billion (or 12%) to its GRP, supporting a range of industries including the accommodation and food services and allied retail trade sectors (Destination NSW 2018)

Table 1: **Top five industries by contribution to GRP and top five employers by industry**

Industries by contribution to GRP in 2016	Employers by industry in 2016
1. Construction (16.9%)	1. Health care and social assistance (17.8%)
2. Manufacturing (12.0%)	2. Retail trade (12.4%)
3. Rental, hiring & real estate services (11.9%)	3. Education and training (9.9%)
4. Health care and social assistance (7.7%)	4. Accommodation and food services (9.5%)
5. Agriculture, forestry and fishing (6.3%)	5. Construction (9.3%)

Source: REMPLAN data incorporating Australian Bureau of Statistics' (ABS) 2016

Physical capital comprises the items produced by economic activity from other types of capital such as the built environment, infrastructure and equipment (houses, schools, clinics, roads, farm machinery, and producer goods accessible by the community). Based on 2016 Census data key attributes of physical capital for the region are:

- Separate occupied houses (73.8%) are the dominant dwelling type, followed by semi detached (10.5%) and unoccupied dwellings (10.2%). A small percentage are flats or units (9.1%) and caravan, cabin or houseboat (3.6%) dwellings (ABS 2016b).

- The internet is accessed from most dwellings in the region (72.8%), compared to no internet access (18.1%) (ABS 2016b).

- There are a total of 86 private schools, 221 public schools, 29 hospitals and 31 libraries (Education NSW 2016; NSW Health 2016; Private Schools Directory 2016).

3.2 Biophysical

The North Coast is characterised by coastal sand dunes, major estuaries and floodplains, through low foothills and ranges, to the very steep hinterland of the Great Dividing Range. The topography of the region and coastal setting results in climate conditions that vary across the region. It is very wet along the coast, especially in the north, but drier inland. Summers are warm across the region, with cool winters in the foothills and along the Great Dividing Range.

North Coast is one of the most biologically diverse regions of New South Wales; conservation areas include World Heritage areas, national parks and reserves, marine parks, declared wilderness areas, crown reserves dedicated for environmental protection and conservation, and flora reserves.

There are nine major river catchments in the region – the Tweed, Brunswick, Richmond, Clarence, Coffs Harbour Waterways, Bellinger, Nambucca, Macleay and Hastings. The region also includes 49 significant coastal lakes and estuaries, 900 wetlands and 70 littoral rainforests.

3.3 Expected regional climate change

Information on projected climate for the region can be found in the North Coast Climate Change Snapshot report on the AdaptNSW website (OEH 2014) The snapshot provides near future (2030) and far future (2070) scenarios (see Table 2).

The climate projections for 2020–2039 are described in the snapshots as *near future*, or as 2030, the latter representing the average for the 20-year period. The climate projections for 2060–2079 are described in the snapshots as *far future*, or as 2070, the latter representing the average of the 20-year period.

In summary:

- The region is expected to experience an increase in all temperature variables (average, maximum and minimum), more hot days, and fewer cold nights for the near and far futures. Heatwaves are also projected to increase, be hotter and last longer.

- Seasonality of rainfall will change. Autumn and spring rainfall will increase in the near future and the far future. The majority of models agree that winter rainfall will decrease in the near future and the far future. Summer rainfall is projected to decrease in the near future; however, summer rainfall is projected to increase in the far future.

- Fire risk will increase during summer, autumn and winter, with projected increases in average and severe Forest Fire Danger Index values in the near future and the far future. Autumn is projected to have a slight decrease in fire weather.

Table 2:   Climate change projections for the North Coast region

Climate variable (average across the region)	Trend	Projections	
		Near future (2030)	**Far future (2070)**
Atmospheric CO_2	Increase	A2 IPCC emissions scenario	
Max. temperature	Increase	0.4 – 1.0°C	1.5 – 2.4°C
Min. temperature	Increase	0.5 – 1.0°C	1.6 – 2.5°C
Hot days	Increase	0 – 5 days (Richmond Valley – 5 –10 days)	3 – 12 days (Richmond Valley – 10 – 20 days)
Cold nights	Decrease	0 – 20 days	0 – over 30 days
Heatwaves	Increase (frequency)	0.9 – 1.5 events	2.5 – 4.5 events
	Increase (intensity [a])	1.5 – 7.5°C^2	3 – 15°C^2
	Increase (duration)	0.5 – 2.5 days	3 – 9 days
Annual rainfall [b]	Drying & wetting	–8% to +11%	–6% to +31%
Changes in average rainfall by season [b]	Drying & wetting	Summer: –17% to +14%	Summer: –10% to +39%
		Autumn: –9% to +37%	Autumn: –8% to +39%
		Winter: –40% to +30%	Winter: –35% to +38%
		Spring: –18% to +25%	Spring: –18% to +49%

[a] Amplitude is the hottest day of the hottest heatwave of the year. Units are °C^2 because it is the product of two temperature anomalies.

[b] Negative values represent drying and positive values represent wetting under projections for annual rainfall and seasonality rainfall. Source: Office of Environment and Heritage (2014).

Climate change will impact agricultural systems (affecting crops, evaporation of surface water, and stock), vulnerable groups within regional communities (such as the ill, very young and the elderly), natural ecosystems, regional infrastructure and fire management (see Appendix A).

3.4 Vulnerability affecting government services

Local decision-makers identified six factors that affect the vulnerability of the North Coast region and which interact to set constraints and opportunities around the ability of government to service the community (OEH 2016). Already influencing the region, the importance of these vulnerabilities is likely to be amplified by changes to climate:

1. **Narrow coastal plain:** The steep hinterland, river systems and low-lying coastal plains, which give the North Coast landscape its character, make the region particularly sensitive to changes in flooding and sea level rise.

2. **Population demographics and change:** The influx of retirees and loss of youth to the major cities mean the North Coast population is ageing faster than many other regions in New South Wales. This older age group is generally considered more vulnerable to the impacts of climate change and will present both challenges and opportunities for the region.

3. **Infrastructure (development):** Infrastructure and settlements are exposed to current and future climate related risks with significant investment required to meet the growing needs of the health and aged care sector, provide equitable access to transport, and to overcome the infrastructure maintenance and upgrade backlog.

4. **Regional networks:** Regional networks are considered strong, but are often informal. There is a need for agencies and levels of government to come together regularly to share information on adaptation and solve the common problems it represents. The ageing workforce and imminent retirement of people in these networks needs to be managed to ensure the networks are maintained.

5. **Leadership:** Stronger and more coordinated leadership across all levels of government, business and the community can assist in prioritising, supporting and driving adaptation on the North Coast. Population demographics were viewed as an important contributor to this vulnerability.

6. **Funding models and priorities:** The complexity of adaptation governance, competition for limited resources and 'short-term' financial cycles make it difficult to direct funding to adaptation actions. The financial sustainability of local governments under the current funding model was also a major factor limiting adaptation. Leadership was viewed as an important contributor to this vulnerability.

Vulnerability

Regions across New South Wales vary in their vulnerability to climate change. Figure 13 shows a snapshot of vulnerability for the North Coast region taken from data presented in the North Coast Integrated Regional Vulnerability Assessment (IRVA) (Volume 1; OEH 2016). The snapshot draws on workshop activities, the adaptation survey, discussions and supporting literature and data to illustrate regional vulnerability as three components:

- **red boxes:** exposure to the range of biophysical and socioeconomic drivers that could potentially stress the ability of the region to function

- **orange boxes:** sensitivity to the diverse impacts that result from exposure to drivers of change

- **green box:** adaptive capacity, which is the set of attributes that act to determine how the region might respond to reduce future vulnerability. If present, these attributes can enable adaptation. If these attributes are absent or negative, then adaptive responses will be constrained, and the region will remain vulnerable.

Climate drivers
1. Flooding
2. Storm events
3. Sea level rise
4. Changing rainfall patterns

Adaptive capacity
Local innovation
Sense of community
Community risk preparedness
Climate-adaptive infrastructure
Regional/local social networks
Resource availability/security (natural, financial, human)
Comprehensive long-term regional planning
Shared accessible regional knowledge
Connected tech-assisted learning
Digital communications platform
Community health

Non-climate drivers
Biosecurity
Employment
Political cycles
Social apathy and division
Inadequate telecommunications
Demographic change/migration
Ecosystem change
Land use change
Policy confusion

Direct impacts
Ocean acidification
Increased risk-taking behaviour (1,2)
Changed risk management (1,2)
Increased hospital presentations (1,2)
Increased business cost (1,2)
Power failure (1,2)
Increased call on emergency services (1,2)
Disproportionate impacts on vulnerable groups (1,2)
Altered tourist visitation (1,2,3)
Transport disruptions (1,2,3)
Damage to infrastructure/built environment (1,2,3)
Increased bushfire risk (2,4)
Changed herbage quality (grazing) (4)
Changed surface water quality (1,2,4)
Decreased agricultural productivity (1,2,4)
Damage to ecosystems (1,2,3,4)
Damage to cultural heritage (1,2,3,4)

Indirect impacts
Land use conflict
Demand for policy innovation
Declining social/mental health
Demand for protective structures
Limited disaster response capacity
Increased agriculture production costs
Changing volunteer base and demand
Loss of vulnerable ecosystems and heritage sites
Increased homelessness/illegal dwellings/isolation
Increased pressure on local government resources
Increasing demand for health/aged-care services
Increased infrastructure maintenance costs
Increased building/development costs
Changed property values/rising rents
Increased insurance premiums
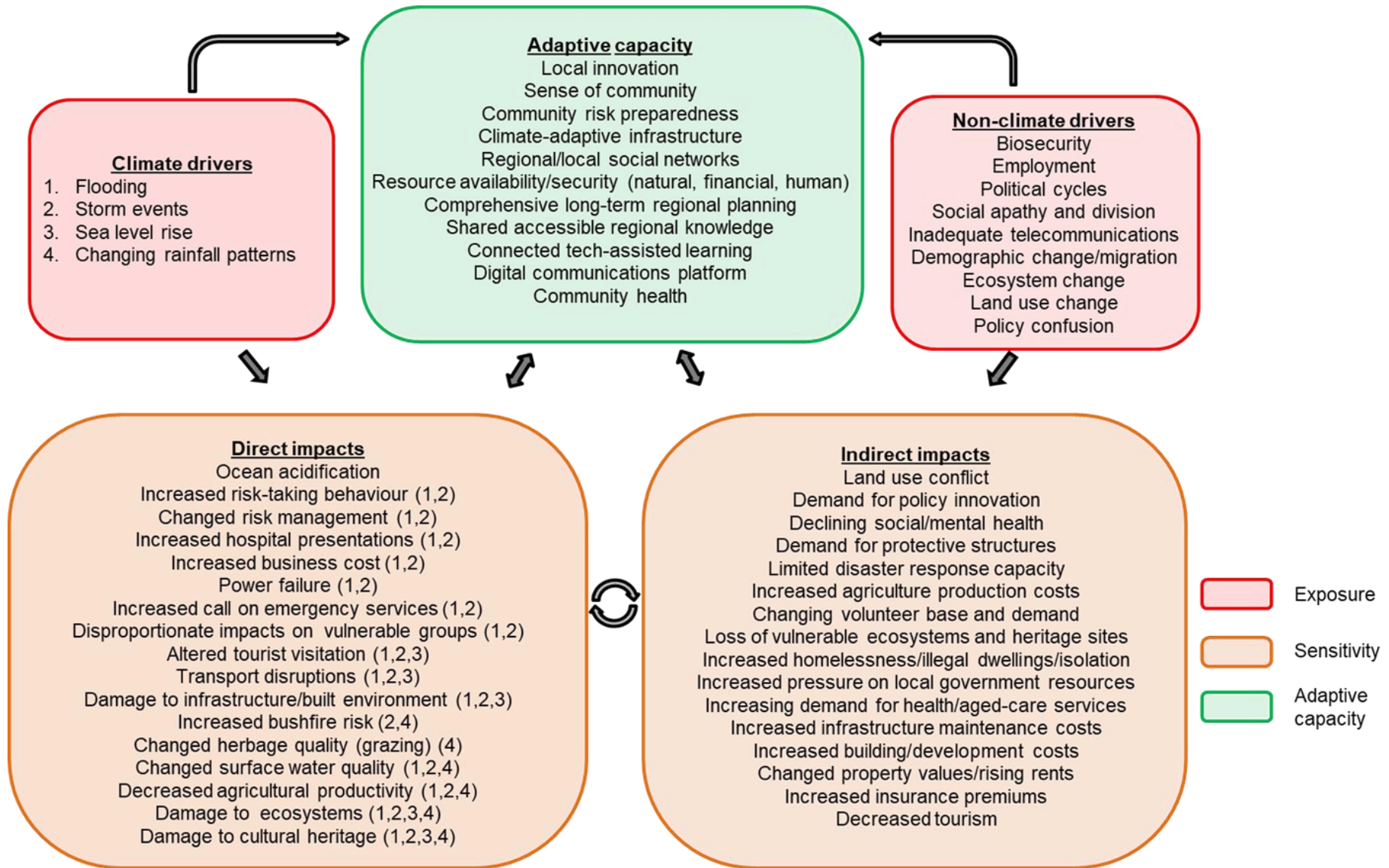Decreased tourism

Exposure
Sensitivity
Adaptive capacity

Figure 13:   Snapshot of vulnerability in the North Coast region Numbers in brackets under direct impacts link the impact to the climate driver(s)

Exposure

Climate drivers

The main climate drivers of the North Coast region were more frequent and intense floods and storm events, sea level rise and changes in rainfall patterns. Of these drivers, changes in rainfall patterns, sea level rise and increased storm events are projected in the regional climate modelling mentioned in Section 3.3 above and on the AdaptNSW website (OEH 2014).

Non-climate drivers

Non-climate drivers are drawn from the system transition models representing the range of socioeconomic and biophysical changes currently affecting the North Coast region. They operate at a range of scales from national (political cycles, policy confusion) to regional (biosecurity, demographic change, land-use change) and local (employment, social apathy and division). While they act independently of climate drivers, they may interact with climate impacts within the region. For example, demographic change is in part influenced by capital city house prices, employment, migration, and the natural environment of the region. However, in combination with climate drivers, demographic change, for instance, increases local exposure of the community to impacts of climate change (such as flooding and storm events) and increases demands on emergency management and other government services.

Sensitivity

Direct impacts

The impact of climate change on the North Coast region manifests, most immediately, through the effects of extreme events. These direct impacts, shown in Figure 13, summarise the initial interconnected effects that ripple through the region's systems (see also the impact chain diagram in Figure 16). For example, for the food and agriculture sector, an increase in rainfall intensity can cause increased flooding, which in turn can cause damage to critical infrastructure including roads, bridges, loss of stock and crops, which then results in a decline in agricultural productivity, economic activity and employment in the region.

Indirect impacts

These are the concluding impacts, which have 'snowballed' along the impact chains see also the impact chain diagram in Figure 16. They represent further socioeconomic and biophysical drivers of change that affect the region, culminating from climate drivers, and are heavily influenced by non-climate drivers in complex ways. For example, indirect impacts include land-use conflict, declining social and mental health, the demand for policy innovation and decreased tourism. Increased pressure on local government resources, increased insurance premiums, increased building and development costs and rising house prices can place pressure on local services for the homeless, and expand the number of illegal dwellings.

Adaptive capacity

The attributes listed under adaptive capacity represent a set of available resources, or changes to resource use, that provide options to act to reduce regional vulnerability to climate change in the face of future uncertainty. They were identified from data collected for the North Coast IRVA (OEH 2016).

For example, climate-adaptive infrastructure and community risk preparedness will assist during and after extreme events. The North Coast has strong local social networks that are able to share accessible regional knowledge. This increases the sense of community and assists in the ability of the communities to recover after events. The transition pathways identified in the system transformation models (Chapter 2) and the 'first steps' projects outlined in Chapter 5 provide a mechanism to support and enhance regional adaptive capacity.

While sectors of the regional economy may prioritise differently the various aspects of vulnerability that affect their service delivery, there is considerable overlap among them. Table 3 lists the sectoral priorities for the direct and indirect impacts and adaptive capacity indicators.

Table 3:   Sectoral priorities for direct and indirect climate impacts and adaptive capacity

Sector	Direct climate impacts	Indirect climate impacts	Adaptive capacity
Economy, industry and agriculture	• Changed risk management • Decreased agricultural productivity	• Demand for protective structures • Increased agricultural production costs	• Climate-adaptive infrastructure • Comprehensive long-term regional planning
Human services	• Disproportionate impacts on vulnerable groups	• Interrupted employment	• Shared accessible regional knowledge • Sense of community
Settlements and infrastructure	• Damage to infrastructure/ built environment • Damage to ecosystems	• Increased pressure on local government resources • Increased homelessness / illegal dwellings / isolation	• Comprehensive long-term regional planning
Landscapes and ecosystems	• Loss of biodiversity • Damage to ecosystems	• Change in resource availability • Increased pressure on protected areas	• Regional/local social networks (leadership) • Comprehensive long-term regional planning
Emergency management	• Increased call on emergency services	• Limited disaster response capacity • Change in volunteer base and demand	• Community risk preparedness • Resource availability/ security (natural, financial, human)

4. How do we know?

4.1 Description of the ERA process

The Enabling Regional Adaptation (ERA) process has been designed to develop a shared understanding among stakeholders of the likely vulnerability to climate change, and stimulate action to plan adaptation. To undertake the assessment, ERA engages state and local government participants from different sectors to ensure cross-sectoral and cross-scale operational knowledge and constraints are considered.

Sector	Scope
Emergency management	Emergency management (fire, flood, heat, bushfire), infrastructure and utilities, public health / disaster management
Human services	Education, health, senior, youth and child services, meals on wheels, library services, disability services, community services, health and education asset management and planning
Economy, industry and agriculture	Business development, tourism, legal, professional services
Landscapes and ecosystems	Natural resource management, biodiversity, conservation, Aboriginal and historic heritage
Settlements and infrastructure	Regional and local strategic planning, local development, buildings and settlements, transport (rail, road, freight, buses) water (stormwater, sewer, water), energy, telecommunications, community infrastructure

Due to the complexity inherent in analysing adaptation at a regional scale, the approach uses both qualitative and quantitative techniques to integrate multiple lines of evidence gathered through subregional workshops, participant surveys, and shift-share analysis to identify locally competitive industries derived from ABS Census data.

ERA engages participants in cross-sectoral workshops where they are provided with regional climate projections, socioeconomic data and regional knowledge. Through a series of hands-on activities participants determine impact chains, adaptive capacity and key regional systems. Final outputs of this process provide a description of regional climate vulnerabilities, system transition models and projects to activate pathways (Figure 14). An online survey was also undertaken before and after the workshops (see Chapter 6).

ERA has been carried out in such a way that it incorporates:

- a system thinking approach that acknowledges communities exist within human–natural (or social–ecological) systems
- participatory engagement in which stakeholders co-create an understanding of vulnerability through their deep understanding of the region
- a focus 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
- qualitative analysis supported wherever possible with quantitative data, which acknowledges that societal interactions are complex and contradictory in nature, and not amenable to expert-led, reductionist approaches to problem analysis.
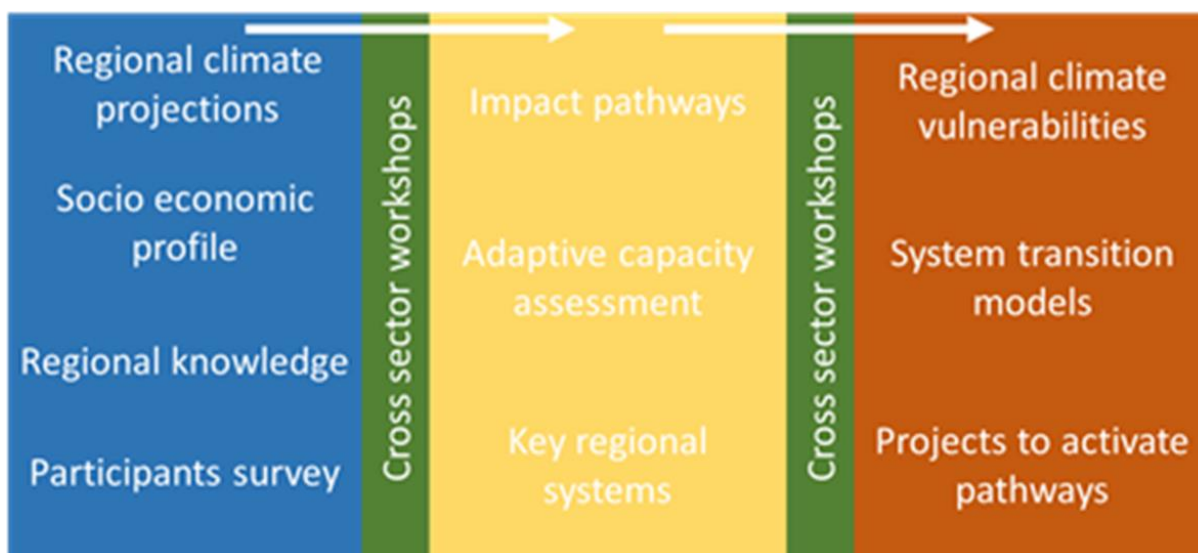
Figure 14: Enabling Regional Adaptation process

4.2 North Coast regional workshops

In 2018, OEH and the Institute for Sustainable Futures led a series of workshops in the North Coast region as part of the ERA process. The workshops used participatory learning techniques to discuss, explore and gather information and data on the impact of climate change on regional systems and opportunities to respond. The workshops were held in two stages: the first workshops focused on validating regional climate vulnerabilities already identified through the 2014 North Coast Integrated Regional Vulnerability Assessment (IRVA) (OEH 2016) and the follow-up workshops focused on developing regional change models.

Two workshops were held 29–30 May 2018 in Goonellabah and Coffs Harbour. The workshops facilitated a consultation with 93 decision-makers drawn from local councils, NSW Government agencies and federal agencies. These workshops were designed to:

- review the 2016 IRVA to understand the climate impacts for the region and verify adaptive capacity to respond
- present the latest climate projections for the North Coast region
- construct a climate impact timeline to encourage consideration of climate projections in light of extreme climate events, regional socioeconomic trends and policy processes (Figure 15)
- identify key regional systems that need to change.

Two further workshops were held 11–12 September 2018 in Ballina and Coffs Harbour with 61 participants. These workshops built on the outcomes of the initial regional workshops to:

- develop qualitative, system change models that identify transition pathways leading to a transformed future
- prioritise regional adaptation actions (through discrete projects) to promote transition and limit maladaptation
- create visualisations of regional adaptations
- continue to build the regional capacity to deliver best practice adaptation.

A total of 154 attendees were from NSW Government agencies, with representatives from local government and a federal government funded organisation, including:

- Aboriginal Affairs *
- Ballina Shire Council
- Bellingen Shire Council
- Byron Shire Council
- Clarence Valley Council
- Coffs Harbour City Council
- Crown Lands
- Department of Education
- Department of Family and Community Services *
- Department of Industry *
- Department of Planning & Environment *
- Department of Premier & Cabinet *
- Department of Primary Industries
- Destination North Coast
- Environment Protection Authority
- Industry Sugar Cane
- Kempsey Shire Council
- Kyogle Shire Council
- Lismore City Council

- Marine Parks Authority
- Mid North Coast Local Health District*
- Nambucca Shire Council
- National Parks and Wildlife Service
- North Coast Area Health Service*
- North Coast Local Land Services*
- NSW Ambulance
- NSW Office of Water
- NSW Police*
- Office of Environment and Heritage*
- Port Macquarie-Hastings Council
- Public Works
- Regional Development Australia*
- Richmond Valley Council
- Roads and Maritime Services*
- Rous County Council
- State Emergency Service
- Southern Cross University
- TAFE NSW*
- Tweed Shire Council.

Note: An asterisk denotes organisations represented on the project steering committee.

A further workshop was held on 30 November in Coffs Harbour with 12 participants. This workshop facilitated by OEH engaged Heritage Division staff in OEH, Aboriginal Affairs and local governments to further develop the cultural heritage transition model. This workshop built on the outcomes of the initial regional workshops to develop a qualitative, system change model that identifies transition pathways leading to a transformed future.

The workshop process acknowledged that the understanding of the current vulnerability of government service delivery in the region relies on collection of the tacit knowledge that resides in the collective store of experience of NSW public sector decision-makers. The information gathered from the consultations aims to inform regional planning to enable regional adaptation to climate change.

Figure 15: Climate impact timeline for the North Coast region

North Coast IRVA validation

Consultation for the North Coast IRVA was completed in 2014. The report can be downloaded from: climatechange.environment.nsw.gov.au/Adapting-to-climate-change/Regional-vulnerability-and-assessment/North-Coast.

The first step of ERA was to conduct a rapid validation process of the North Coast IRVA findings to understand the current status of vulnerability in the region and document any changes that may have occurred in the period between completion of the IRVA and the commencement of ERA in 2018.

The validation was conducted as a world café in facilitated small group discussions. Each group was asked to review a summary of the North Coast IRVA impacts (direct, indirect and cross-sectoral) and adaptive capacity, and to consider the key changes in the region since the IRVA (see Section 3.4).

Impact chains

Understanding how climate variability and extreme events will affect the region is a vital first step towards planning and implementing adaptation responses. In light of the regional climate projections and socioeconomic information, participants at the IRVA in 2016 constructed influence diagrams to illustrate impact chains and influence relationships stemming from each of the major climate variables (Figure 16). These diagrams allowed two types of impacts to be identified along impact chains: direct impacts were those that were directly attributable to climate change and appear on impact chains in close proximity to climate variables; indirect impacts resulted from the flow-on effects of climate variables and were also influenced by external regional drivers. Indirect impacts appeared further along the impact chains.
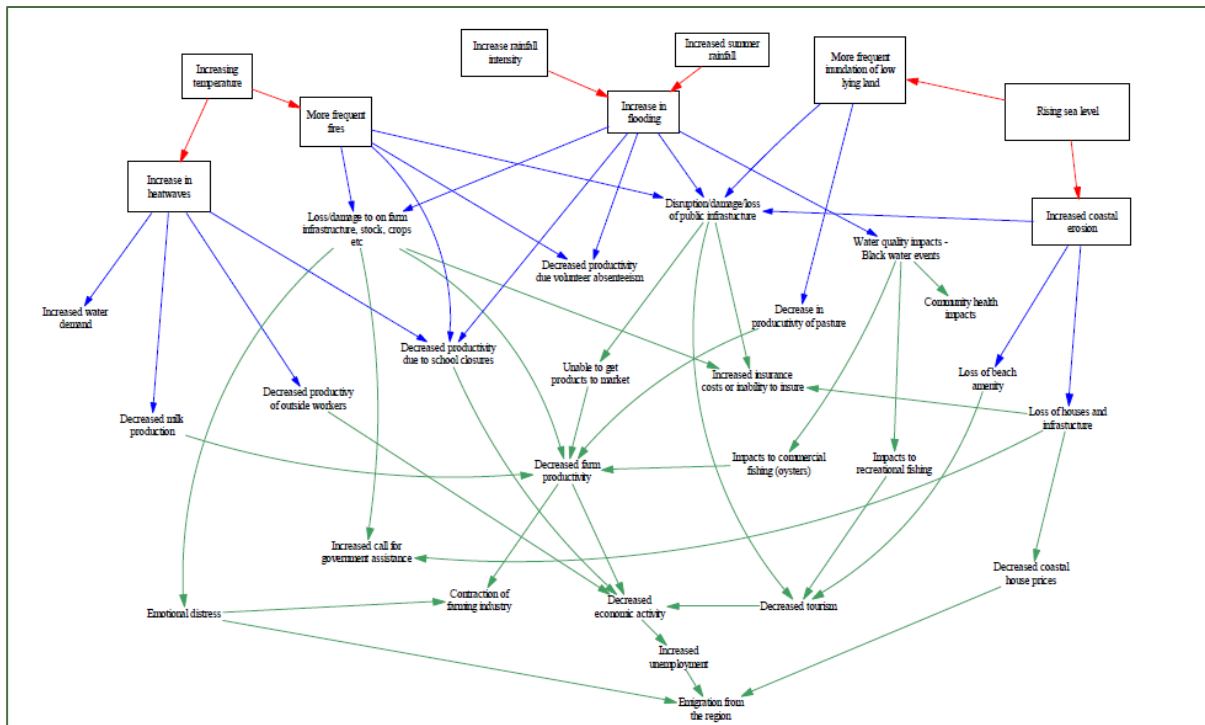

Figure 16:   Food and agriculture climate impacts chains

4.3 Key regional systems

The sub-regional workshops identified nine key regional systems considered most in need of transformation to adapt to climate change. These systems were refined in the integration workshops to reduce redundancy and focus specifically on systems that could be influenced through action at the regional scale. The models are not intended to represent all aspects of the region; rather they reflect the expertise of workshop participants and provide a mosaic of the major systems of the region, such as:

- Settlements and land-use planning
- Resilient communities
- Cultural heritage
- Biodiversity
- Emergency management
- Food and agriculture
- Infrastructure and water
- Energy
- Tourism.

4.4 System change models

Thinking of adaptation as a series of strategic pathways to transition away from business-as-usual was an effective technique to engage workshop participants in a discussion of system transformation in the region. The approach envisions transformational change toward a desirable future as a series of transition pathways that emerge from current practice either through existing innovations or because of new drivers of change (Figure 17).

For each of the key systems the workshop participants discussed:

- **business-as-usual (BAU)** – what constitutes BAU in their service delivery area and what changes or 'tweaks' are being made to ensure resilience of the current system
- **system drivers** – the relative strengths of multiple drivers determine the extent and direction of change within the system. Drivers of change lead to the emergence of 'pockets' of innovation that offer transition pathways to a 'planned' transformation
- **transition pathways** – any new practices/changes/trends that may serve as an alternative to BAU that are emerging now or in the near future. These pathways could emerge from changes in the economy, society, the environment, technological development or politics
- **barriers and enablers** – for selected transition pathways participants identified the barriers to and enablers of change, who they need to work with, and any aligned processes or policies
- **transformed system** – participants were asked to identify their vision of service delivery in 2050 and articulate what the features of the transformed system would be.
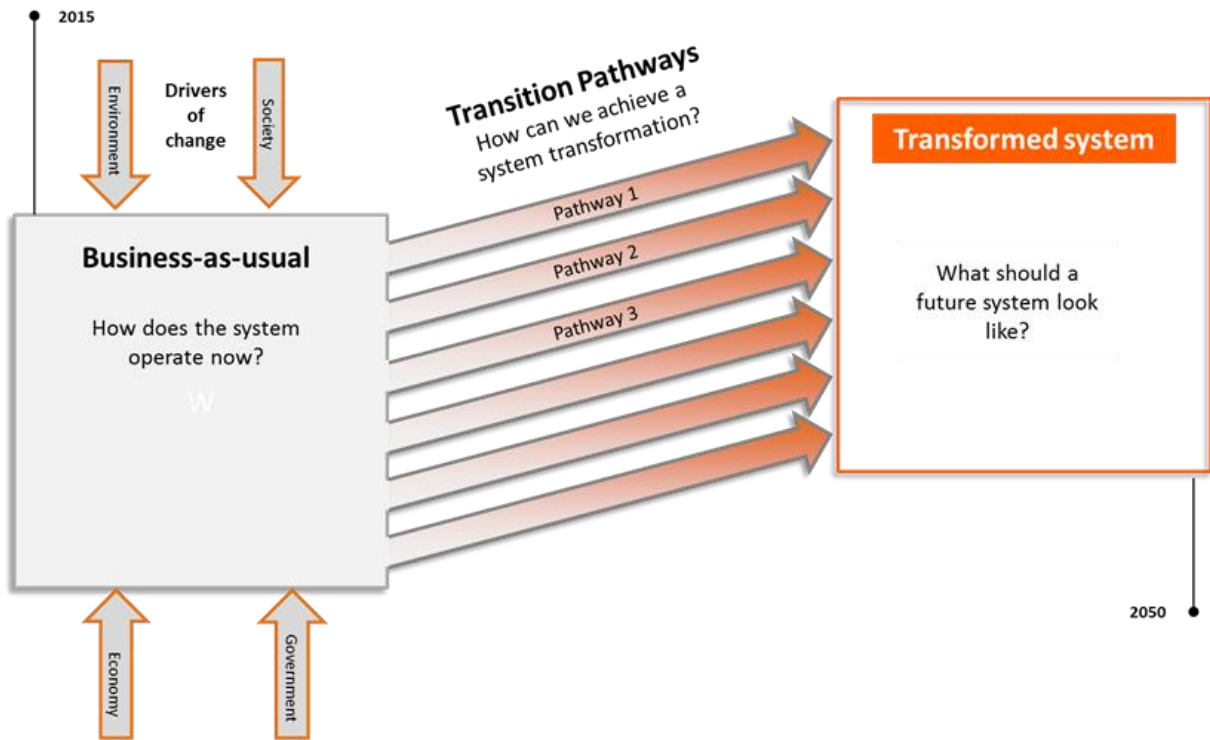
Figure 17:   Conceptual model of transformative change Source: adapted from Jacobs et al. (2016)

5.   What can we do about it?

5.1   Projects to activate pathways

Workshop participants voted on the various pathways for each of the nine regional systems to determine the key priorities for government from the range of transition pathways. The participants then worked together in cross-sectoral groups to identify transition projects to progress toward regional transformations to address climate vulnerabilities. Descriptions of these projects are given in Table 4.

Table 4:   Pilot projects to activate pathways

Pilot project	Description	System
Cross dependency risk analysis of critical infrastructure	Pilot cross dependency risk analysis of critical infrastructure in Ballina.	Infrastructure and water
Person-Centred Emergency Preparedness	Making all North Coast communities prepared and self-reliant for all hazards. Identify opportunities to embed community resilience education programs into the region..	Resilient communities
Northern Rivers 100% renewable energy transition to 2050	All energy sourced from renewables by 2050 at household and community level	Energy
One Map: Hazard Data & Resilience Planning for all	Delivering a single map to provide all NSW public with historical and predicted hazard and resilience planning data, to be used in decision-making around dwelling, development and natural disaster preparedness. An all-hazards modelling tool/app to support policy decision-makers and community. This tool/app to graphically represent all hazard risks and past events.	Settlements and land-use planning and Emergency management
Emergency management planning for climate change risks	Emergency risk management incorporates climate change considerations into future planning decisions.	Emergency management
Climate resilient energy infrastructure and pricing	Building on existing microgrid pilot projects and looking for opportunities in Northern New South Wales for microgrid technologies that would build on the region's long-standing leadership in renewable energy.	Energy
Resilient business management skills in a changing climate	Build climate resilient business management and identify opportunities such as access to newer markets, cost-effectiveness in adaptation efforts and differentiation through products and services.	Food and agriculture
Advancing the capacity of Richmond and Clarence floodplain farmers to deal with climate risk	Investigate and benchmark attitudes and knowledge of North Coast floodplain farmers towards local climate risks, adaptation strategies and opportunities, and their capacity to put adaptation best management practices (BMPs) in place. Knowledge gained will flow into the development and implementation of industry-specific extension programs and decision support tools to facilitate the transition to, and adoption of climate resilient farming practices.	Food and agriculture

Pilot project	Description	System
Map your projects	An app to share social and community projects to the wider community and stakeholders to increase awareness across the region.	Resilient communities
Sharing knowledge: Aboriginal and Torres Strait Islander communities	Co-design with Aboriginal and Torres Strait Islander communities to share knowledge around climate change and community resilience.	Resilient communities
My Place: Promoting an environmental and sustainable community	An app that identifies for communities the environmental and sustainability incentives available in their region. The app enables communities to promote and share their actions with neighbours and links their actions to rate reductions.	Biodiversity
Climate Adaptation into BMPs	Incorporate climate risk and adaptation into farm BMPs.	Food and agriculture
Mapping high-risk assets to identify infrastructure hotspots	Map all assets that have received funding via Natural Disaster Relief and Recovery Arrangements (NDRRA). The aim will be to identify infrastructure hotspots impacted by natural hazards.	Infrastructure and water
Transdisciplinary development of community-led sustainability frameworks (CSFs)	Southern Cross University will lead via the Urban Climate Change Research Network (UCCRN) – Australian Oceania Hub, with the involvement of the National Centre for Flood Research, to undertake research around building resilience in communities and business and sharing this knowledge across the region.	Resilient communities
Think Tank: Investment generation innovation hub	The investment generation hub will encourage innovation and adaptation for private and public infrastructure. The Think Tank will provide private and public asset owners a market solution to test adaptation and new investment options.	Infrastructure and water
New Comers are Welcome Here	Preparing people coming into the North Coast region with information/ resources to prepare for hazards.	Settlements and land-use planning
Climate change impacts and risks embedded into a cost–benefit analysis framework	A cost–benefit analysis tool (CBA) provides a methodology to assess different options. At the moment, CBA tools do not consider the risks of climate change impacts, nor do they take into account the benefits of mitigation or adaptation. This project aims to ensure that the costs of climate change impacts and the benefits of adaptation / mitigation of risks are incorporated into the calculations of a CBA tool.	Infrastructure and water
North Coast Electric Vehicle Network	Provide a market for electric vehicles (EVs) across the region with an aim to promote EV infrastructure and uptake. Build a partnership with the ACT Government though its transition to zero emission vehicles.	Energy
The North Coast – a Sustainable Events Destination	Develop a sustainable events guide and tools to calculate an event's carbon footprint to measure the environmental cost of events. Event managers can minimise the impact of their events through a local offsets program. The guide can be used to host and market sustainable events in the North Coast region.	Tourism

Pilot project	Description	System
Voluntary house purchase program	Expand and enhance the voluntary house purchase program in the North Coast region, with the aim of moving people away from hazard prone land and thereby reducing risk to the emergency management sector, local government and insurance sector.	Emergency management
Social enterprise: Sustainable housing project	Develop a social enterprise to provide people access to training and pathways to build lost cost, energy efficient and sustainable housing. Using a marketplace solution that will benefit the community in affordable and sustainable housing.	Resilient communities
The only thing you should leave behind…..Is your offsets	Develop a localised offset program for tourism and events in the North Coast region to improve resource management, lower the clean-up costs of major events and increase funding for local projects.	Tourism
Beyond Basics – User guide for practitioners	Embedding urban environmental decision-making into planning (updated star rating system for North Coast)	Settlements and land-use planning
Linking people to jobs, skills and housing affordability	Develop a greater understanding of population change and population growth in the North Coast region. Investigate these changes and their links to housing affordability, jobs and skills.	Resilient communities
Digital Tourist Tracker	Track individual tourist movements in the region to provide real time data to improve decision-making and grow these destinations and experiences.	Tourism
Uplifting development tool	Sustainable residential designment greenfield and infill development rating tool including climate change for North Coast.	Settlements and land-use planning
Research Institute partnership	An adaptive infrastructure and planning research node to be developed to explore new emerging technology for adaptive infrastructure.	Infrastructure and water
Social licence to support sustainable agriculture	Supporting viable sustainable agriculture social licence to operate on the North Coast.	Food and agriculture
Urban Environment Intelligence – UEI	Integrated modellings as a planning tool (e.g. SIM city for planners).	Settlements and land-use planning

5.2 Actions underway

Since the inception of the NERA project in the North Coast region, a number of actions to enhance regional adaptation planning have commenced.

Six Community Resilience Innovation Program (CRIP) projects are currently underway in the North Coast region:

- Lismore City Council funded to develop a Community Recovery and Resilience Action Plan – An Adaptable Community Model: $40,000 to develop a model to establish 'Community Hubs' during emergencies to support community-led responses to disasters.
- Get Ready Lismore, Kyogle and Richmond Valley – Know the Risks and Be Prepared: $38,000 to implement a 'Get Ready' all-hazards campaign to help residents, visitors and businesses in vulnerable locations in Lismore, Kyogle and Richmond Valley be disaster ready.
- Lismore Chamber of Commerce and Industry will develop an online portal and database to provide businesses in the Lismore region with access to more information before, during and after natural disasters.
- Tweed Shire Council is to develop strategies to manage donated goods and spontaneous volunteers for Byron and Tweed Shires.
- Northern Rivers Community Gateway is to develop a system to manage, train and support spontaneous volunteers across the Northern Rivers.
- An innovative project to build disaster preparedness and resilience of culturally and linguistically diverse and refugee communities in the North Coast has been funded under the Community Resilience Innovation Program. This Red Cross project 'Harnessing the power of gender and language in emergency services' will be based in Coffs Harbour to engage non-English speaking communities with the emergency services.

Other projects aligning with NERA:

- Tweed Shire Council is involved in an industrial land swap to reduce community and industrial vulnerability to flooding by moving high value and large employers to above maximum probable flood level and back zoning areas.
- Some local councils in the region are taking a proactive approach to climate adaptation by adopting a climate change policy and establishing renewable energy targets.

5.3 Supporting processes

Increasing Resilience to Climate Change

This partnership program between Local Government NSW and OEH provides funding to address identified climate change risks and vulnerabilities facing NSW councils.

Objectives

The Increasing Resilience to Climate Change program has been established to encourage:

- implementation of actions to address identified climate risks
- regional consideration of climate change impacts in decision-making
- implementation of climate change adaptation actions beyond business-as-usual projects and programs
- enhanced adaptive capacity.

The Climate Change Fund is providing $1,100,000 of funding in Round 1 for projects delivered within two years. Grants of between $30,000 and $120,000 are available to individual councils. Grants of between $50,000 and $300,000 are available for regional projects to coordinate adaptation projects across a number of councils. Collaboration with one or more councils, regional organisations, private sector or government agencies, community groups and other organisations is encouraged.

Community Resilience Innovation Program

The Community Resilience Innovation Program (CRIP) supports a broad range of community-led projects designed to increase all-hazard disaster preparedness and build community capacity and resilience. CRIP projects are based on collaboration and partnerships between local community organisations and emergency services agencies. CRIP aims to:

- encourage local communities to engage in creative, community-focused activities that will enhance disaster resilience
- develop effective partnerships and build networks between local community organisations, councils, businesses and emergency services agencies
- foster ways to effectively engage the local community in emergency management and resilience building
- share knowledge and lessons learnt about new approaches and models through project evaluation
- support initiatives that can be integrated into current business and maintained in the longer term.

CRIP is a scheme under the Natural Disaster Resilience Program, funded by the NSW and Commonwealth governments through the *National Partnership Agreement on Natural Disaster Resilience.*

6. Measuring progress

6.1 Adaptation process

The ability to detect change is a critical component of any monitoring program because it facilitates adaptive management (Allan & Curtis 2005); however, issues associated with monitoring and evaluating climate adaptation are well-documented and include (Bours et al. 2013):

- measuring adaptation against a moving climate baseline
- consideration of avoided impacts through counterfactual arguments that are difficult to prove, such as 'if we hadn't undertaken this adaptation action the outcomes might have been much worse'
- the difficulty with attempting to attribute an adaptation outcome to a particular course of action, as often multiple actions have contributed to improved climate resilience
- local adaptation actions can have outcomes that span multiple scales, sectors and responses
- the lack of a universal set of indicators against which adaptation can be measured.

Despite these difficulties, organisations (private and public) are moving from *awareness* about the need to manage climate change risks to *implementing actions* to manage them. This has led to the emergence of a common set of practices considered necessary to deliver effective adaptation to climate change: the adaptation process cycle (Figure 19). All the processes in the cycle commonly occur as part of action to adapt to climate in New South Wales.
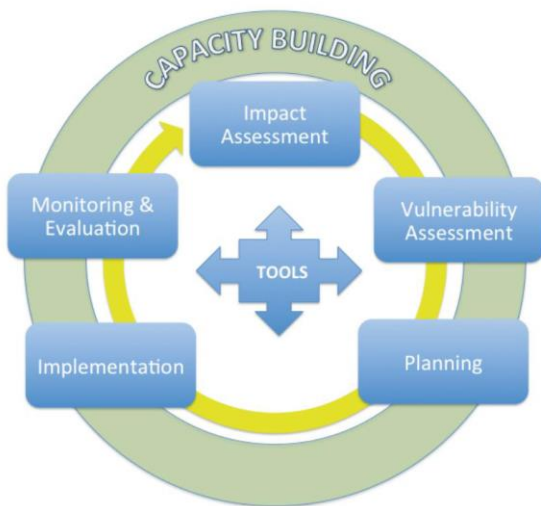

Figure 18: The adaptation process cycle Source: Hansen et al. (2013)

A well-defined process cycle is central to effective benchmarking. Benchmarking can be used to evaluate an organisation, business or process against external criteria. The objectives of benchmarking are to determine what and where improvements may be made, to analyse the ways in which other groups achieve high performance, and to use this information to drive improvements in performance. Benchmarking represents a 'soft policy' that encourages flexible planning, local consultation and incorporation of local context, coupled with institutional support at higher scales of governance. Soft policy instruments can sustain proactive behaviour to achieve desirable outcomes that are embedded and accepted in everyday practices.

For climate change, benchmarking the adaptation process at the regional scale circumvents many of the problems with attempting to assess and aggregate local-scale adaptation actions. The ERA process focuses on assessing the degree to which organisations are employing an effective adaptation process rather than the effectiveness of government adaptation processes or interventions; the underlying assumption being that good process leads to good adaptation decisions. This type of approach was used by Hansen et al. (2013) in a national climate adaptation benchmarking exercise conducted across a number of sectors in the USA.

6.2   Adaptive capacity

One way to promote adaptation action is to build regional capacity to adapt (Jacobs et al. 2015). Targeted capacity building requires an understanding of where the barriers to action lie in the region, which is generally related to the resources available for adaptation and the ability to use them. These resources commonly include awareness, knowledge and skills, and staff resources (human capital), engagement and networking with the community and other organisations (social capital), the formulation of strategic plans, and the financial resources to implement adaptation actions. Monitoring adaptive capacity over time can provide an additional measure of regional change.

6.3   Regional online survey

A qualitative survey was conducted to benchmark regional adaption actions at the start of the project, to provide a baseline, and following completion of the NERA workshop process as a preliminary assessment of change. The survey was available online for a period of four weeks from March to April 2018 (initial) and again in February 2019 (post-workshops).

In total, 66 people from across all levels government in the region completed the baseline survey. Almost half (46%) of respondents represented state government agencies, 44% from local government, 10% from regional agencies. In total, 65 respondents completed the follow-up survey. The representation of these respondents was spread across state government agencies (56%), local government (43%) and non-government organisations (1%). The majority (71%) of respondents had attended at least one of the OEH Enabling Regional Adaptation workshops in 2018. One respondent identified themselves as being of Aboriginal or Torres Strait Islander heritage in the baseline survey and four respondents identified themselves as being of Aboriginal or Torres Strait Islander heritage in the follow-up survey.

Perceived key climate change risks

The respondents identified a number of climate related risks facing the North Coast region (Figure 19). The top four risks were perceived to be flooding, intense storm events with high winds, sea level rise and changing rainfall patterns. The four most important event types were incorporated into the workshop discussions to develop the region's snapshot (see Figure 13).

Importance of climate change adaptation

A series of questions was asked to ascertain the importance of climate change adaptation from an individual and organisational perspective. The majority of the respondents (82%) agreed that climate change adaptation is a moderate to strong priority both personally and in their professional roles. Only 5% said it was not a priority. In contrast, over half (53%) of respondents noted that climate change adaptation was a moderate to strong priority for their organisation and a further 26% considered it a slight priority. About 18% said it was not a priority for their organisation and a further 3% did not know.
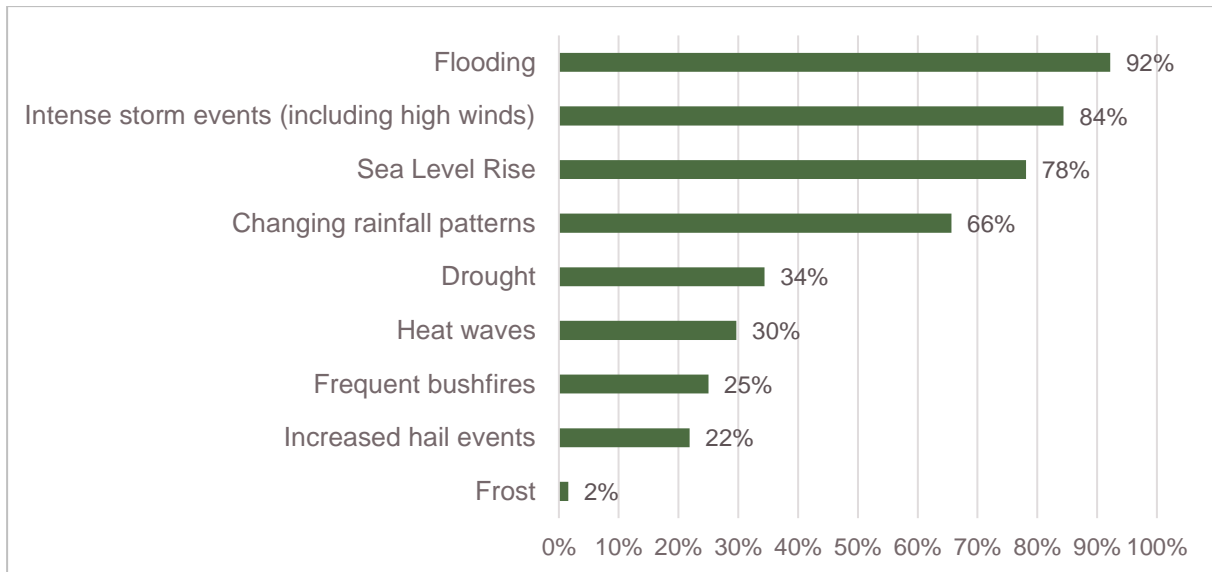
Flooding 92%
Intense storm events (including high winds) 84%
Sea Level Rise 78%
Changing rainfall patterns 66%
Drought 34%
Heat waves 30%
Frequent bushfires 25%
Increased hail events 22%
Frost 2%

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Figure 19:   Climate risks identified for the North Coast region

Adaptation action

The surveys explored the wide range of adaptation actions that organisations or individuals had been involved with in the past, actions they are currently engaged in and adaptation actions that are likely to occur in the future (Figure 20).

The top three adaptation actions that have occurred in the past are:

- assessing the risks posed by climate change
- awareness raising or education of staff and local communities
- conducting vulnerability assessments.

The top three adaptation actions currently underway are:

- assessing the risks posed by climate change
- encouraging the emergency management sector to account for climate change
- changing policies and strategies to account for climate change impacts.

Two of these actions were also identified as the most important future actions: assessing risks and changing policies and strategies. Awareness raising and education were also important future actions. All of these actions are important to provide the evidence base for policy decisions and build cross-linkages. Developing a climate adaptation plan and capitalising on climate change benefits were the least pursued adaptation actions in both surveys, although capitalising on benefits was seen as important for the future.

Adaptation actions can span multiple scales, sectors and responses as shown in (Figure 21). Adaptation actions such as assessing climate risks, adaptation training for staff and communities, encouraging the emergency management sector to account for climate change and revising or changing policies and strategies to account for climate change impacts were conducted at the local scale. At the regional scale, conducting vulnerability assessments and training for staff and communities were nominated more often.
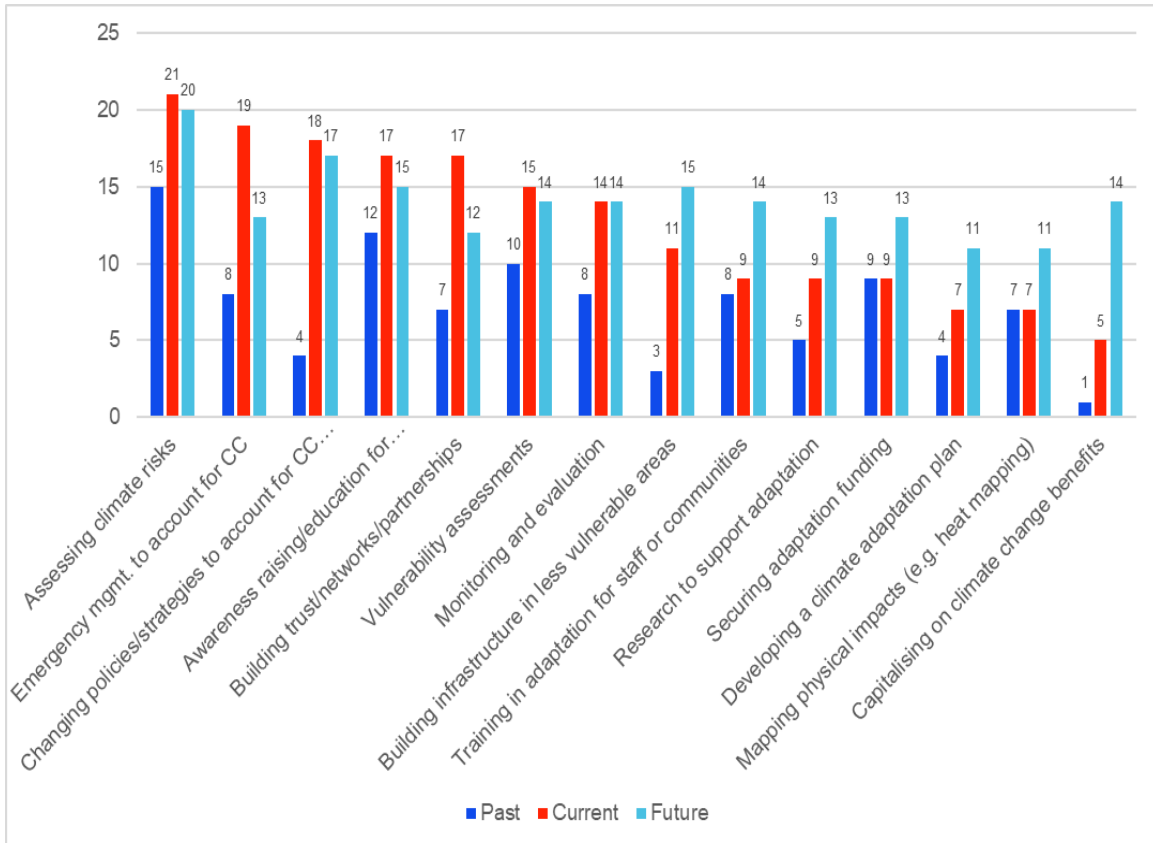
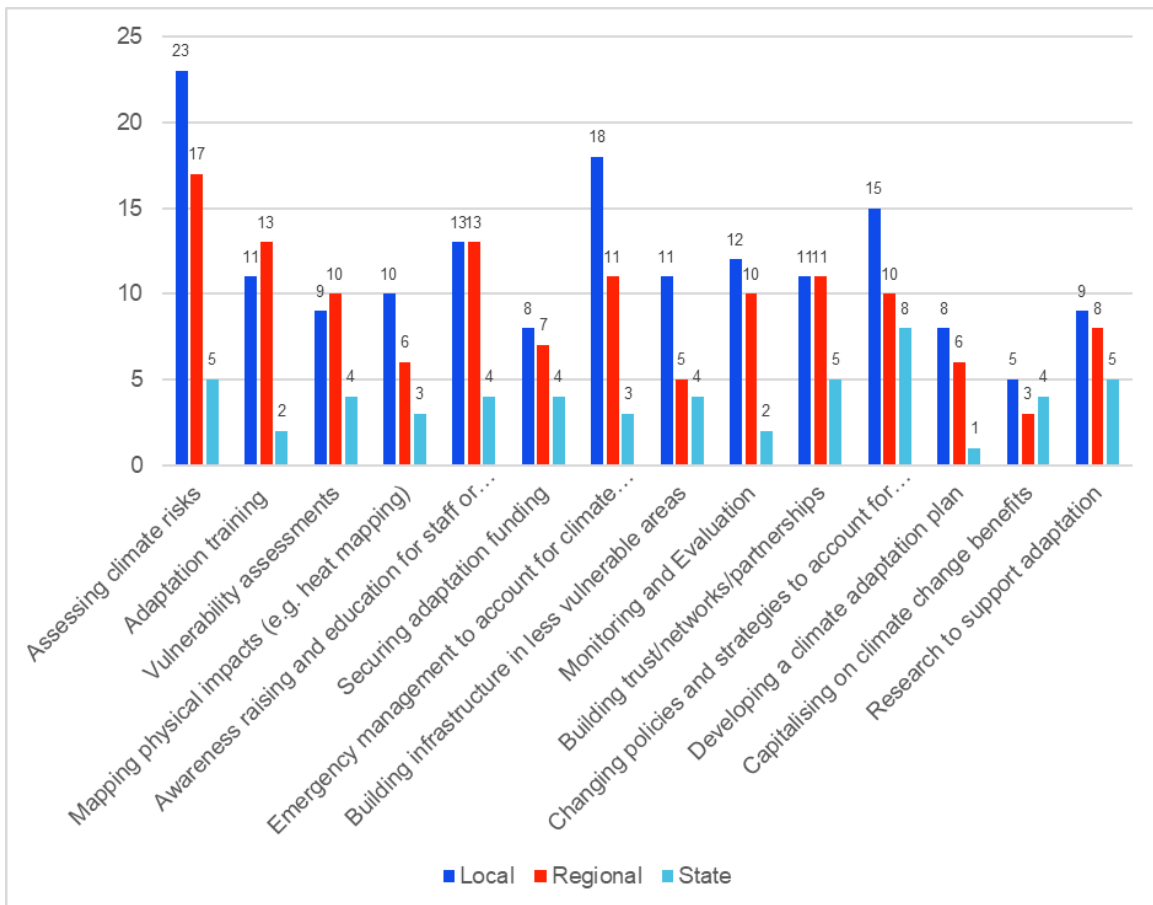**Figure 20:   Adaptation actions across temporal scales**

Figure 21:   Adaptation actions across geographical scales

Organisational capacity to undertake climate change adaptation

The survey also explored organisational capacity to undertake regional adaptation actions. Organisational capacity can be broken down into seven key areas:

1. Awareness of the impacts of climate change
2. Knowledge and skills to adapt to a changing climate
3. Resources to undertake regional adaptation action
4. Engagement with the community and organisations within the region
5. Strategic planning
6. Funding for adaptation
7. Implementation of regional adaptation.

Median responses to the capacity assessment statements suggested that the region is generally constrained in its capacity to adapt. Respondents believed they were equally constrained across all seven key areas of capacity.
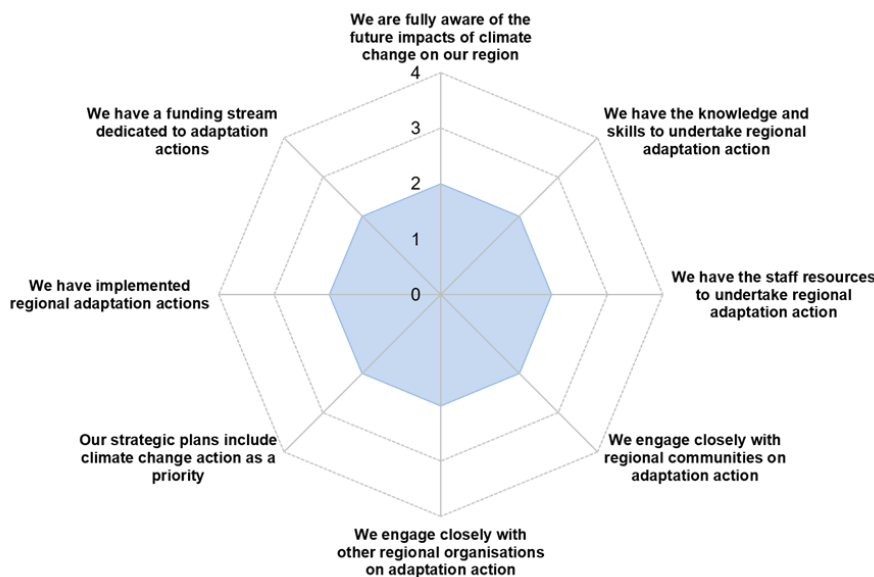

Figure 22: Adaptive capacity for the North Coast Ratings are the median level of agreement with each statement where 1 = strongly disagree, 2 = disagree, 3 = agree, 4 = strongly agree; N = 21

Regional adaptation initiatives

The surveys aimed to gain a deeper understanding of the specific types of adaptation actions that had taken place or were planned for the region. Some of the adaptation actions identified include coastal and flood risk management, natural resource management, as well as waste and energy management.

Coastal and flood risk management

Some local councils are in the process of developing a floodplain risk management plan that includes flood studies and mapping that accounts for the potential climate impacts on future flood risk profiles. In some cases, this has led to changes in building regulations. Tweed Shire Council is involved in an industrial land swap to reduce community and industrial vulnerability to flooding by moving high value and large employers to above maximum probable flood level and back zoning areas. Funding from OEH for the Industrial Land Swap has been a major factor and influence in this local council's mitigation strategies.

Initiatives are underway to make infrastructure such as bridges more flood resilient as well as building flood levies to reduce impacts from flooding; however, funding for flood damaged structures to be made more resilient is difficult to obtain, and some guidelines specifically

exclude funding this type of betterment. Other actions focus on additional water storage and new sewer and water infrastructure to address impacts from sea level rise.

Natural resource management (NRM)

Adaptation in the NRM space covers a wide range of activities such as regional weed management, establishing biodiversity corridors and supporting agriculture to be more climate adapted. Some councils have gone through a process to identify biodiversity priorities and have undertaken on-ground works to provide viable biodiversity corridors and pathways to assist the movement of species. Other projects focus on tree planting for urban cooling and the removal of invasive weeds. The Department of Primary Industries offers capacity building for the agricultural sector to adapt to climate change through the Farming in a Changing Climate courses such as Flood Ready Dairying (North Coast) and Flood Ready Cane Farming (North Coast).

Reducing emissions from waste and energy production

One council has imposed a waste levy that has been used to offset carbon emissions. They are also working toward establishing a plan to set a target for renewable energy. Other activities include running training programs for industry targeting energy efficiency.

Factors that constrain adaptation action in the region

Some local councils in the region are taking a proactive approach to climate adaptation by adopting a climate change policy, undertaking strategic planning, and providing training to enhance green skills for council staff. However, many councils are constrained by a lack of priority given to climate change by executive management as well as a lack of resources and skills in the local government sector to deal with climate change. One respondent noted that local government staff are overwhelmed with current planning and workloads, therefore climate adaptation is a further drain on already stretched resources. Funding is a constant challenge for local government along with a lack of clear policy direction from the state and federal governments (i.e. having each LGA work on its own climate change policy and initiatives creates duplication). This inertia is slowly being overcome through collaboration and additional funding (e.g. OEH's Industrial Land Swap funding) to support early adopters and champions, and demonstrate the need for change and the path forward. Furthermore, opportunities for shared innovation and problem solving could also be improved with common policy direction and resourcing (funding and skills).

Future actions

Planned actions span a number of areas such as green infrastructure, soil management, renewable energy, cultural fire projects, adaptation research, and water and land-use planning to manage the impacts of coastal inundation and flooding. A number of actions are planned for the future to manage flood risk including modelling the floodplain and coast to better understand risks, flood planning in new subdivisions, voluntary buy back of properties in high flood risk areas as well as assigning coastal inundation risk to assets in an asset register. Efforts are planned in the agriculture sector for the improved management of topsoil and nutrients on farms to prevent soil loss to streams during heavy rainfall events.

Monitoring and evaluation of adaptation actions

Programs, research and recommendations require continual monitoring, evaluation and adjustment to ensure they meet the needs of the regional communities in a dynamically changing environment. The final survey question asked if monitoring and evaluation (M&E) of adaptation initiatives is undertaken on a regular basis. Only 17% of respondents confirmed that adaption actions are being regularly monitored with a further 27% noting that M&E occurs infrequently. Approximately 41% of respondents indicated that actions are not being monitored and 15% were unsure.

Appendix A: Expected physical responses to climate change for the North Coast

Physical response	Trend	Projection	Implications
Heat	Increase	Heatwaves are projected to occur more often, be more intense and last longer. Across most of New South Wales there will be more days over 40°C. For further information refer to *Minimising the impacts of extreme heat: A guide for local government*: climatechange.environment.nsw.gov.au/Adapting-to-climate-change/Local-government	• Human health • Urbanisation • Biodiversity • Fire weather • Agricultural productivity
Hillslope erosion	Increase	Areas which already experience high erosion rates are projected to see increases in erosion. For this region, soil erosion is projected to increase by 4.9% in the near future and 14.7% in the far future. For further information refer to *Soil Erosion Climate Change Impact Snapshot*: climatechange.environment.nsw.gov.au/Impacts-of-climate-change/Soil/Soil-Erosion	• Water quality • Agricultural productivity • Biodiversity
Soil properties (SOC, pH and sum of bases)	Increase – decrease	North Coast region is projected to experience an overall decline in soil organic carbon (SOC) stocks in both the near and far futures. Some small pockets along the coast of slight increases in SOC stocks. The region is projected to experience a slight alkalisation of soils in the near and far futures. It is projected to experience an overall increase in the sum of bases (macro-nutrients) in the near and far futures. For further information refer to *Soil Properties Climate Change Impact Snapshot*: climatechange.environment.nsw.gov.au/Impacts-of-climate-change/Soil/Soil-Properties	• Agricultural productivity (+ and −) • Natural ecosystems
Rainfall erosivity	Increase	In the region rainfall erosivity is projected to increase in autumn and spring for both the near and far futures. In the near future rainfall erosivity will slightly decrease in summer; however, increases are projected for summer, autumn and spring and significant decrease in winter by the far future. For further information refer to *Rainfall erosivity* in the *Soil Erosion Climate Change Impact Snapshot*: climatechange.environment.nsw.gov.au/Impacts-of-climate-change/Soil/Soil-Erosion	• Water quality • Agricultural productivity • Biodiversity
Rainfall extremes	Increase	Rainfall extremes are projected to increase in the near future and far future. For further information visit the Adapt NSW website: climatechange.environment.nsw.gov.au/Impacts-of-climate-change/Floods-and-storms	• Flooding • Agricultural productivity • Emergency services • Local government

Physical response	Trend	Projection	Implications
Flood		For further information visit the Adapt NSW website: climatechange.environment.nsw.gov.au/Impacts-of-climate-change/Floods-and-storms or your local council.	• Urban and rural properties • Agricultural productivity • Emergency services • Local government
Hydrology (surface flow/ runoff and recharge)	Increase – decrease	The projections of future runoff are spatially variable across the North Coast. In the near future there is a mix of projected increases and decreases in runoff, with summer runoff decreasing in the western part of the region. In the far future for the whole region, summer, spring and autumn are projected to increase in runoff and winter runoff is projected to be lower in coastal areas. In the near future, recharge during summer is likely to be lower in the region. In autumn and spring months there is a general trend for a small increase in recharge for the near and far futures. Projections are spatially variable in the far future, with some higher and some lower recharge in different parts of the region. For further information refer to *Hydrology Climate Change Impact Snapshot*: climatechange.environment.nsw.gov.au/Impacts-of-climate-change/Water-resources/Groundwater-recharge-and-surface-runoff	• Councils' stormwater infrastructure • Town water supplies • Agricultural productivity
Drought	Increase	For this region, time spent in drought is projected, with medium confidence, to increase over the course of the century. For further information see the CSIRO and BoM Technical Report (2015): www.climatechangeinaustralia.gov.au/en/publications-library/technical-report/	• Human health • Town water supplies • Agricultural productivity • Biodiversity
East coast lows (ECLs)	Seasonality changes/ increasing intensity	Climate modelling projects a decrease in the number of small to moderate ECLs in the cool season with little change in these storms during the warm season. However extreme ECLs in the warmer months may increase in number but extreme ECLs in cool seasons may not change. For further information visit Adapt NSW website: climatechange.environment.nsw.gov.au/Impacts-of-climate-change/East-Coast-Lows	• Emergency services • Water security • Local government
Fire weather	Increase	The North Coast is expected to experience an increase in severe and average FFDI values in the near future and the far future; however, autumn is projected to have a slight decrease in severe fire weather in the near future (taking into account increases in autumn rainfall). For further information visit the Adapt NSW website: climatechange.environment.nsw.gov.au/Impacts-of-climate-change/Bushfires	• Fire regimes • Emergency services • Hazard reduction

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