



Putting uncertainty under the cultural lens of Traditional Owners from the Great Barrier Reef Catchments

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Abstract

Indigenous peoples in Australia, and globally, are situated in an unusual context of both significant vulnerability and unique resilience to climate change which influence their perceptions of climate risk and uncertainty. Their vulnerability to climate change arises in part from their contexts of living in many of the harshest and isolated environments. Their resilience originates from their accumulated knowledge of specific environments over millennia, mediated through *sui generis* cultural institutions. Our results illustrate that indigenous groups primarily perceive uncertainties related to volition of actors and institutions. When they are involved in climate adaptation planning in ways that mobilise their cultural institutions and knowledge, they can safely manage these uncertainties through their agency to determine and control key risks. We demonstrate that climate justice approaches can be strengthened for indigenous peoples by applying a linked vulnerability-resilience analytical framework. This enables stronger consideration of how unique cultural institutions and knowledge, which are not available to all vulnerable groups, affect indigenous perceptions of uncertainty in climate adaptation planning. We use this analytical approach in a case study with Yuibera and Koinmerburra Traditional Owner groups within the Great Barrier Reef Catchment. We conclude that a specific focus on *sui generis* indigenous knowledge and cultural institutions as a source of resilience can strengthen climate justice approaches and work more effectively with indigenous peoples in climate change contexts.

Keywords Uncertainty · Indigenous peoples · Climate adaptation planning · Great Barrier Reef (GBR)

Introduction

Globally, many indigenous peoples live in “isolated, fragile, and harsh environments”—areas that will be particularly “vulnerable to environmental change due to their latitude, topography, distance from the sea, soil’s quality” (Macchi et al. 2008, p.20). Indigenous peoples in Australia form the majority

of populations in many of these environments, such as the Torres Strait, and climate change impacts on their country are already evident, including extreme weather events, climate variability, and sea level change (Green et al. 2010; McIntyre-Tamwoy et al. 2013). For all indigenous peoples in Australia, and most globally, climate change compounds over-arching issues of socio-economic disadvantage, chronic poor health, and the burdens of the colonial history of dispossession and hostile policy settings (Green et al. 2009; Howitt et al. 2012). These vulnerabilities are exacerbated by uncertainties about climate change—both its future trajectories, its impacts, and how these interact with the social-ecological systems in which they are embedded (Miller and Morissette 2014).

Nevertheless, indigenous peoples’ traditional knowledge, practices, customary law, institutions, and governance systems, developed over centuries and often millennia of occupation of the same areas, contribute unique sources of experience and knowledge that have enabled them to respond to challenges of climate change both now and in the past (Jayalaxshmi and Berardi 2016; Nakashima et al. 2012). In Australia, the unique *sui generis* (i.e., originated in the site where they operate) cultural institutions and knowledge of

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indigenous peoples over their diverse traditional territories are recognised legally through the *Native Title Act 1993* and extensively documented (Horton 1994). In this paper, we examine perceptions of climate uncertainty through a case study with indigenous peoples on the Great Barrier Reef, and highlight how their context of both vulnerability and of resilience, generated by their unique *sui generis* cultural institutions and knowledge, leads them to prioritise volition uncertainty—whether they can gain the agency for climate action through their own actions founded in their cultural institutions.

In Northern Australia, for example, indigenous peoples' knowledge of indicators of seasonal change, accumulated over at least 50,000 years of continued occupation (Clarkson et al. 2017; Tobler et al. 2017), underpins adaptive responses to climate change (Leonard et al. 2013). This accumulated baseline information about their environment, and approach of basing environmental management actions on seasonal indicators such as flowering of trees, supports an adaptive approach that has enabled them to navigate climate change over millennia (Head et al. 2014). These contexts of maintaining unique knowledge and adaptation approaches relevant to climate change, while living in highly vulnerable environments and enduring ongoing socio-economic disadvantage, characterise what Head et al. (2014, p.188) identify as the “paradox” of indigenous peoples and climate change response. Climate justice approaches highlight that those already exposed to other forms of vulnerability are often the most exposed to climate and environmental change. Analysis that recognises procedural, distributional, and cognitive aspects of justice has proven key to understanding how climate vulnerability can be best addressed with such vulnerable groups (Schlosberg and Collins 2014). The approach also engages the notion of justice as recognition that the costs and benefits of climate action are not equally experienced by groups in the society (Bulkeley et al. 2014).

However, climate justice approaches have only recently begun to address how to strengthen the resilience that indigenous peoples and local communities have as a result of their unique *sui generis* knowledge and customary governance, and their adaptive approaches to environmental management (Mathur et al. 2014). In this paper, we use a linked vulnerability-resilience framework, adapted from Maru et al. (2014), to analyse indigenous perceptions of uncertainty associated with climate change, as a means of addressing this “paradox” that indigenous peoples demonstrate both vulnerability and resilience that need to be considered to understand and support their climate responses. Our analysis shows that their primary concerns about uncertainty are related to volition—whether they have agency to define and control key risks, in order to counter vulnerability from colonial legacies, and reinforce effective adaptation arising from their knowledge, cultures, and territorial rights.

Uncertainty about climate change and its potential impacts is a significant issue globally, and substantial scientific effort

has been focused on how to communicate and quantify uncertainty, but with little attention to volition (Mastrandrea et al. 2010). In the field of climate science, calculating uncertainties has focused on the statistical quantifiable dimensions, less so on the unquantifiable uncertainties (Dessai and van der Sluijs 2007). Scientific projections of future atmospheric compositions and associated climate conditions are designed primarily to address the probability of a known impact occurring or of a range of possible scenario outcomes, both of which use rational thought and action in the present (Dessai and van der Sluijs 2007).

Increasingly, the science community is recognising the important role of unquantifiable uncertainties, such as volition, and how local perceptions of risk and uncertainty are important in meaningful engagement with communities about climate change (Dessai and van der Sluijs 2007). As Hulme (2008) argues, the prevailing epistemology behind climate science makes way for particular futures and perspectives consistent with the scientific knowledge system. The socio-cultural institutions in which change, actions, and perceptions of uncertainty, which are critical to community engagement in action to address climate change, have been little considered (Douglas 1992; Zinn 2008). Nevertheless, perceptions of uncertainty have been identified as a key factor in determining actions to respond to climate change (Lindenfeld et al. 2014).

Studies across indigenous groups demonstrate diverse perspectives and levels of understanding, including about uncertainties, with related diversity in capacities to respond and manage climate impacts (Cruikshank 2001; McIntyre-Tamwoy et al. 2013; NAILSMA 2010). For example, indigenous climate change concerns in the Murray-Darling Basin of Australia are underpinned by narratives of colonisation, dispossession, and the ongoing effects of agriculture, which generate uncertainty about how and whether indigenous peoples can understand and manage climate change on their own terms (Nikolakis et al. 2016). Indigenous peoples globally demonstrate significant interest in mobilising and sharing traditional knowledge to aid climate adaptation (McMillen et al. 2017; Nakashima et al. 2012). However, this interest is tempered by concerns and uncertainty about the management of risks, including moral hazards to cultural values (e.g., absence of legal protection of the socio-spiritual obligations associated with shared knowledge from a particular community), material harms (misappropriation and overharvesting), and lack of benefit sharing (Williams and Hardison 2013). These uncertainties impede indigenous peoples' responses to climate change and thus are important to understand.

In this paper, we first present and justify our analytical framework, then the case study context and methods for research. Next, we present the results of Traditional Owner perceptions of uncertainty under climate change and their desired responses for inclusion in regional climate adaptation planning. We conclude with a discussion about how specific focus

on *sui generis* indigenous knowledge and customary governance, supported by the linked vulnerability-resilience analytical framework, can strengthen climate justice approaches as a means of responding to unique indigenous perspectives of uncertainty about climate change.

Analytical framework: linked vulnerability-resilience and categories of uncertainty

Resilience has many definitions but is considered here as the capacity of a system to absorb disturbance and still maintain its same controls, key structures, and functions; we refer to “desirable resilience” where this characteristic of persistence supports desired social goals and values (Maru et al. 2014). Resilience arises from the capacity of a community to address climate-related uncertainties in ways that allow it to function and renew itself—termed “adaptive capacity” (Cinner et al. 2018). Adaptive capacity, in turn, depends on social networks, institutions, and learning—opportunities to access and use resources and the agency to determine whether to and how to change in the face of climate change and other challenges (Cinner et al. 2018).

Positive resilience strengthens adaptive capacity and is sourced and amplified through accumulated knowledge, experiences, cultural institutions, and practices, attuned to particular environments and environmental change, typically more systemic, and long-term. As noted above, while indigenous peoples typically experience lack of access to the political, economic, and social resources of the dominant societies and nation-state governments now occupying their traditional territories, their cultural connections and customary governance provide ongoing access to valued accumulated knowledge of their environments (Berkes 2012; Jayalaxshmi and Berardi 2016).

In Australia, indigenous people have deep cultural connections to their land and seas, referred to as their “country”, and associated systems of kinship, customary law, and knowledge systems, that involve obligations and responsibilities to a complex web of ancestral beings, future generations, and country (Altman and Kerins 2012). These connections and associated knowledge systems provide the basis for natural resource management that responds to the impacts of climate change (Green and Raygorodetsky 2010; Rose Bird 1996). This worldview conceptualises the health of the people and their country as deeply connected and incorporates practical activities such as fishing, hunting, burning of country, accessing country, and finding pathways to gain greater recognition (Jackson et al. 2012; Rose Bird 1996). Leonard et al. (2013), for example, details how indigenous people in Australia’s Kimberley region monitor plant phenology and animal behaviour as seasonal indicators in ways that support adaptation of their practices (such as times and places for burning vegetation and customary fishing and hunting) to changing environmental conditions. Petheram et al. (2010)

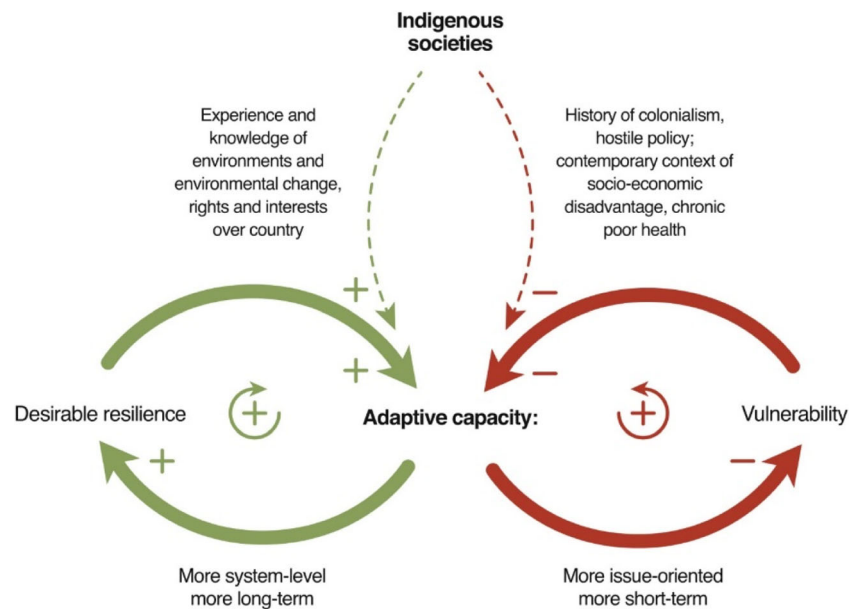
noted that Yolngu people in the Northern Territory attributed the strange changes they observed on their environment, over multiple years, partly as a consequence of inappropriate actions on their traditional lands that included tourism, mining, and recreational fishing, as well as the effects of climate change. Such indigenous perspectives on and relationships with their local environments are defined by their worldview, values, culture, and institutions and are passed down from generation to generation through story telling (Berkes 2008; Green et al. 2009; Petheram et al. 2010).

Vulnerability is sourced from colonial processes of territorial acquisition that disrupted indigenous peoples’ connections with their traditional territories, amplified by political marginalisation, socio-economic disadvantage, and associated chronic poor health, and exacerbated by the harsh environments that indigenous peoples frequently occupy (Hibbard and Lane 2004; Lane and Hibbard 2005; Whyte 2018). Justice theory states that vulnerability is exacerbated when these underlying social and political conditions are not properly recognised in the distributions of goods and risks (Schlosberg 2012). Increased vulnerability reduces adaptive capacity through weakening of the capital holdings, networks, and institutions upon which adaptive capacity depends (Cinner et al. 2018). Vulnerability corresponds to symptoms of loss of self-determination-based independence and community self-reliance, conditions that are often reproduced and occur even where interventions have resulted from well-intentioned social and economic policies to support “development” (Dhillon 2018; Howitt et al. 2012; Maru and Davies 2011). Vulnerabilities often arise from the absence of cultural and political recognition that underpin distributive injustice (Schlosberg 2012; Whyte 2018).

Adaptive capacity of indigenous peoples is therefore influenced by two opposing cycles of positive reinforcement. The first is the positive reinforcement of resilience arising from their experience and knowledge of environments and environmental changes, associated with rights and interests over country, which are gaining increasing recognition by nation-state governments throughout the world and particularly in Australia (Brondizio and Le Tourneau 2016; Hill et al. 2013). The second is the positive reinforcement of vulnerability, arising from the history of colonialism and hostile policy, producing the contemporary context of socio-economic disadvantage and chronic poor health, which injustice continually reinforces (Maru and Davies 2011; Schlosberg and Carruthers 2010) (Fig. 1).

Indigenous peoples’ perception of uncertainty related to climate change is situated within this context of both vulnerability and resilience. Rather than focusing on uncertainty as the probability of a known impact occurring or of a range of possible scenario outcomes, our analysis takes account of the broader socio-cultural dimensions of uncertainty. According to Raskin et al. (2002), future uncertainties that are part of complex socio-ecological systems involve ignorance,

Fig. 1 Linked vulnerability-resilience framework showing how both vulnerability and resilience are positively reinforced and affect adaptive capacity. Source: adapted from Maru et al. (2014).



surprise, and volition as distinct sources of uncertainty. Ignorance is based on incomplete information about the dynamics of a system that generates multiple probabilities for possible future scenarios. Surprise is due to the inherent properties of complex systems which can exhibit emergent phenomena (related to feedbacks and dynamism) and structural shifts when thresholds are crossed. Kates and Clark (1996) offer several characteristics of surprise: they can confound social expectations, they are not completely unpredictable, can be both negative or positive, and they present opportunities to increase our capacity to manage environmental problems. Volition refers to the unique roles of human actors, whose future choices have not yet been made; and to human institutions that create and reinforce their own trajectories, leading to unpredictable responses in climate change arenas (North 1992; Raskin et al. 2002).

Our analytical framework links the context of indigenous peoples—with sources of both vulnerability and resilience that affect their adaptive capacity—and these categories of uncertainty that are relevant to this context (Table 1).

Case study context and geography

The Australian Government committed \$44 million to Regional Natural Resource Management (NRM) Planning for Climate Change across 56 NRM regions through its Clean Energy Future (CEF) Plan in 2012 (Australian Government 2013). The funding programme was designed to assist regional NRM organisations to update their NRM plans using regionally synthesised science products to aid climate adaptation responses with a particular focus on climate change impacts on land (Bohnet et al. 2013).

This paper is based on a research project undertaken in the Mackay-Whitsunday, one of the four geographically distinct NRM regions in Far North Queensland, grouped in the Wet Tropics Cluster of the CEF programme (Fig. 2).

Climate adaptation planning in the Mackay-Whitsunday area occurs in a highly contested landscape of diverse values and activities including mining, tourism, agriculture, fisheries, urbanisation, and aboriginal custodianship, which represent multiple demands for the region's resources (Bohnet et al. 2013). Aboriginal peoples from this area have long pursued legal recognition of their traditional and custodial rights to country, including the protection of important cultural sites such as freshwater lakes, and management of ecosystems that are important to culturally significant species such as medicinal plants or marine species. These can conflict with agricultural interests where some of these sites may be located on farmland or where farming practices such as chemical inputs are perceived to be harmful to important species, or where major infrastructure has changed the flooding patterns and hence the way Traditional Owners can collect resources from freshwater wetlands or how they envision their country.

The likely scenarios for future climates will add to existing challenges of resource access with projections of an increase of average maximum and minimum temperatures, increase in the temperature of hot days and frequency and duration of extreme temperatures, increased intensity of extreme rainfall events and less frequent but more intense cyclones. These conditions present uncertainties about future productivity of agricultural production, from increased evaporation and contamination of agricultural land through sea level rise, damage to infrastructure and housing from floods; as well as strain to human health from heatwaves (Reef Catchments 2016).

Table 1 Analytic framework relating types of uncertainty for sources of resilience and vulnerability in building capability for climate adaptation planning

Sources of resilience and vulnerability		Types of uncertainty for building climate adaptation planning capability	
Ignorance	Surprise	Volition of actors	Volition of institutions
Source of resilience experience and knowledge of environments, rights and interests over country	Strategies and preparation based on ethical processes that address multiple scenarios of climate change	Ability to draw on kin network, rights and access to manage country	Recognition of indigenous cultural resources, rights and interests that is part of wider societal adaptation planning
Source of vulnerability—history of colonialism, contemporary context of socio-economic disadvantage, chronic poor health	Engagement on the potential impacts of climate change on existing environmental, socio-economic and institutional vulnerabilities	Future opportunities to utilise IK with science to address climate change through indigenous driven processes	Future multi-scale climate adaptation planning that continuously engage indigenous peoples as key groups with particular long-term relationships, interests and values over their traditional lands and seas
	Type of and amount of loss of country from sea level rise; type of changes in distribution and availability of culturally important species		

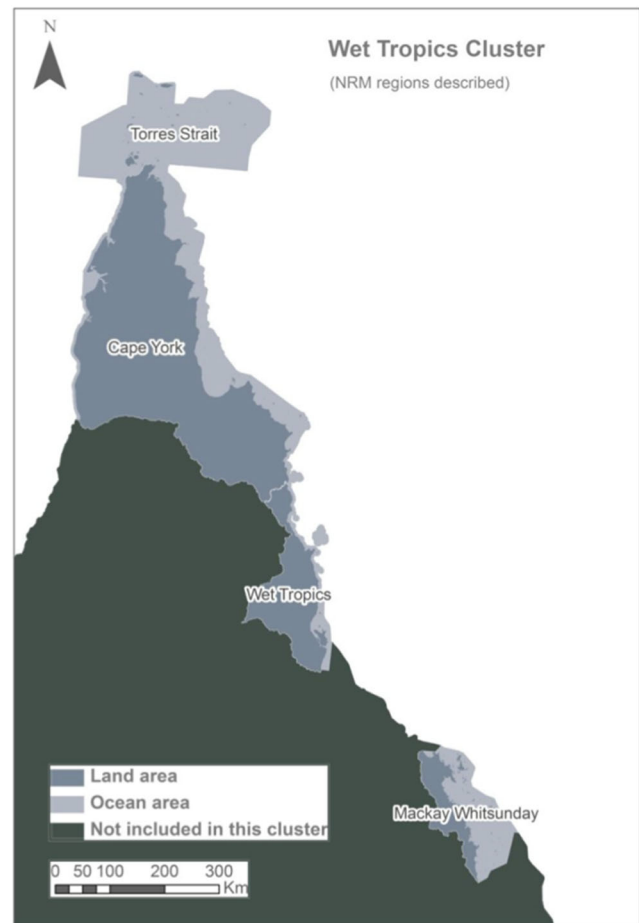


Fig. 2 Four regions in the wet tropics climate cluster. Source: Moran et al. (2014)

In the Mackay-Whitsunday regions, many challenges arising from colonial histories exist for Aboriginal people, as with other Aboriginal groups across Australia, in adapting to climate change (Howitt et al. 2012; see Veland et al. 2013). Occupation of Aboriginal people’s traditional lands in Mackay first occurred through granting of pastoral leases by the Queensland colonial government in the mid-1800s. The first Aboriginal reserve in Queensland was established in Mackay in 1870, where Aboriginal workforces were rounded up and could be protected from the native police raids, and where they were permitted to continue their hunting and cultivation practices (Kidd 1997). The establishment of cotton and sugar plantations by 1877 increased the demand for labour that drew mainly from the trade in Melanesian labourers, as well as Asians and Europeans to fill the shortfall (Kidd 1997). Descendants of these communities continue to be residents in the Mackay region.

Under the *Aboriginal Protection and Prohibition of the Sale of Opium Act (1897)* Aboriginal people were relocated to reserves, and any children of “mixed race” were removed into state (management) care. Aboriginal people’s rights to marry, move, earn, and keep their wages were all controlled

by the Queensland State Government under this policy which continued until the early 1970s (Kidd 1997). This historical landscape of colonisation and dispossession is a strong feature in how groups frame their engagement and the types of futures they imagine for country and people in planning for climate adaptation.

Research methods

The aim of the project case study was to partner with the organisation Reef Catchments NRM and indigenous people from the area to do climate adaptation planning. Representatives from two Traditional Owners groups, an indigenous ethnobotanist, a climate officer from the NRM agency, and a Commonwealth Science Industrial Research Organisation social science researcher collaborated to design the project and develop adaptation strategies using both climate science and indigenous knowledge. Representatives from the Yuibera and Koinmerburra Traditional Owner groups expressed interest in response to an invitation put to the Reef Catchments NRM Traditional Owner Reference Group. The two Traditional Owner groups are custodians of land and sea country in the GBR Catchments and both are urban based. Yuibera country includes the regional town centre of Mackay. Nine participants from both groups who lived in the township and were selected by their cultural representative bodies participated at different times throughout the project. Demographic information about the participants was not collected as part of this study.

The research consisted of field work and workshops that brought together western science that included modelled climate projections and regional maps of environmental risks, with indigenous knowledge to develop climate adaptation strategies. The climate projections and environmental risk maps included sea level rise and flood and erosion risks, as well as potential temperature and vegetation changes. Pictorial books were used to talk about climate change and maps were used to aid discussion about the types of environmental shifts that could occur on country as a result of climate change. Traditional Owners also talked about changes they are seeing on their country and shared photos of places. The climate projection and environmental risk maps were effective tools that engaged all parties to share their knowledge about changes occurring on country, including their different perspectives of the types of social and economic conditions that affect adaptive capacity. For the Traditional Owners, the maps showed the landscape view of the environmental risks, such as river bank erosion that can affect culturally important species and places on their country. These maps allowed a proper discussion about places that Traditional Owners could access, where they had relationships and could access private property, and the limits of their resources and capability to respond to ongoing change on their country.

This was a seven-month project that began with a week-long camp at Cape Palmerston National Park with the Traditional Owners who wanted to share, record, and map some of their knowledge and values about their country. The camp was followed by workshop discussions that included projection and risk maps of: sea level rise to 2100; seagrass distribution, storm surge, and flood risks based on past events and landscape vulnerability; and social sensitivity maps based on existing environmental risks and census data. Interviews throughout the research were used to confirm team observations made during the project case study and to evaluate progress with the Traditional Owners. The final stage of the project involved the participation of the Traditional Owners in a multi-stakeholder regional climate adaptation planning workshop to develop the Reef Catchments NRM climate adaptation plan.

Data from the workshops and interviews were coded in NVivo under broad categories of uncertainties related to sources of vulnerability and resilience.

Results

Influence of vulnerability and resilience on perceptions of uncertainties

Traditional Owners recognise the need to counter the influences of colonisation and dispossession which underpin vulnerability. Two types of vulnerability were highlighted: vulnerability from colonisation and dispossession; and vulnerability from changes and losses on country. They also seek to strengthen their resilience through a focus on two particular aspects: protecting what is left; and adapting to different uses of country. Each of these was associated with uncertainties of ignorance, volition, or surprise (Table 2).

Associated with vulnerability: legacies of colonisation and dispossession and uncertainty about recognition and access to country

The enduring impacts of colonisation through removal from country and loss of access to country were a major feature of Traditional Owners' accounts and pointed to uncertainties around maintaining relationships with their traditional lands (Table 2, row 1). Both the Koinmerburra and Yuibera Traditional Owners recalled experiences and fear of family members being removed from their traditional lands to be placed on missions as part of colonial government policies:

Mum's mother grew up in Rockhampton but her father lived and worked on country. The threat of the kids being taken under the Act was real. She talks about an extended family member being taken to the Woorabinda

Table 2 Sources of vulnerability and resilience identified by the Traditional Owners and their associated uncertainties of ignorance, volition, and surprise

	Areas of concern and actions	Uncertainty of concern to Traditional Owners	Type of uncertainty
Associated with vulnerability	<p>1. Historical legacies of colonisation and dispossession of indigenous peoples from their traditional territories</p> <p>2. Changes and losses on country including:</p> <ul style="list-style-type: none"> • loss of important water holes and camping grounds on the coastal fringes from sea level rise • Loss or degradation of culturally important species from changing temperatures • Loss of cultural sites from sea level rise 	<p>Uncertainty about recognition and access to country</p> <p>Uncertainty about whether they will be able to maintain cultural connections with future resources</p>	<p>Volition of actors: future choices of other (non-Traditional Owner) actors to allow them access to their country</p> <p>Volition of institutions: future requirements for recognition as Traditional Owners and instruments that will support access</p> <p>Ignorance: whether cultural resources will be available in the future</p> <p>Surprises: whether culturally important species will shift their populations, change, adapt or become present or absent in novel ecosystems</p> <p>Volition of actors: Whether Traditional Owner actors will be able to maintain culture and identity without access to specific cultural resources</p>
Associated with resilience	<p>3. Protecting what is left:</p> <ul style="list-style-type: none"> • Protecting cultural assets that demonstrate their connection and cultural assets • Recording their knowledge and cultural assets • Managing country holistically <p>4. Adapting to using different country</p>	<p>Uncertainty about their influence on management</p> <p>Uncertainty about negotiating access to different country</p>	<p>Volition of actors: Whether other actors will recognise their connection, and support their management roles without continuing existence of specific cultural sites and resources that demonstrate this</p> <p>Volition of institutions: whether the institutional engagement mechanisms will enable Traditional Owners appropriate opportunities, financial and other resources to influence management; whether the public broadly will be sufficiently aware of Traditional Owners' cultural connections under climate change to support their roles</p> <p>Volition of institutions: whether responses from government and Aboriginal culture will enable their access; whether both government and Aboriginal cultural institutions will appropriately manage access by climate migrants arriving on country</p>

mission... Many lived in the fear that they would get herded up and put on missions. (Interview on country - Koinmerburra Traditional Owner)

Their placement into missions resulted in the loss of spiritual and customary practices and associated knowledge, requiring adherence to colonial rules that further weakened indigenous governance. For the Koinmerburra Traditional Owner, the lack of documentation of the removal of her ancestors represents potential erasure of their presence from their country. Sites that clearly demonstrate their distinct Aboriginal history and cultural values before European settlement are therefore important in reasserting their rights as Traditional Owners. Some of these sites that are threatened with inundation through sea-level rise were chosen by the Traditional Owners for the project activities in order to record and map this knowledge to protect it for future generations:

The sites show that there was occupation, that we were there... if we lose that and we don't do anything about it, we've pretty much lost our past, our culture, our mob... our rightful heritage and identity. (Interview on country - Koinmerburra woman)

Traditional Owners explained how the connection between these threatened sites and the people is more important than just the continuing existence of the site—the key concern is not primarily whether the site will be flooded by sea water, but whether their connections to the site and involvement in management continue as the site is flooded:

All our cultural learning it revolves around mother earth. It's not just this part, like climate change, there is water, being involved in all aspects... [and] working together on that. If we don't have mother earth [she] does not reproduce. If we look after that she sustains us. (Interview - Koinmerburra Traditional Owner)

Managing all aspects of their traditional lands and waters is intimately connected to their culture thriving and the health of people. Climate change is one consideration that will affect this relationship, by engendering physical changes to the country and important sites. However, the lack of recognition of Traditional Owners' ancestral relationship to their land, their artefacts, their laws, and values to be on country and to look after country is a greater concern. National parks are perceived as imposing a set of rules that prevents access to important sites and places with stories and artefacts that require looking after, in order to manage threats like sea level rise. Looking after country requires cultural practices, including

camping on country to share knowledge between generations, and hunting and collecting of cultural plants. Previous attempts to introduce cultural protocols to establish a minimum set of rules for government agencies to engage about work on country were not fully utilised by national parks:

The artefact site, and even in the wetlands [fresh water sources that were used by ancestors who dwelled on and occupied the coast line], the swamps they are full of hymenachne. Why can't they [National Parks] clean it out? That's our history. Let's try and get together and keep it clean. That's important to us. That shows that we were here. They just don't care about our culture. (Interview on country - Koinmerburra Traditional Owner)

For the Traditional Owners, an absence of recognition of their customary obligations to their ancestors and their traditional lands, and trust between them and the national park agency, presents a significant uncertainty about climate-induced changes, such as sea level rise, and how this will affect the future health of their country and their culture.

Associated with vulnerability: changes and losses on country and uncertainty about whether they will be able to maintain cultural connections with future resources

For the Traditional Owners, change and loss on country are certain. They have been observing environmental change and severe weather on their country since their youth, including flooding of the township vicinity that is now a built city, inundation of their homes, loss of freshwater pools to saltwater, and movement up river of mangroves that are important for food and teaching of the younger generation. Nevertheless, some family groups have been able to continue their cultural connections and responsibility for intergenerational knowledge transfer despite this dynamism of the environmental conditions:

I think we've been lucky as a family group. Most of us have lived here all our lives. Our children come back with their children cause they want to teach them here now. A lot of our food [traditional food] is in our mangroves. There are 3 or 4 different species [mangroves] up the back of Blacks Beach. It protects artefacts from storm surges. Mangroves are coming back into the waterway. Our children go in the mangroves to get food. Once you teach them to do that, they know where to go, they know their country, and it is part of their connection. (Workshop - Yuibera Elder)

However, each group faces different challenges of access to their lands and seas, as accessible areas are largely only the designated public access areas; and of access to resources to stay on their traditional lands. For some groups, limited access to country has meant that they have become distant observers of its changing condition. Development, including agriculture, mining, and the expanding urban setting, and changing environmental conditions, bring uncertainty about the types of cultural resources and conditions they will access in the future. The Traditional Owners expressed concerns about the impacts of both economic and environmental change including the effects of mining and shipping on country and important species, run-off and pollution into waterways, and weather events that erode the coast including ancestral fish traps. In the context of intermittent access to country, potential shifts of key plants and animals, and/or unfamiliar ones moving into their country, may occur too quickly for cultural connections to be maintained.

Some groups observe extreme losses whenever they are able to access country such as damage to artefacts from vehicle traffic and management actions, loss and degradation of seagrass and culturally important species such as dugongs, removal of bush foods and medicines, and loss of knowledge through migration and elders passing. A Koinmerburra Traditional Owner was heavily discouraged after seeing the impacts of severe weather and human activity on their country. Lack of regular access to country meant the changes were occurring too quickly for the cultural practices of close observation to understand the patterns of change—which severely limits the ability to respond appropriately:

I don't know how to feel about it. Every time you come out, you go out to a site, and it may be destroyed. You feel like you lost a piece of yourself or your mob. (Interview on country - Koinmerburra Traditional Owner)

The rapid pace of change triggers three different types of uncertainty for Traditional Owners: potential *ignorance* about whether cultural resources will be available in the future, potential *surprises* about their future location, and potential lack of *volition* to access cultural resources and maintain culture and identity (Table 2, row 2).

Associated with resilience: protecting what is left and uncertainty about their influence on management

Protecting what is left of their culture and of country that they can access for future generations is important to enable Traditional Owners to draw on their sources of resilience—their experiences and knowledge of environments and environmental change (Fig. 1). The presence of important cultural sites, plants, and artefacts are important indicators of a

protected culture that is still practiced, enabling connection to country and resources for future generations:

It's just when you're coming out, if the sites are there, you feel that connection more. Just makes you feel alive... your culture is still alive for future generation. We've always said we've got to protect whatever sites we can. Our kids and grandkids we want to show them the sites and tell them the stories and what they were there for and how our mobs used the country and environment. (Interview on country - Koinmerburra Traditional Owner)

The Traditional Owners identify critical uncertainties around how actors' and institutional volition will influence their ability to protect country (Table 2, row 3). Strategies of recovery currently rely on their own efforts to relocate artefacts, create awareness of their culture, and record their existing sites, including through video footage, for future generations. However, as many others are now responsible for their country, such as national parks, project partnerships are critical—but the conditions of engagement introduce uncertainty about whether partnerships will support the necessary actions by Traditional Owners to protect country:

We want outcomes as a mob. To me it's pointless if we don't get anything out of this [climate adaptation planning]. We want to create relationships, partnerships, projects, looking after spots that are key areas or sites to us. A lot of our sites are gone, whether it is through weather, climate or man-made. It's really important to us because it's all we've got left. (Workshop - Koinmerburra Traditional Owner)

Traditional Owners need to secure clear beneficial outcomes for their groups in project partnerships, both to recognise their traditional custodial roles (i.e., strengthen sources of resilience) and also to adjust to losses endured over decades of colonisation (i.e., reduce the effects of sources of vulnerability). However, enduring partnerships are challenged by uncertainties around funding for Traditional Owners' roles, for example through jobs as rangers and contracts to undertake on-ground works. Our science partnership was perceived to have strengthened resilience by supporting their way of knowing country, and their aspirations to manage country if given the opportunity.

Associated with resilience: adapting to using different country and uncertainty about negotiating access to different country

The Traditional Owners' awareness about potential losses of land and cultural resources from sea level rise triggered

questions about whether ownership and access rights over land would therefore need to be re-distributed. Key concerns arose about how and whether they would be involved in this decision-making, and what the consequences would be for their ongoing access to cultural places and country. For them, preparation for any potential land ownership or access negotiations with government and farmers on the coast need to be entered into and nurtured early, and have uncertain outcomes in terms of institutional and actor responses (Table 2, row 4).

When I looked at that [sea-level rise projection scenario], I said god that is going to go over the top of my camp. Do I need to go up on higher ground? We got to be careful because the farmers and cattle property owners are the ones sitting on higher ground we like to camp on. We got to work toward breaking the barriers down with these cane farmers and the cattle property owners. Are they going to give it [land] back to us? Who will tell these property owners, sorry you've got to move your property further back from the ocean. Who has the right to do that? And where does it leave us? (Workshop - Yuibera Traditional Owner)

Traditional Owners perceive that negotiations with other holders of ownership and access rights to lands to ensure equitable redistribution as sea levels rise could help redress the long displacement of the local indigenous groups. They also recognise that any such negotiations also need to occur with other Aboriginal groups, who are the Traditional Owners of those lands, through their customary institutions. They expressed uncertainty about how these negotiations would be conducted and what the results would be. Concerns also exist around potential new migrant populations from the Torres Strait Islands, communities that have a historical link to the region from the colonial labour trade, as a result of the impacts of sea level rise. The Traditional Owners highlighted uncertainties about the results of negotiations around access to and use of their traditional lands by immigrants, and potential impacts on their cultural practices and laws from greater pressures that may be placed on those limited places and on culturally important species.

Responses that will help lower perceived uncertainties

Lowering uncertainty about the aspects of vulnerability and resilience highlighted above requires the Traditional Owners being on their country to know about and act on changes. It also requires effective engagement in decision-making to lower uncertainty about institutional responses and management influences.

Associated with strengthening resilience: being on country to know about and act on climate change

The Traditional Owners seek to be supported and resourced to monitor change in important places on-country, including places visited from childhood, that have important stories as well as cultural species, to aid them to closely observe and make greater sense of the impacts of climate change and the multiple pressures on their country. Collating and recording knowledge of their country is one action that would strengthen their sources of resilience, ensuring transfer of knowledge between generations and providing a record of their presence and occupation of country. The lack of voice for the Traditional Owners in making claims about their culture in western society has made collation and recording all the more important in order to protect their culture and to incorporate their values into management plans. Recorded knowledge provides greater evidence to negotiate to protect what they have left. Creating awareness about their culture, for example through activities in primary schools, was identified as one strategy to ensure their values are recognised in the wider community:

Teaching at the schools, teaching our culture and its importance to us. Our culture revolves around the environment and this is why we look after it and how we look after it. (Workshop - Koinmerburra Traditional Owner)

The Traditional Owners want to be on country to respond to climate change and the multiple pressures, including tourism, agricultural run-off, weed infestation, and erosion of coastal areas, on their country. However, working on country has to be done in a way that strengthens culture in order to strengthen resilience to impacts of climate and other changes. Their customary obligations and responsibilities to future generations and to look after their traditional lands and seas through indigenous institutions are crucial to this resilience, particularly for the youth:

Living on country and doing it on country. It's no good doing it in the city. Getting back on country is important to work on climate change. Until they [youth and Traditional Owners] know about our culture and the way it is supposed to work. A lot of our kids have missed out on their culture and it's important to bring them back. (Interview - Yuibera Traditional Owner)

Associated with strengthening resilience: effective engagement in decision-making

Traditional Owners can strengthen their sources of resilience through engagement that recognises their rights over country

(Fig. 2). However, they are very unsure about whether this will occur:

Are we going to be part of decision-making of what happens to country, especially in areas of value to us? We need to be there with them all sitting at the same table rather someone talking to us and then going out representing us. We don't want that. (Workshop - Yuibera Traditional Owner)

Traditional Owners perceive that effective engagement in decision-making requires recognition of their culture, including their knowledge and roles as custodians, and the right to express their identity, practices, and lores to others on their country and ultimately to have compliance authority. Looking after country together provides an opportunity to improve the current situation, which currently falls short of the required recognition of indigenous culture. Through working together to make decisions about country, Traditional Owners perceive an opportunity to uplift the respect for their protocols, knowledge, and their values from the professional and wider community who reside in, earn a living on, or share in the use of the resources on their traditional lands.

Discussion

Our results show that indigenous groups perceive primarily uncertainties related to volition of actors and institutions. When they are involved in climate adaptation planning in ways that mobilise their cultural institutions and knowledge, they can safely manage these uncertainties through their agency to determine and control key risks. Key risks indigenous groups face arise from the historical context of colonisation and dispossession that have enduring legacies (Cameron 2012). By asserting the expression of their knowledge, exercise of their rights and interests to their traditional lands and participation in decision-making that have environmental and health impacts, they reinforce their resilience under the conditions of multiple drivers of change. These endeavours to counter enduring political marginalisation and revitalise indigenous traditions and customary governance are firmly embedded in emerging indigenous social movements for environmental and climate justice (Dhillon 2018).

The ongoing impacts of a history of dispossession and of climate change are inseparable vulnerabilities for indigenous peoples who are engaging for a more just outcome for their society (Schlosberg and Carruthers 2010). Procedures and responses to climate and environmental change must engage the continuing “consequences” of colonisation in ways that strengthen local capacity and culture (Howitt et al. 2012). While the impacts of climate change are being observed by indigenous peoples through changes in seasonal patterns and

indicators, many of their immediate concerns and uncertainties relate to socio-economic institutional barriers to sustainable development, issues that have a direct impact on their capacity to respond (Maru and Davies 2011; Petheram et al. 2010). Indigenous agency to directly participate and design mechanisms to strengthen their capacity to respond to climate change remains weak in many post-colonial societies (Dhillon 2018).

Schlosberg (2004), Bulkeley et al. (2014), and Visvanathan (2005) identify attributes of justice that are relevant to findings of this study: procedural (encompassing recognition and participation), distributional (equitable sharing of risks and benefits), and cognitive (respect for diverse ways of thinking about and knowing the world). Calls for procedural and cognitive justice resonate with Traditional Owners' advocacy to be recognised as custodians of their country by the wider public, particularly by western institutions, and as a foundation for indigenous groups to enter decision-making forums about their country. Nevertheless, climate justice has not focused attention to specific recognition that indigenous peoples bring their own *sui generis* cultural institutions and knowledge to the climate response context (Dhillon 2018). Indigenous peoples prioritise negotiation to enable them to protect their values and ultimately their relationship to their country in climate adaptation (Whyte 2018). In the modern discourse on climate change and adaptation, assumptions are often made about human agency, current and future risk, and the relevant temporal and spatial scale for understanding and acting that are focused on the nation-states roles (Howitt et al. 2013; Mathur et al. 2014; Veland et al. 2013). For the Traditional Owners in this study, recognition of their way of knowing, their particular relationship to country, of their role not just as (marginalised) stakeholders but Traditional Owners with a long history and ongoing responsibility, independent of the nation-state now established on their traditional territories, are key to the way they want to be approached and engaged for climate adaptation and to strengthening capabilities for long-term resilience.

For indigenous peoples, engagement in climate adaptation planning is about building economic, social, and cultural wellbeing for their ongoing indigenous societies as well as addressing environmental issues (Dhillon 2018; Howitt et al. 2012). Engagement in climate adaptation planning by the groups in this study focused on reducing vulnerabilities and strengthening socio-economic, institutional, and cultural resilience. However, the primary uncertainties were associated with negotiating a positive outcome with government, neighbouring groups, or NRM agencies for climate adaptation, uncertainties related to building long-term resilience of the indigenous societies, and their unique knowledge and governance systems. The nature of engagement triggered uncertainties about whether the indigenous perspective would be given due respect and consideration by regional institutional actors and whether the process would support their particular perspective to be properly heard within an inclusive discourse space.

Conclusion

The primary uncertainties for indigenous peoples in climate change are about volition of actors and institutions, and are linked to their agency to define their risks and to develop counter vulnerability strategies from the ongoing impacts of colonisation and reinforce their resilience from their knowledge and culture. The lack of inclusion of indigenous peoples to determine their own path in responding to the impacts of modern society and associated climate and environmental changes both increases the uncertainties they face and their vulnerabilities. Cultural institutions are critical in shaping how societies, including indigenous groups, define, measure, and engage risk and uncertainty. Recognition of the role of culture in framing climate discourse, and of the importance of diversity of perspectives, is central to a just approach in addressing climate adaptation. The need for more inclusive procedures of engagement that support the particular indigenous ways of knowing, of being in place, and of the capabilities from being on country that allow them to derive resilience from place and their histories, are more urgent but themselves also represent a form of risk where they are not properly executed. Participation that respectfully enables the co-existence of multiple types of knowledge and the uncertainties that are inherent to them provides greater surety that planning will be robust and supports capabilities for a resilient society. The distribution of the risks and benefits of climate adaptation and of the responses developed are critical considerations that need to be undertaken with indigenous groups to ensure a just outcome. Nevertheless, a specific focus on *sui generis* indigenous knowledge and customary governance as a source of resilience can strengthen climate justice approaches.

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