MONSOONAL NORTH
NRM CLUSTER

CLIMATE CHANGE IN AUSTRALIA

IMPACTS & ADAPTATION INFORMATION FOR AUSTRALIA'S NRM REGIONS

A handbook for enhancing social resilience in the Monsoonal North of Australia

Citation

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Executive Summary

The Monsoonal North of Australia is a place of challenge and opportunity. Whilst managing the climate and its impacts on natural resources is not new, the 21st century is shaping up to be a period of unprecedented rapid environmental change. The aim of this handbook is to assist planners within the Natural Resource Management (NRM) organisations of the Monsoonal North to prepare landholders within the region to become more "climate ready".

"Climate ready" means anticipating and preparing for the expected climate challenges ahead, and working to build resilience of the region to climate change. Changes in Australia's climate, including average temperatures, rainfall and seasonal weather patterns will act to push some natural resource systems towards their thresholds of tolerance, threatening the future of industries and communities dependent on them. Preparing for climate change sooner rather than later is critically important to moderate future risks and to meet opportunities that arise.

We review the most up-to-date thinking on adaptation planning and resilience. In sum, social science conducted in the region highlights that only a small proportion of landholders are prepared for climate challenges. Those that are not sufficiently prepared risk experiencing significant social and economic impacts and will accelerate soil degradation processes, compromising the future productivity of the region.

The standard climate change scenario for the Monsoonal North is that the region will become hotter. Some areas and some seasons may be drier, whilst other areas and other seasons may be wetter. We do not suggest specific land management strategies that should be adopted. Instead, we highlight the importance of landholders developing their own capacity to identify, experiment with and implement strategies and some approaches that could be used by NRM organisations to support them.

Our key message is that humans can influence the impacts that climate change might have through adaptation. By building the capacity of landholders to adjust to plausible future climate scenarios, people and the resources that they are dependent on can cope and adapt to the changes ahead. Here we review what is known about enhancing the adaptive capacity of landholders and maintaining regional resilience.

Resilience is the capacity to cope and adapt to change. Enhancing adaptive capacity and moderating the likely impacts of climate change on the natural resources of the region will contribute towards building resilience of the region. Typically, adaptive capacity is associated with creativity and innovation, testing and experimenting, recognising and responding to changes, adaptive management, flexibility and reorganisation, managing risk and having necessary resources at hand. These characteristics are not only necessary within the landholders themselves, but also within households, communities, regions, industries and NRM organisations.

NRM planning processes are an important vehicle through which to enhance regional resilience. The sorts of actions that NRM organisations can undertake to assist landholders within the region to adapt to climate change include: working to facilitate better networks; increasing environmental awareness; developing strategic/business skills; creating an interest in technology; developing collaborative input into NRM planning processes; and fostering a culture of shared learning. Monitoring adaptive capacity will be important for adaptive management and for evaluating the effectiveness of NRM initiatives.

In this handbook we highlight the importance of understanding, addressing and reporting on resilience as an integral part of the NRM planning and delivery processes. We hope that there is sufficient inspiration for NRM organisations to take on this important challenge.

Nadine Marshall
CSIRO, Land and Water Flagship

1. Introduction: Being climate ready, being resilient

Message 1. Through building the capacity of people to adjust to plausible future climate scenarios, people can plan for and adapt to climate changes.

Managing the climate and its impacts on natural resources is not a new challenge. Ever since the inception of agriculture some 4-10,000 years ago, human civilisations have had to contend with 'good' years and 'bad' years. However, the 21st century is shaping up to be a period of unprecedented rapid environmental change and with it comes great challenges to the relationship between nature and humanity. Past emissions of greenhouse gases have already committed the global climate system to significant warming and increases in extreme weather events for decades to come, where even the most drastic mitigation efforts are unlikely to limit climatic changes over this period.

The natural resources across the Monsoonal North are predominantly used for grazing, agriculture, fishing, horticulture and mining and these resources are highly sensitive to changes in temperature and rainfall. Changes in Australia's climate, including average temperatures, rainfall and seasonal weather patterns will act to push these natural resource systems towards their thresholds of tolerance, threatening the future of industries and communities that depend on them.

Preparing to adapt to climate-related changes sooner, rather than later, is critically important. By building the capacity of resource-dependent people to prepare for changes in the condition of their natural resource we may be able to moderate future risks and rise to meet opportunities that may arise. Our key message is that people can influence the impacts that climate change might have through adaptation: through building the capacity to adjust to plausible future climate scenarios, people and the resources that they are dependent on can cope and adapt.

This handbook is focused on the people and the land of the Monsoonal North NRM cluster (See Figure 1), and complements the "Adapt NRM" guide associated with this project at a national level.

The Monsoonal North

The Monsoonal North encompasses most of Australia's tropical north. The area of 1,906,000km2 and includes the Burdekin Dry Tropics, Northern and Southern Gulf and parts of the Territory and WA Rangelands NRM regions. The region comprises a range of landscapes including dry tropical savannas, tropical rainforests, vast floodplains and wetlands, arid rangelands and steep mountain ranges in the west, as well as numerous important river systems, e.g. the Burdekin, Daly, Todd, Mitchell and Norman. Climatically, the region is hot and humid and characterised by distinct wet and dry seasons, driven by the seasonal monsoon. Land use in the Monsoonal North includes grazing, cropping, mining, tourism, recreation and conservation. Indigenous people own or manage about half of the land.

What does successful adaptation look like?

Adaptation will make a major difference to the impacts that are likely to be experienced. In particular, preparing for the challenges of the future makes for business sense and adaptation success. Successful landholders will be those that can maximise productivity during any one season and minimise impact on the future ability of the land to produce. Successful NRM groups will be those that can work with landholders to sustain the resources of the region.

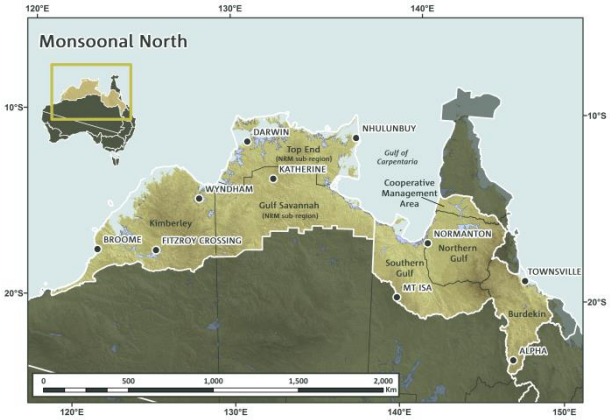


Figure 1. The Monsoonal North region of Australia.
Source: www.climatechangeinaustralia.gov.au

Message 2. Focus on people and you will sustain the land.

People with the capacity to accept and adopt sustainable resource management practices are better prepared to meet plausible future climate scenarios and be "climate ready". People with the capacity to adopt sustainable practices and contribute towards environmental stewardship can support the resilience of the ecosystem and in turn address their own wellbeing. Through a focus on increasing the adaptive capacity of people, it is possible to sustain the land.

One of the aims of this handbook is to provide insights into the characteristics of resilient people and make suggestions to build resilience of landholders and NRM stakeholders for the resilience of the people-resource system.

The specific challenge faced by people living in the Monsoonal North will be to build the productivity and profitability of their resource-based industries and enterprises without degrading the natural resources on which they depend. Success not only depends on maximising productivity during any one season, but also on minimising impact on the future ability of the land to produce.

Climate change and drought

Of particular concern is that degradation processes within the region are especially accelerated during drought periods, especially on the grazing lands. During drought situations, which may become more 'normal', if stocking rates are too high at the onset of drought, soil sustainability will be diminished and the productivity of future years will be impacted. In these instance it is difficult for cattle producers to demonstrate resilience and adaptation to climate change.

Different strategies are used by different people to different effect. It is not an aim of this handbook to prescribe specific adaption strategies for landholders, but to encourage landholders to increase their capacity to innovate and identify adaptation options that will work best for their situation. Successful people and successful industries are those that do not necessarily subscribe to what everybody else is doing, but are those that are able to listen and respond to feedbacks (environmental, economic, social), and who plan, experiment, reorganise, refine strategies, monitor, learn and reflect. Recent and local social science research within the Monsoonal North region has shown that people, industries and organisations that have higher levels of adaptive capacity are better able to manage the risks associated with change, can plan, experiment, reorganise, and learn, are more likely to have financial and psychological buffers and are more proactive. These are the people that are more likely to adapt to change and survive, doing what they love best.

ACTION: Invest in developing the adaptive capacity of local landholders so that they can cope and adapt to climate change impacts and sustain the land upon which they live.

2. Living with a changing climate in the Monsoonal North

Message 3. The Monsoonal North is a place of challenge and opportunity.

The Monsoonal North is mostly comprised of grazing lands, or rangelands, which are typically variably productive and socially remote. Rangelands represent some 33% of the world's terrestrial landscapes and 70% of the Australian landmass. The people of the rangelands of the Monsoonal North, like so many people globally, must contend with variability in the climate each season within the context of an already harsh environment. Drought, for example, is a 'normal' characteristic for cattle producers in the region. In Queensland drought was declared 15 times in the 25 year between 1965 and 1989 and in some areas (e.g. Charters Towers) prior to 2000 drought declaration could occur for up to 34% of time.

Drought

Drought in Australia is defined by the Australian Bureau of Meteorology as rainfall over a three-month period being in the lowest 10% of what has been recorded for that region in the past. This definition takes into account that drought is a relative term and rainfall deficiencies need to be compared to typical rainfall patterns including seasonal variations. This definition uses rainfall only because long-term records are widely available across most of Australia. However, it does not take into account other variables that might be important for establishing surface water balance, such as evaporation and condensation (see: Wikipedia 'drought in Australia').

Remaining sustainable through drought is a key challenge in the Monsoonal North region. Most environmental degradation, such as erosion, occurs during or immediately after drought periods. Hence, making the most of good years and avoiding losses and reductions in resource condition in drought years is imperative. Success not only depends on maximising productivity during any one season, but also on minimising impact on the future ability of the land to produce. Recognising such critical periods and years can be crucial in determining the extent and magnitude of associated socio-economic impacts.

Knowing when and by how much to adjust stocking rates in response to changes in forage availability, for example, can differentiate between those producers who are likely to be successful in the long term and those that are not. Primary producers must also allocate resources each season on the basis of their expectations about yields, prices and future seasons. Producers that can anticipate or effectively react to climate extremes are more likely to adapt to new climate conditions, however, previous research has suggested that this capacity is not distributed equally among cattle producers.

Message 4. There is no 'most likely' future with respect to rainfall.

The last century

Over the last century, mean temperatures across the Monsoonal North region have risen by approximately 0.9°C, although in some parts of north-west Australia, mean temperatures have declined since 1960 due partly to greater rainfall and cloud cover. Rainfall across the whole region has increased slightly during the last century, especially in the north-west, but prolonged periods of drying have also occurred. The sea-level around Australia has also increased by approximately 2.1mm per year between 1966 and 2009 once the effects of land movement, natural climate variability and changes in atmospheric pressure are accounted for. This is consistent with observed global averages.

The next century

Climate projections indicate that is very likely that average and extreme temperatures, as well as evaporation, will continue to rise across the Monsoonal North in all seasons. Rainfall projections, however, are extremely variable and different climate models produce very different results that include both drier and wetter futures (see Table 1 below). Over the next few decades, rainfall changes are likely to be driven mainly by natural climatic variability, including the El Niño Southern Oscillation. Nevertheless, there is a high probability that the intensity of extreme rainfall events will increase. It is also likely that the frequency of tropical cyclones will decline although more of those that do occur will be of a higher intensity (i.e. a higher proportion of category 3, 4 and 5 storms).

Representative Concentration Pathways (RCPs)

Climate projections consider climate responses within a range of consistent scenarios (Representative Concentration Pathways or RCPs) that describe how greenhouse gas and land use will vary in the future. RCP8.5 describes a high emission scenario in which atmospheric CO_2 concentrations continue to increase rapidly, reaching 940 ppm (parts per million) by 2100. RCP4.5 is an intermediate scenario in which emissions peak and then stabilise at around 540 ppm by 2100. (Two other RCPs, RCP 6.0 and RCP2.6, are also used in climate projections but are not presented here).

It is difficult to project changes in fire weather as fuel is a major driver of fire regimes and this varies in relation to rainfall. It is likely that fire frequency will not change in the wetter northern part of the region but, depending on rainfall, change may occur in the south. Fires that do occur, however, are likely to be more intense.

It is very likely that sea-levels will continue to rise over the coming century. A rise of between 60mm and 170mm above the 1986-2005 level is projected by 2030. By 2090, the extent of sea-level rise will depend more on the emission scenario with a rise of 280mm to 650mm projected under RCP4.5 or 380mm to 850mm under RCP 8.5. Sea-level rise is projected to be very slightly greater in the west of the region (e.g. Broome) than in the east (e.g. Karumba) under all scenarios.

Sea surface temperatures are also projected to increase by about 2.2 to 4.1°C by 2090 under RCP8.5 and the ocean will also become more acidic.

Table 1. Most likely Climate Futures for the Monsoonal North based under RCP4.5 and RCP8.5 for 2030 and 2090. Table shows the range in relative change in temperature, rainfall and relative humidity compared to 2015. Note that there is no 'most likely' future with respect to rainfall. (Data from Climate Futures Tool; www.climatechangeinaustrala.gov.au) * indicates % of agreement between climate models. Colours differentiate between major climate futures, i.e. for temperature, yellow indicates a warmer future, orange a hotter future and red a much hotter future. For rainfall and relative humidity, light brown indicates a future with little change or a small reduction, green indicates a future with little change or wetter and dark brown indicates futures with medium to large decreases.

	Temperature (˚C)	Rainfall (mm)			Relative Humidity (%)		
2015	15 – 36 ˚C	2 – 1600 mm			20 – 90 %		
RCP 4.5							
2030	+0.9 warmer (95% agreement)*	+0.6 to -7.9 little change to drier (90% agreement)			-0.2 to -2.6 little change to small decrease		
2090	+1.9 hotter (65% agreement)*	-0.0 to -10.6 little change to drier (70% agreement)*	-0.0 to +7.3 little change to wetter (67% agreement)*		-1.4 to -4.8 little change to medium decrease	-1.4 to +0.7 little change	
RCP 8.5							
2030	+1.0 warmer (93% agreement)*	-0.3 to -6.9 little change to drier (77% agreement)*	-0.3 to +8.2 little change to wetter (72% agreement)*		-0.5 to -2.2 little change to small decrease	-0.5 to -0.0 little change	
2090	+3.9 much hotter (80% agreement)*	+2.3 to -9.6 little change to drier (52% agreement)*	+2.3 to +9.0 little change to wetter (47% agreement)*	-9.6 to -26.9 drier to much drier (40% agreement)*	-0.7 to -4.8 little change to medium decrease	-0.7 to -0.0 little change	-4.8 to -9.0 medium to large decrease

3. What is social resilience?

Message 5. Resilience is the capacity to cope and adapt to change.

Resilience is the ability of social and ecological systems (such as cattle producers and rangelands that are mutually dependent on each other) to cope and adapt to change. Social and ecological systems continually face change, but it is those systems that are able to cope and adapt that are resilient. Systems that are resilient typically share similar properties, and much research has occurred within the region to identify what these properties are. Sustaining natural resources and the societies dependent on them (linked social and ecological systems) might thus be possible through the maintenance of properties that can confer resilience. The properties that we focus on in this handbook are those associated with the landholders themselves.

Not all landholders have the same ability to be resilient. Properties of landholders typically associated with resilience include possessing creativity and innovation (for identifying solutions or adaptation options); testing and experimenting with options; recognising and responding to effective feedback mechanisms; employing adaptive management approaches; possessing flexibility; being able to reorganise given novel information; managing risk and having necessary resources at hand. These characteristics are not only necessary within the landholders themselves, but also within their households, communities, regions, industries and nations.

Recognising resilience
Recognising and enhancing resilience becomes increasingly important for those facing significant climate change impacts, and for the NRM organisations assisting them. Defining resilience as compromising of i) adaptive capacity and ii) resource dependency highlights that we should be focusing on enhancing the adaptive capacity of landholders rather than decreasing their sensitivity to change. Recognising adaptive capacity and exploring ways to enhance adaptive capacity for adaptive success are the main aims of this handbook.

Resilience is closely related to vulnerability, and is often described as the "practical antonym" of vulnerability. Technically, vulnerability is a function of the character, magnitude, and rate of climate variation to which a system is exposed (exposure), its sensitivity, and its adaptive capacity. These components are typical of both ecological and social systems (Figure 2).

Typically, resilience is assessed by measuring sensitivity (or resource dependency in social systems), and adaptive capacity. That is, the exposure function is less important to measure when describing resilience. (Systems are seen as resilient to 'surprises', rather than resilient to something specific). Resilience therefore describes how people cope with change ("potential impact") and how they adapt (via their adaptive capacity). Importantly, landholders might be highly dependent on the grazing resource, but are not necessarily vulnerable to climate change if they have high adaptive capacity. For this reason, we focus on increasing adaptive capacity as a means to reducing vulnerability and increasing resilience (see Figure 2).

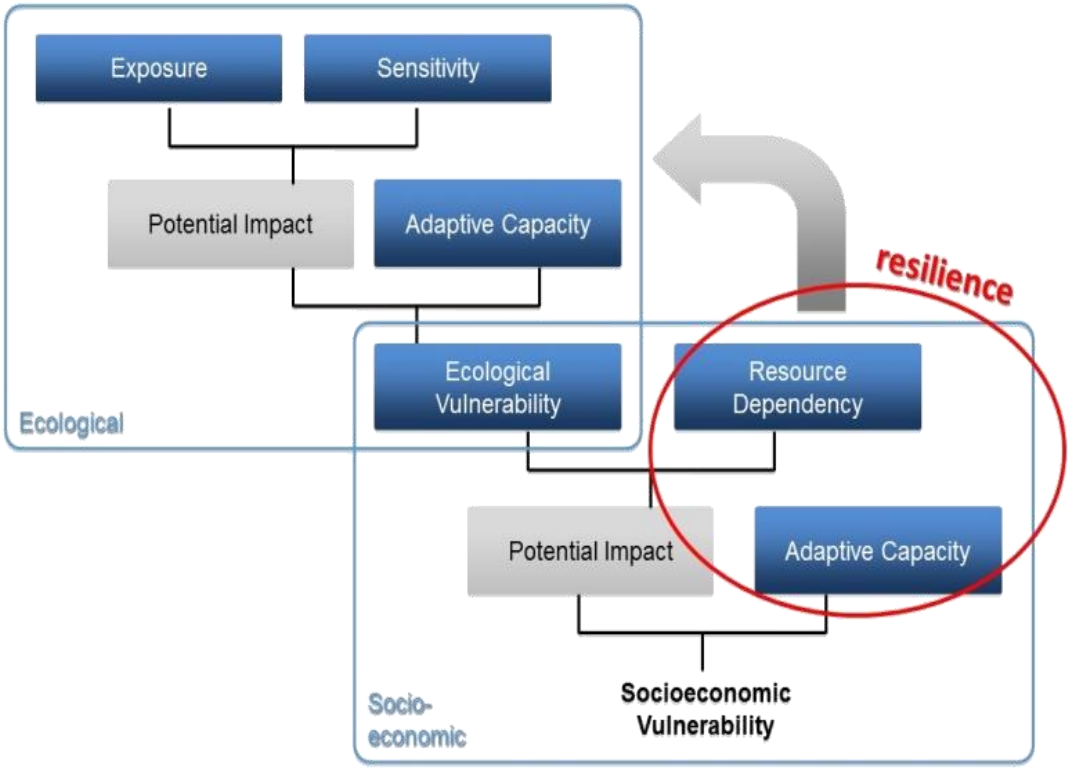


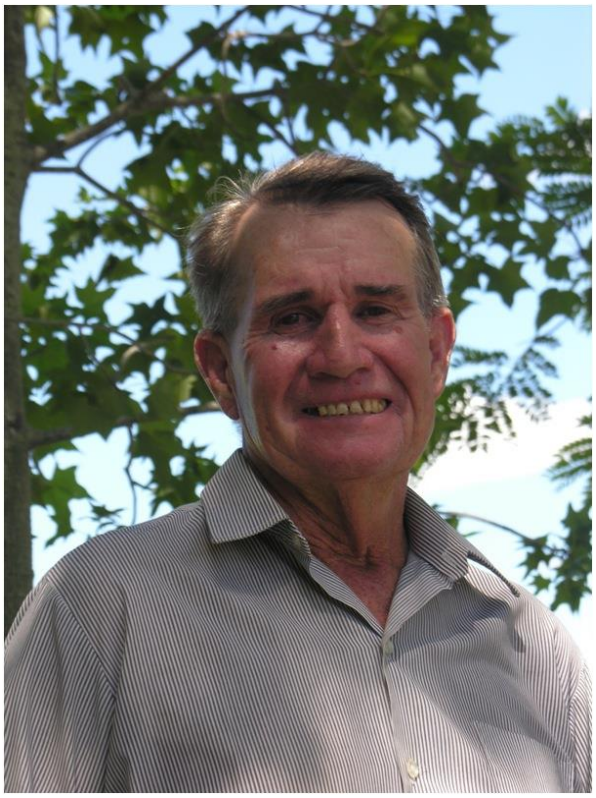
Figure 2. A modified IPCC vulnerability diagram that highlights the important components of vulnerability and resilience in linked social and ecological systems.

The sensitivity of resource-users to climate change is determined to a large extent by how dependent they are on a climate-sensitive natural resource. Resource dependency is thus a good measure of climate sensitivity. Resource-users such as cattle producers can be dependent on a natural resource in economic and non-economic (social) ways. Those who are more dependent on the resource will have less flexibility with which to experiment with their options for the future.

Case-study research within the Monsoonal North region suggests that there are several characteristics of people that are associated (correlated) with higher adaptive capacity. These include: possessing creativity and innovation for identifying solutions or adaptation options; testing and experimenting with options; recognising and responding to effective feedback mechanisms; employing adaptive management approaches; possessing flexibility; being able to reorganise given novel information; managing risk and, having necessary resources at hand.

A key ingredient of adaptive capacity is the flexibility to experiment and adopt novel solutions. For example, a landholder with high adaptive capacity and threatened with drought will plan and experiment with new ways of running their business so as to remain viable. They may decide to access new markets or invest in different parts of their business, acquiring new skills or forming new networks or cooperatives. Most usually, they would come up with an innovative solution.

Whilst resources are certainly important in climate adaptation processes (a person with more resources is better able to experiment with their options for the future for example), the capacity to cope and adapt to change by developing a successful strategy is more important. Given equal resources, not all individuals, communities or NRM groups will be equally successful in their adaptation to change.



Message 6. Adaptive capacity can be measured.

Adaptive capacity has been measured in the Monsoonal North region by social surveys according to four key attributes that describe the important 'preconditions' for adaptation to occur. They are:

1. The perception of risk and managing for uncertainty: How risk is managed reflects individual and cultural differences in experiences, knowledge, beliefs, values, attitudes and judgements as well as differences in abilities to plan and execute plans. How individuals and organisations perceive the risks associated with change and manage for uncertainty is key in determining their ability to cope and adapt.

ACTION: Facilitate landholders to learn about managing risks and uncertainty.

2. The ability to plan, learn and reorganise: This component reflects the capacity to anticipate the future and prepare. The capacity to plan, learn and reorganise in the face of change is dependent on novelty, creativity, experimentation, learning and planning. Without it, any response to climate changes will be reactive and there will be less opportunity for input from others.

ACTION: Facilitate landholders to develop skills to plan for the future, and encourage them to discuss their plans with others – especially colleagues.

3. The ability to cope with change: In social systems, the ability to cope is a measure of the proximity to emotional and financial thresholds. A serious emotional issue such as health issues, divorce, or family trauma can significantly undermine the best laid intentions. Similarly, all change is expensive and people that have a financial buffer or access to credit are better able to absorb the costs of change. Regardless of how adaptive people are on all other dimensions, this dimension can significantly outweigh all others in determining adaptive success.

ACTION: Encourage landholders to develop financial buffers for climate crises and to be aware of the various community support services available to them.

4. The level of interest in change: This dimension of adaptive capacity corresponds with the degree to which the system is capable of 'self-organisation'. Individuals that have a higher level of proactive interest in adapting to the requirements of the future usually have a higher related financial, social and/or emotional flexibility. An interest in adapting is necessary for individuals to identify the consequences, impacts and possible responses "adaptation options") to climate change.

ACTION: Encourage landholders to develop an interest in climate change adaptation through exposing them to a range of different sources of information and regularly communicating about climate change adaptation ideas.

Measuring adaptive capacity.

The capacity of individuals to cope and adapt to a range of change events has been assessed using a variety of approaches. Some approaches are inductive and use community-driven measures to assess capacity, whereas others are deductive and derived from the scientific literature. Some measures of adaptive capacity are best for comparing across scales, whereas others are more suitable for stand-alone assessments of specific communities or sectors. The technique most appropriate for a given area or industry will depend on the expertise available, goals and budget. Existing baseline datasets are available for the Monsoonal North from CSIRO. Social scientists can assist NRM groups to design and implement surveys if needed, and many NRMs groups already have in-house expertise.

4. What is the resilience of the Monsoonal North?

Message 7. Social resilience within the Monsoonal North is low.

Climate adaptation processes are proving to be less straightforward across the Monsoonal North. Some landholders appear better able to cope and adapt, whilst some are more vulnerable than others. Research in 2010 found that only 16% of cattle producers across the northern beef industry, which includes the Monsoonal North, had sufficient capacity to meet the climate challenges of the future.

The different types of landholders in the Monsoonal North region

Recent research across the Monsoonal North area (Northern Beef industry) identified four types of cattle producers according to their vulnerability to climate change, which was based on measures of resource-dependency and adaptive capacity. The two most vulnerable types were the most prevalent within the sample. The main type of cattle producer represented 43% of the sample (Type I). This type was vulnerable because they had low skills for planning, experimenting, reorganising and learning and little interest in adapting to the future. They were 59 years old on average and were only weakly networked within the industry. Their businesses were generally small (mean size was 72,728 ha, 1.9 employees, 4,600 head of cattle and a business turnover between A$1 to $5 million).

The second type of cattle producer represented 41% of the sample (Type II). They had limited capacity to manage risk and uncertainty and lacked strategic direction in their businesses, thus leaving them vulnerable. These producers were 51 years on average. Their businesses were medium-sized (mean size was 111,634 ha, 3.4 employees, 7,000 head of cattle and a business turnover between A$1 to $5 million).

Type I and II producers combined represented about 84% of the sample. Only 16% of producers appeared to have higher levels of resilience to change. The next category of cattle producer, represented 13.4% of producers (Type III), and had a stronger psychological and financial buffer than Type I and II producers. They were well networked and tended to operate large businesses (mean size was 364,639 ha, 8.9 employees and a business turnover between A$1 to $5 million).

The last type of producer, representing only 2.6% of the sample (Type IV), managed risk well, liked to experiment with options and was interested in change. Their mean age was 41 years old. They were well networked and used technology such as seasonal climate forecasts. They also operated larger businesses (>A$5 million) and perceived themselves as responsible for the future productivity of their land.

Message 8. Adaptive capacity within Indigenous communities is expressed differently.

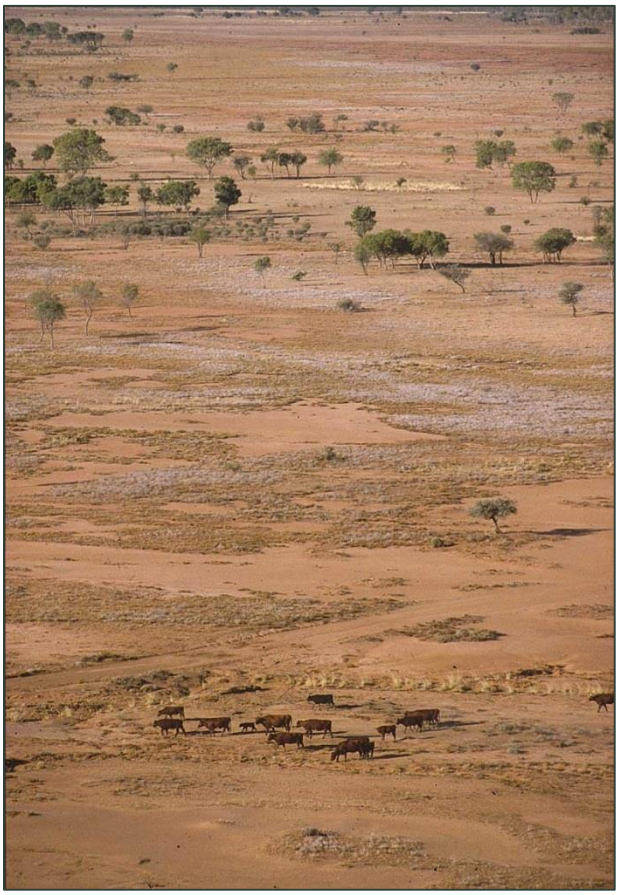
Adaptive capacity is not always expressed in the same way, particularly by people with different cultural characteristics and livelihoods. So care needs to be taken when seeking to 'measure' the adaptive capacity of people who manage natural resources very differently to those within the agribusiness sector. The underlying concept of adaptive capacity is the same for all people and communities – the ability of individuals and communities to cope with change and maintain or enhance liveability under different circumstances (e.g. under climate change). However, the indicators used to measure adaptive capacity need to reflect the culture and livelihoods of the target audience.

Aboriginal and Torres Strait Islander people living in remote communities are renowned for their deep connection to their country, and how the health of their country influences their personal health and wellbeing. Attributes of strong adaptive capacity for Indigenous people living in remote communities include:

- Strong relationships within their family and community (enables the exchange of traditional knowledge and personal experiences);
- Acceptable and feasible options for managing the health of their country (e.g. knowledge and resources to control feral animals and weeds);
- Personal and community resources to fulfil cultural responsibilities (e.g. managing country, spending time with community, high-level of mobility to maintain relationships);
- Acceptable and feasible options for enhancing their health and wellbeing, and that of their family (e.g. affordable access to high-quality housing and food).

A feature of remote Indigenous communities with strong adaptive capacity is their strong 'bonding' social capital, where strong relationships within a community often provides a 'safety net' and a degree of self-reliance, such as during periods of extreme weather (e.g. tropical storms, floods).

While outside support and resources can strengthen the adaptive capacity of communities distant from urban centres (e.g. robust infrastructure, energy-efficient comfortable housing), as with landholders living on pastoral stations, remoteness is not a pre-determining factor of adaptive capacity or vulnerability. Outside support can also strengthen the 'bridging' social capital of remote communities, so mutually beneficial connections to specialist expertise and information can be established (e.g. so the latest climate science can inform 'grassroots' adaptation).



5. Some important influences on adaptive capacity

Message 9. Many factors can influence adaptive capacity; use these to enhance adaptive capacity.

Knowledge of the factors that influence adaptive capacity may assist NRM organisations to understand or even facilitate why some landholders are better able to adapt to change than others. There are many factors that have been found to be significantly correlated with adaptive capacity in people of the Monsoonal North. Not all factors can be easily managed by NRM organisations. They include; size of business, access to credit, place attachment, employability, family dependency, income diversity, environmental knowledge and awareness, technology, networks, equity and place attachment. We suggest some strategies for each one.

- Bigger businesses are more likely to buffer themselves but they are also sensitive to change.

The business skills that people possess can be good indicators of their competitive advantage within the resource industry and their level of transferable skills outside of the resource industry. Often, the extent of business skills possessed by an individual is correlated with the size of the business that they operate. Generally, larger businesses are more likely to buffer themselves from unpredictable problems such as mechanical breakdowns, difficulties with employees and fluctuations in the weather, since they can take bigger risks and experiment with their options for the future. Owners of larger businesses are more likely to be strategic, have the capacity to motivate, plan, organise and act, and are more likely to be driven by economic incentives to harvest the resource. Capital investments, however, may limit flexibility and stifle innovation.

By comparison, smaller businesses (e.g. family farms) may have greater flexibility to undertake short-term changes and internalise some unforeseen expenses.

ACTION: Encourage smaller businesses to buffer themselves, and encourage bigger businesses to be more flexible.

- Access to credit during crisis events can affect how individuals respond to change

The income and debt levels of a resource user and their ability to access credit can also significantly influence the extent to which they can effectively respond to change. Resource users with smaller financial buffers often lack the flexibility with which to successfully absorb the costs of change and are therefore reluctant to take on further risks. Resource users with higher financial status or access to credit are more likely to be able to diversify.

ACTION: Encourage landholders to make sure that they can access finance during difficult times.

- Increasing employability can help during crisis times (age, education, level of transferrable skills and attitude to working elsewhere)

People living and working in resource dependent communities often have limited experience in other occupations. As a result, they may lack transferable skills and consequently can become 'locked' into their occupation. People that are older, have limited formal education, or are uninterested in working elsewhere are likely to be especially sensitive to impacts from climate change, since they are usually least equipped to take advantage of other employment opportunities. People with increased employability have been associated with higher levels of adaptive capacity.

ACTION: Encourage landholders to plan for situations where they may need to gain alternative employment at least for some time. This may require them to develop new skills.

- The level of attachment to the grazing occupation can work to both enhance and hinder adaptive capacity

When a person with a strong occupational attachment is suddenly faced with the prospect that they are no longer able to continue in their current occupation, they not only lose a means of earning an income, they lose an important part of their identity. Hence, individuals with a strong identity created around their occupation (e.g. as a cattle producer) are likely to be

especially sensitive to changes in the resource, but their attachment to that occupation can also work to motivate actions to ensure longer term viability.

ACTION: Remind landholders that by planning for drought or flood enables them to continue working within their occupation. However, it may also be important to remind landholders to consider alternative occupations in case they need to.

- Families act to both hinder and enhance adaptive capacity

Impacts on primary producers will also be felt by those in their social and economic networks. Family members are likely to be most sensitive to impacts on resource users such as loss of income or livelihood. These social dependencies also mean that resource users with dependents may be especially sensitive to climate changes since they will be less able to experiment with their options for the future and are consequently less flexible in their approach to change.

ACTION: Encourage landholders to discuss with their families what they would do during climate crises. Having any plan is better than no plan.

- Having a diverse household income provides more options during critical times

Individuals with income derived from multiple resource types or sectors are likely to be less sensitive to resource impacts from climate change. In many regions, individuals tend to diversify their income sources to spread risk, manage seasonality, increase flexibility, achieve stability and better cope with shocks in any one system. For example, a producer may operate a small shop or business in addition to their farming business. Such individuals can be expected to have more options for responding to climate-induced changes to key resources, and thus will be less sensitive to climate changes than those that derive most of their income from a single enterprise, even though investing across a range of skills sets can be challenging.

ACTION: Encourage landholders to consider diversifying their household income, at least to some extent.

- Recognising changes in the environment helps people to recognise the need for practice change.

Some individuals have invested substantially into developing local environmental knowledge and can detect subtle changes in resource condition over time. However, this investment usually means that individuals are less likely to move and develop such knowledge again elsewhere. The benefit of local environmental knowledge is that individuals tend to be better adapted to current conditions, and better able to recognise the need for practice change.

ACTION: Encourage landholders to carefully monitor the condition of their land and be aware of any changes that their land may be undergoing.

- Environmental awareness, attitudes, beliefs tend to be associated with people that have a greater interest in the future

Environmentally educated and aware resource-users tend to be more flexible and supportive of resource-protection strategies. They can develop identities such as 'marine or land stewards', which makes them less dependent on traditional resource management practices, and more willing to adapt new practices that enhances not only their own resilience to change, but that of the environment.

ACTION: Encourage landholders to learn about climate change impacts on the environment and how their practices can influence the impacts that do eventuate.

- People that access technology, climate information and expertise

Individuals that have access to, and a propensity to use climate technology, information and skills (such as forecasting information and accessing expertise) are better prepared to reorganise for the future. Planning is an essential component for successful climate adaptation.

ACTION: Point landholders to the various sources of climate information and expertise available to them. Encourage landholders to use technologies such as *Seasonal Climate Forecasts.*

- People that are better networked have higher adaptive capacity

Networks can be formal - through legal structures and government agencies, or informal – through friends, families and associates. Individuals with stronger, more informed and more effective networks have reciprocal connections and interactions, higher levels of trust, and access to information that is exchanged for mutual benefit. People that are well networked are expected to have a great capacity to adapt to changes.

ACTION: Facilitate regional networking events between landholders, with NRM staff, and with other people that can assist landholders to better prepare and cope with climate crises.

- People that are especially attached to their land tend to be more sensitive to change but also more motivated to protect it

This concept describes the level of connection that individuals have with their physical community. It describes the identity created around the locality, the sense of pride associated with belonging to the town and the strong friendships and networks that exist within it or connections to ancestors. People will often prefer the stability associated with remaining in the one community, and this can increase their dependency on the natural resource and decrease their capacity to effectively respond to climate change.

ACTION: Remind landholders that by planning for drought or flood enables them to continue living at their place. However, it may also be important to remind landholders to consider alternative places to live in case they need to.

6. Enhancing resilience: some NRM suggestions

Message 10. Adaptive capacity can be enhanced through involving people in Natural Resource Management planning processes.

Information sharing and engagement with NRM organisations and managers can be a major influence on the resilience of people and natural resources in the Monsoonal North region. Meaningfully and effectively involving people in NRM planning, program and project implementation processes can help to provide a politically and culturally supportive environment. Those most likely to benefit from adaptation planning will also be in the best situation to identify strategies that are most feasible, attractive and acceptable. However, there are surprisingly few research studies that test the effectiveness of various engagement processes towards strengthening resilience and adaptive capacity. We offer some suggestions that NRM organisations within the Monsoonal North cluster might consider to assist landholders to enhance their adaptive capacity.

Some ideas for NRM Organisations to enhance regional resilience:

Practice active adaptive management. Adaptive capacity of landholders can be strengthened by NRM organisations if these organisations practice active adaptive management and actively test the effectiveness of the strategies they use. Active adaptive management can help to increase adaptive capacity through experimenting with different strategies, learning from strong feedback loops and incorporating new information into the design of new strategies.

Hold NRM workshops or other learning and networking opportunities for landholders. Risk, uncertainty, skills for strategy, planning, experimenting, learning and financial buffers are all critical factors for adaptation that can be learned. Providing opportunities for landholders to explore these factors within their own working lives may be a useful strategy. Workshops that explore these concepts may also stimulate an interest in adaptation and pro-active behaviour such that well designed workshops may address all dimensions of adaptive capacity simultaneously.

Partner with community services. Psychological or emotional buffers relating to health issues or financial crises need to be explicitly addressed if the capacity to adapt is to remain intact within the region. Developing partnerships with a range of community services including regional counselling services may help to develop emotional and psychological buffering capacities. Additional community services that may be useful to partner with include community clubs, charities and sports associations.

Communicate about climate change. Extension services, communication outputs, community discussions are some strategies that NRM organisations may consider in order to foster an interest in climate change adaptation and encourage proactive behaviour. Local media, radio and television are useful vehicles to communicate with regional landholders, and online communities using social media are likely to grow over time.

Assess adaptive capacity within your region. Design and administer very simple surveys, or commission more extensive surveys, and collect social data to inform your planning processes of the current status of adaptive capacity within your NRM region. By monitoring the adaptive capacity of landholders, stakeholder organisations, and even your own organisation, you may be able to keep a finger, “on the pulse” and evaluate current social, economic and environmental conditions. Partnering with social scientists can be a great way to monitor adaptive capacity, particularly to get started and to reduce the work load.

Involve people in goal setting processes. Many research studies have shown that meaningful involvement in the decision-making process is essential to foster feelings of satisfaction, understanding, trust and confidence in the future. These feelings are necessary for a successful transition to adapting to change. If people feel confident and empowered in the future then they are more likely to positively assess the risks associated with change and their ability to cope: both of which are important in maintaining adaptive capacity.

Message 11. Adaptive capacity can be enhanced through better connecting people with each other and with the land.

The adaptive capacity of landholders to live sustainability with their natural environment is partly determined by their ability to act collectively. This ability is often referred to as social capital. Social capital includes knowledge about land management and it is developed through shared or social learning. Social capital describes the level of social interaction, social networks and social relations that exist within a community. The level of social capital within a community provides some indication of the capacity for a community to cope with change and adapt. It helps to explain the ease with which change events are accepted and incorporated into people's lives. Those with stronger, more informed and more effective networks are more resilient to generic change events than those with weaker ties.

Encouraging landholders within the Monsoonal North to recognise land degradation (and the need to respond) will be important for their adaptive capacity.

Landholders could also be encouraged to better connect with the land by encouraging them to be climate change aware. Climate change awareness is the extent that primary producers accept, understand, relate to, and prioritise climate change as a driver of change within their system.

ACTION: Empowering landholders to recognise environmental degradation might be achieved through supporting the monitoring of resource condition, encouraging or facilitating historical analyses of land condition (such as viewing old photos, accessing anecdotal information, reading old reports) and contributing to the enhancement of networks around resource condition.

Message 12. Adaptive capacity can be enhanced through managing uncertainty.

A lack of planning for climate adaptation has been attributed to some extent to a lack of certainty to what the future may look like. Whilst understandable, plans need to be made regardless; any plan is better than no plan. Uncertainty in the future need not be seen as a barrier to action. A constructive approach for climate adaptation planning is to plan for a range of plausible climate scenarios, and take the path of "least regrets".

NRM Organisations can build social resilience through identifying what desirable and feasible trajectories might look like for the future of their region. Pathways to alternative futures can be visualised through structured scenarios developed in conjunction with community participants and leaders. Futures that attain or avoid particular outcomes can be identified, and the necessary resilience-building policies can be designed and implemented to assist community members to remain on the planned trajectory.

Sources of uncertainty:

There are many sources of uncertainty in the future, yet many can be effectively managed to enable planning. Here are some sources that NRM organisations may be aware of (from the Adapt NRM 2014 brochure):

- ***Natural variability*** – uncertainty exists around future ecological condition and its spatial and temporal variation across a period of time and geographical area.

- ***Observation/Data error*** - Observation error is the failure to properly observe, measure or estimate processes and quantities. It results both from imperfect methods of observation (or not measuring key factors) and from sampling error.

- ***System uncertainty*** - our system understanding is limited by the understanding of all the links – thus, even with complex models, any projections (qualitative or quantitative) will have uncertainty.

- ***Inadequate communication*** - inadequate communication relates to the difficulty of effectively conveying information between scientists, managers and stakeholders. When communication is ineffective, information is lost, which can manifest itself as uncertainty.

- ***Unclear objectives or lack of goal setting***- unclear management objectives are ones that are expressed vaguely, not fully conceived, scaled improperly, or difficult to quantify.

- ***Outcome uncertainty*** – when actions are not implemented properly it is not possible to know whether the plan was a good one or not. This uncertainty undermines the ability to determine whether management actions and recommendations are truly working—that is, if models and other tools recommend policy or strategy X, but the practice Y is implemented instead, then it is not possible to conclude that policy X was either effective or ineffective.

Message 13. Enhance adaptive capacity by focusing on four important dimensions.

Adaptive capacity is operationalised according to the following four dimensions:

(i) how risk and uncertainty are perceived and managed,
(ii) the development of skills for planning, learning, flexibility and experimenting,
(iii) the degree of financial and psychological flexibility, and
(iv) the level of interest in and willingness to proactively undertake change.

In the following boxes we suggest different strategies to enhance adaptive capacity across all four dimensions:

(Adapted from Marshall N. A., Marshall P. A., Tamelander J., Obura D., Mallaret King D. & Cinner J., M. (2010) Sustaining Tropical Coastal Communities & Industries: A Framework for Social Adaptation to Climate Change. In: *IUCN - The International Union for the Conservation of Nature*, Gland, Switzerland.)

Adaptive capacity dimension 1: Developing skills to manage risks and uncertainty

How people perceive risks and uncertainty associated with climate change is fundamental to how they will cope and adapt. People who are able to adequately assess risks and manage climatic uncertainty are likely to have a greater adaptive capacity.

Strategy 1: Assess local climate risk perceptions. An example from coral reefs comes from CRiSTAL (Community-based Risk Screening Tool – Adaptation & Livelihoods). See www.cristaltool.org

Strategy 2: Develop action plans for adapting to climate change that directly address people's levels of perceptions of risk and uncertainty and address who will absorb the costs of adaptation and how.

Strategy 3: Some strategies to enhance longer term adaptation will come at the cost of shorter-term risks. Provide financial incentives to undertake such 'risky' strategies.

Strategy 4: Develop community workshops to assist landholders and fishers to better manage risk and uncertainty.

Adaptive capacity dimension 2: Developing skills for planning, learning and reorganising

The capacity to reorganise in the face of climate change is dependent on novelty, creativity, experimentation, learning and planning. Regions that empower individuals to use their full potential, regardless of gender, ethnicity, or social status, are more likely to foster and test innovative ideas and develop effective adaptation plans.

Strategy 1: Create supportive and facilitated environments for the shared learning of adaptation strategies and development of plans.

Strategy 2: Provide facilitated opportunities for landholders to develop business and strategic skills and plans for various climate scenarios (and institutions).

Strategy 3: For an example strategy from developing countries, see the Sustainable Livelihoods Enhancement and Diversification (SLED) participatory approach to progress through the process of discovery, direction-finding and implementing of adaptation strategies. See: http://www.iucn.org/knowledge/

Adaptive capacity dimension 3: Absorbing the costs of adaptation and increasing emotional and financial buffers

The costs of change can be significant for individuals and communities. These costs can significantly discourage individuals and communities from being innovative and experimenting.

Strategy 1: Develop partnerships between stakeholder groups at a local, regional, national and international level to share the costs of change.

Strategy 2: Ensure that the costs of adaptation options and plans are clearly identified and that full or shared responsibilities are committed to.

Strategy 3: Reward early adopters and showcase their efforts to others in the community to increase their social status and encourage momentum for change.

Adaptive capacity dimension 4: Develop an interest in adapting to climate change

For people to change their behaviour and adapt to the changing climate, they need to be convinced that projected climate changes are real and will significantly impact on them

Strategy 1: Monitor changes within the natural resource and potential climate change impacts and communicate this information regularly to the community.

Strategy 2: Use CRiSTAL (google: Community-based Risk Screening Tool – Adaptation & Livelihoods) to encourage community awareness and dialogue about climate change.

Strategy 3: Consider facilitated networking events and other community discussions such as through the media in which discussions are led around climate change adaptation.

7. Planning for climate change

Message 14. Understanding, addressing, monitoring and reporting on resilience is an important part of NRM planning and delivery processes.

NRM planning processes are an important vehicle through which to incorporate resilience thinking that has the potential to have a widespread impact. A first critical step and systematic approach to documenting information includes addressing the following sorts of questions: Who is using the natural resources in the region? For what purposes are those natural resources being used? At what scales are productive systems that depend on natural resources operating? What are the specific resources that are being used? What specifically are the inter-dependencies between landholders and environmental services? What may be the impacts of such inter-dependencies in one subregional area onto another area? What is the adaptive capacity of landholders within the region? What is the vulnerability/resilience of the region to climate change?

Vulnerability and resilience assessments

Vulnerability or resilience assessments will be the logical place to start for most NRM organisations wishing to direct or support efforts to reduce vulnerability and build resilience. By providing knowledge of the relative vulnerability of different components of the socio-economic system, vulnerability assessments can enable decision-makers to prioritise their efforts and provide a basis for early engagement. The actions that could be put in place to minimise vulnerability and strengthen social-ecological resilience will also depend on NRM implementation programs and projects already in place, resources that can be allocated, and commitment from the part of stakeholders.

Knowledge that already exists within NRM agencies can be a useful start to answering these questions and the questions above can form a template for identifying knowledge needs and gaps. The template will need to be user-friendly for a variety of audiences in its content and format. The template could be filled out through focus group discussions with different stakeholder groups, small targeted surveys or a structured process of gathering and sharing data within multi-stakeholder workshops. The results of these should be presented and discussed with all stakeholders to gain collective understanding within the region.

A completed template that addresses a number of dimensions relevant to understanding regional resilience will strengthen the capacity of NRM organisations and managers to address the complexity of adapting to climate change. It should draw attention to the relationships that exist between human and environmental assets and also the inter-dependencies between landholder livelihoods and the grazing resource and values at a number of scales (individual family unity, community groups, sub-regional and regional).

The diversity of such interactions and inter-dependencies will need to be shared and understood in a collective way. NRM planning processes can (and will need to) foster the opportunity for such “collective regional” understanding to take place so as to create the foundations for strengthening social-ecological resilience into the future. Strategies may involve considerations of trade-offs.

While climate adaptation is clearly in the interests of all people, it is often NRM organisations and managers that are best positioned to facilitate a process with stakeholders that can contribute towards such adaptation. As such, organisations might want to consider implementing a monitoring program for social and ecological resilience. Developing a monitoring program that provides a dynamic understanding on the adaptive capacity of landholders may assist to assess the effectiveness of intervention strategies and the capacity available to support new strategies. If sufficient adaptive capacity exists, then region-wide initiatives are more likely to be successful. In particular, the monitoring of landholders’ adaptive capacity can assist NRM organisations as part of their adaptive management processes. Monitoring programs are ideally designed in collaboration with social scientists as development of meaningful social-ecological resilience indicators that can be tracked across time is a complex task, as well as ascertaining tailored monitoring processes that can be effective in any given context.

ACTION: Implement a monitoring program to closely follow the resilience of landholders within the region.

8. Useful references

Message 15. Read other materials to enhance capacity.

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