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Research article

Adaptation to climate change: A study on regional climate change adaptation policy and practice framework

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ABSTRACT

Although planning and policy instruments are important for climate change adaptation, the implementation of these measures is critical for success. This paper studies different climate change adaptation strategies by analysing the measures adopted by stakeholders in charge of government policy development and implementation to minimise the impacts of climate change in the northern tropical region of Queensland, Australia. Local government organisations are responsible for taking a leading role in climate change adaptation. State and commonwealth government agencies are primarily responsible for developing climate transition policies and guidelines, as well as providing limited financial aid to help support the local government. Interviews were conducted with local government practitioners identified from different local government authorities in the study region. Although all the government bodies made some progress in developing better climate change adaptation policies, the interview participants identified that a lot more needs to be done, especially in implementation, including devising and the application of relevant action plans, economic assessments, stakeholder participations and engagement. From a local government practitioners' viewpoint, both the water sector and local economy will face the highest immediate impacts if climate change adaptation actions are not adequately implemented at local government level in the study region. There are currently no notable legal bindings to address climate change risks in the region. In addition, financial liability assessments due to climate risks and cost-share mechanisms among different levels of stakeholders and government authorities to face and prepare for climate change impacts hardly exist. Although the interview respondents recognise their high importance. As there are uncertainties in the achievements of climate change adaptation plans, from a local government practitioners' standpoint, the local authorities should take appropriate actions to integrate adaptation and mitigation works to face and prepare for climate risks rather than focusing only on adaptation. The respondents informed that some work has been done to identify flood prone areas and a few policy documents exist that accommodate sea level rise in planning practice, but these are done in fragments with no holistic implementation, monitoring or evaluation plans put in place.

1. Introduction

The IPCC (2022) reported a worrying picture for the world as climate change has already started to impact most of the planet with just 1.1 degrees C of warming. Climate change responses are categorised into two broad types of action groups, being mitigation and adaptation. Climate change mitigation includes measures to reduce the human contribution to climate change by reducing greenhouse gas (GHG) emission (Hurlimann et al., 2021; IPCC, 2014b). Climate change adaptation involves actions to adjust to the new climatic conditions by taking appropriate measures and taking advantage of climate change benefits, if any (IPCC, 2022; IPCC, 2014a). The recent IPCC (2022) research warns the global community to prepare for more severe impacts if it fails to halve greenhouse gas emission this decade and promptly escalate adaptation measures. Several studies highlight an urgent need to adapt to climate change to complement mitigation actions (Abbass et al., 2022; Dellmuth, & Gustafsson et al., 2021). However, in developed and developing countries alike climate preparedness is not considered a major policy matter in most parts of the world (Szpak, 2021; Hurlimann et al., 2021). Unlike climate change mitigation, research on climate change adaptation is still evolving, with new areas of challenges appearing (Ginbo et al., 2021; SinghIyer et al., 2022; YangLiu et al.,

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2020). Research on how different levels of government adapt to climate change, including adaptation implementation challenges and its measures of success, is limited (Alshehri et al., 2021; Lesnikowski et al., 2021).

Australia is one of the most vulnerable countries in the world due to the projected impacts of climate change (Aryal et al., 2020; Pearce et al., 2018; Steffen et al., 2018). Many parts of the country have already felt potential impacts of climate change in the form of the Millennium drought in 1997–2009. During the Millennium drought, water levels reached critical points in almost all the major reservoirs, affecting several cities (Biswas et al., 2022a) with the subsequent course of mandatory water restrictions being implemented for a prolonged period (Furlong et al., 2016; Low et al., 2015). Australia has experienced an increase of around 1 °C temperature and a reduction in rainfall by around 16% since the 1970s (Silberstein et al., 2012). An alarming climate change projection by CSIRO and Bureau of Meteorology (2015) outlined that compare to the climate in 1980–1990, the temperature is likely to increase by about 2.8 °C to 5.1 °C by 2090 under the high greenhouse gas emission scenario in Australia. In a low greenhouse gas emission scenario, the temperature is projected to increase by around 1.7 °C by 2090 (CSIRO and Bureau of Meteorology, 2015). Climate change adaptation has recently gained importance in the research community (Azhoni et al., 2018; Dellmuth and Gustafsson, 2021; Hurlimann et al., 2021) as it is considered an important, viable tool to complement the mitigation of climate change (Charlton and Arnell, 2011; Preston et al., 2010, 2013). Climate change adaptation relates to many interconnected fields and sectors including: interpretation of climate science and its uncertainties; transboundary climate risks and adaptations; development of policy formulation and implementation; natural resource management and utilization; infrastructure development; and stakeholders' participation and engagement (Alshehri et al., 2021; McClure and Baker, 2018). Policy solely focusing on the implementation of climate change adaptation is rare and, in most cases, it is embedded with high level policy documents and strategic plans (Gurran and Hamin, 2013; Heikkinen et al., 2020). Although research on the implementation part is lacking, there are many studies conducted targeting high-level climate change transition policies, overall adaptation frameworks and different enablers and barriers associated with them (Esteve et al., 2018; Lesnikowski et al., 2021; McClure and Baker, 2018). The existing research on climate change adaptation includes studies on vulnerable areas and communities (Sinay et al., 2020; Hammouri et al., 2015), river basins (Esteve et al., 2018; Sud et al., 2015), distinct territorial areas including California in the U.S and different parts of Europe (Hanak and Lund., 2011; Szpak, 2021), large metropolitan cities, and urban community groups (Gurran and Hamin, 2013; Wijaya et al., 2020). In Australia, while regional authorities play a prominent role in managing and planning for local developments and government infrastructures for regional communities, the existing research efforts primarily target coastal metropolitan cities, high-level climate transition policies and the existing barriers and enablers associated with them. Government organisations in large metropolitan urban areas are expected to have a large customer base, a large amount of budget to spend and positive political interests. Whereas regional government organisations face critical challenges associated with regional context, remote locations, budget constraints, traditional regional community base and lack of political attention. This study examines the current state of climate change adaptation, existing climate transition policies, and the roles and responsibilities of different government bodies in the northern tropical region of Queensland. The case study region is considered one of the most vulnerable territories of Australia due to the alarming projection of climate condition including more frequent devastating natural events, notable changes to its unique biodiversity, coastal flat surface topography (CSIRO and Bureau of Meteorology, 2015; QG, 2022a; QG, 2022b), proximity to the iconic Great Barrier Reef (GBF), regional context and challenges associated with remote locations far away from major urban centers and political hubs.

In Australia, there are three levels of government; federal government; state government; and local government. The study first discusses the roles and responsibilities of state, federal and local government organisations, by reviewing current policy directions from the different governments levels and other relevant literature (Section 3). The study explores climate change adaptation works undertaken, response and responsibilities of local government authorities within the study region and their effects on climate change adaptation. A qualitative study was conducted by surveying and interviewing local government professionals such as policy makers, planning officers, managers, and technical experts. This paper makes an important contribution on what climate change adaptation implementation actions have been undertaken in tropical Queensland and what are the key barriers, challenges, opportunities, and constraints. The study investigates how regional government organisations are working on climate change adaptation in the tropical region of Queensland, what parameters are important for climate change adaptation and why there is a lack of adequate planning and implementation on climate preparedness despite the consensus that climate change is seriously threatening local government infrastructures and community lifestyle. The study examines the perceptions and viewpoints of regional local government professionals to understand how their perceptions affects adaptation strategies and its implementations.

This research article is separated into six sections. The introductory chapter is provided as section 1. Section 2 outlines the study context and overall research methodology. Section 3 discusses the roles and responsibilities of state, federal and local government organisations. Section 4 presents the key results obtained from the interview studies, implementation actions taken by regional local government organisations, success parameters of climate change adaptation measures, key barriers, opportunities and challenges. Section 5 discusses the key findings. Finally, section 6 concludes this research.

2. Study context and methodology

2.1. Study context

The northern tropical region of Queensland in Australia has been selected as a case study in this research as the region is considered one of the most vulnerable to climate change impacts. The southern dry tropic region of the study area faced a major water crisis in recent years due to a drought in 2014–2018 (TWST, 2018). The same region faced an unprecedented flood in 2019. The region is vulnerable to climate change due to an alarming projection of climatic parameters including notable variations in rainfall, changes in evaporation and severe more frequent natural events such as cyclones, droughts, and floods (CSIRO and Bureau of Meteorology, 2015; QG, 2022a). Additionally, the topography of a few major coastal urban centers in the region is primarily flat, just a few meters above the sea level, increasing their vulnerability to coastal hazards such as sea level rise, coastal erosions, and inundation. The extent of the study region and the boundaries of local government organisations (LGO) are outlined in Fig. 1 below.

The case-study area extends from the far north Queensland in the north to the Mackay region in the south. There are three important cities in the region: Townsville, Cairns, and Mackay. These urban centers have more than 90% of the total 0.65 million population in the study region (ABS, 2016).

2.2. Methodology

The overall methodology of this study is outlined in Fig. 2, and consists of three parts; a) studying existing literature and current policy documents to research on the roles and responsibilities of state, federal and local government organisations in the study region, b) literature review and a focus group meeting to finalise interview questionnaire list and, c) conduct an interview based qualitative research by identifying

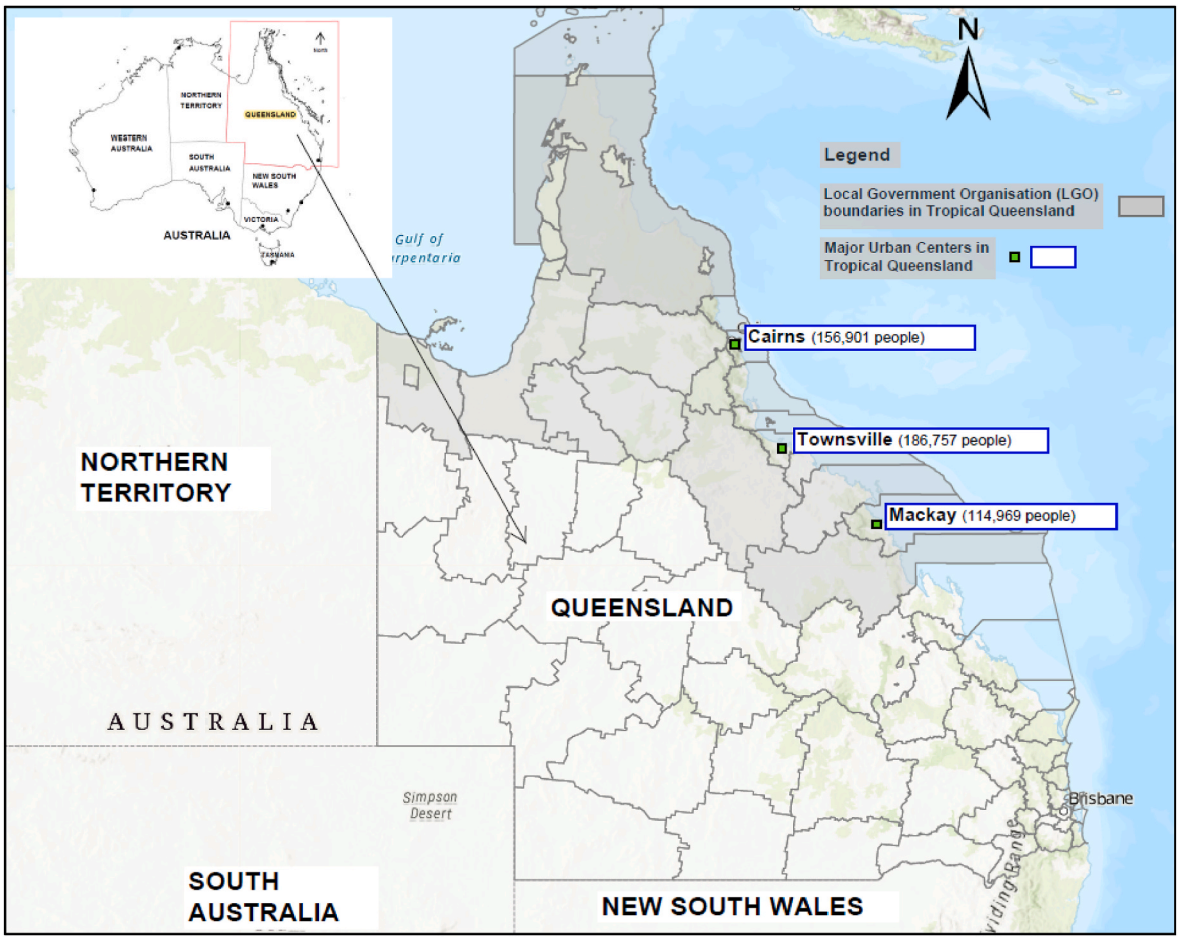

Fig. 1. The aerial extent of the local government organisations (LGO) boundaries in the northern tropical region of Queensland.

appropriate local government practitioners from the study region.

2.2.1. Studying existing literature and policy documents

As part of this research, existing climate change adaptation policy documents accessed from different local, state, and federal government agency's websites were studied. The key words used for this Boolean search were: "climate change", "adaptation", "climate change risk", "climate response", "policy", "strategy", "coastal hazard", "Queensland", "Australia". Additionally, major research databases such as PROQUEST, SCOPUS, and Web of Science were searched using the same key words. The literature review process including the selection of papers, inclusion/exclusion criteria and number of papers reviewed are outlined in Fig. 2. As shown in Fig. 2, abstracts and/or executive summary of 150 policy documents and relevant research articles were reviewed. The research report and policy statements that were directly related to the study context of this paper were studied in full text (total number 81). The literature review helped in distinguishing roles and responsibilities of state, federal and local government organisations in the study region. The findings of the literature review are reported in chapter 3. The study concluded that local government organisations are taking a leading role in climate change adaptation. Consequently, a wide range of local government professionals were identified from the tropical region of Queensland. Forty-six local government professionals were invited to take part in this study. The results from interviews with twenty-seven local government policy experts are reported in this paper. (Appendix A).

2.2.2. Interview questionnaire: literature review and focus group meeting

A comprehensive range of interview questions (structured and semi-structured) were identified using information gathered from the literature review (Fig. 2). Further to this, a focus group meeting was held with local government climate change experts to finalise the interview questionnaire list. This helped to target suitable questions relevant to the case study region. The interview questionnaire was developed focusing on current climate change risk perception in the study region, climate change adaptation implementation actions, success of climate change adaptation, perspective on policy, rules and regulations related to climate change adaptation, short term and long-term strategies, resource constraints and success factors.

In the case of the structured questions, the questionnaire response options were primarily multiple choice in nature to help the researcher to get an overall picture on the viewpoints of the participants. Further to this, semi structured interview questions were asked to gain a detailed insight into the perceptions of the participants and also the reasons behind the perceptions as the method allowed the researcher to ask "how" or "why" type of questions. Appropriate care has been taken to remove identity information of the participants. Although it is not feasible to mention all the interview questions asked during the interview as in many cases these were asked based on the replies of the respondents, an indicative interview questions list relevant to this research paper is provided in appendix B.

2.2.3. Interview study

The interview questionnaire targeted the awareness and understanding of 27 local government professionals employed by different city councils and regional government organisations. The Townsville City Council, Cairns Regional Council, Mackay Regional Council and Charters Towers Regional Council are the largest local government

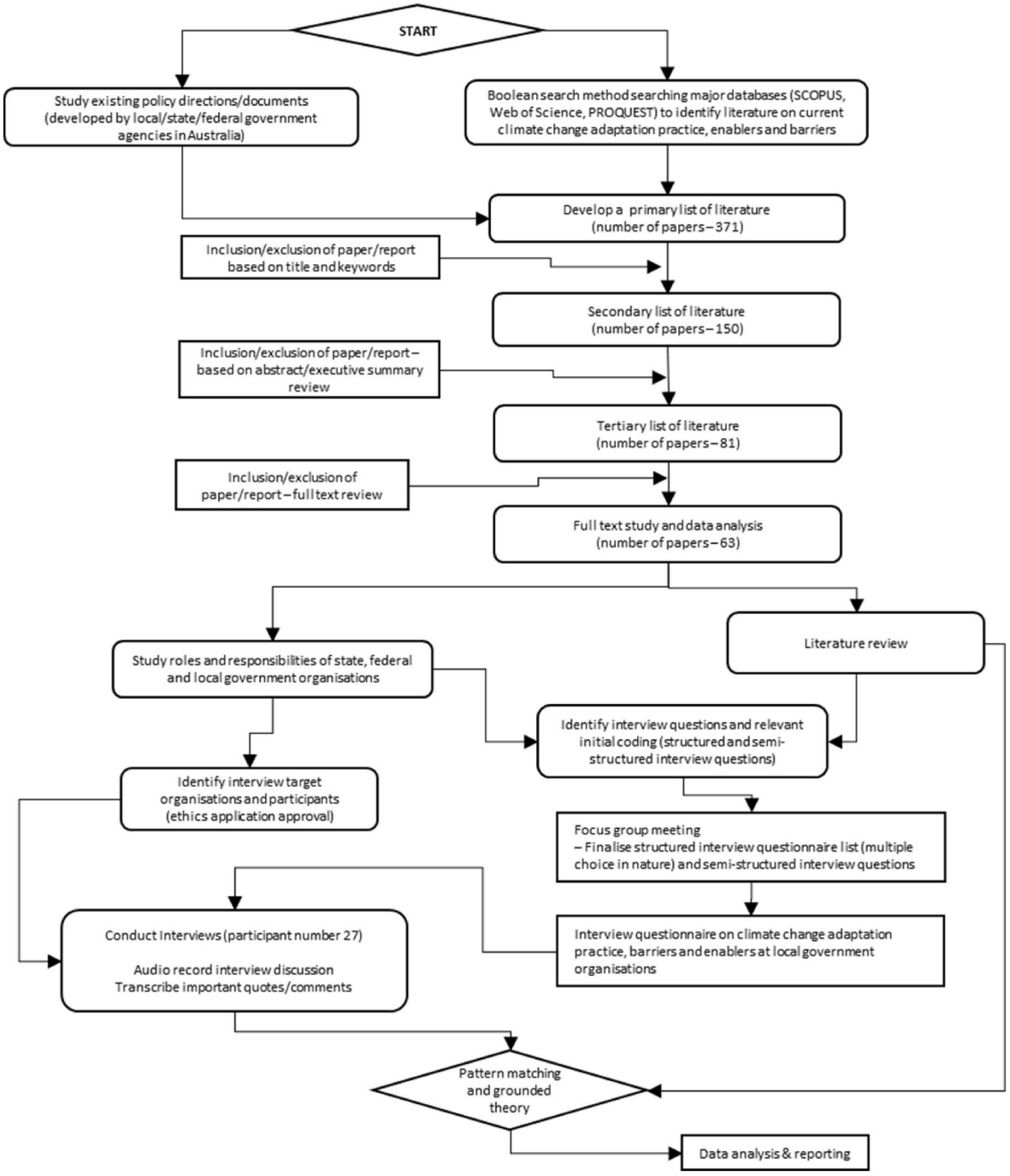

Fig. 2. The overall research methodology.

organisations in the study region serving more than 90% of the population. Considering this, a significant number of interviewed participants were selected from these organisations. Organisational structures were initially studied and then the participants were selected after appropriate consultation with the climate change experts within these organisations. Appendix A summarises the participants of the interview study. Approximately 10–20 min were allocated for structured interview questions whereas around 40–50 min were allocated for semi-structured interview questions. The response of structured interview questions which were primarily multiple-choice questions was collected at the beginning of the interviews. Interview discussion was audio recorded. Thematic summaries of the interview data have been produced and relevant quotes and responses are transcribed. The results of this study across different key questions are compared and analysed using pattern matching and grounded theory (Yin, 2009). Grounded theory is a research method where theories are generated which is grounded in data. Data collection and analysis are done simultaneously in grounded theory to achieve data saturation (Boeije, 2002). As part of this investigation, five interviews were initially undertaken. Data saturation was reported after ten interviews. The researchers did not find any notable changes in response pattern even after twenty interviews. Considering these points, 27 interviews were concluded to be sufficient for this research. As outlined by Strauss and Corbin (1990), there are three stages in grounded theory including open coding, axial coding, and selective coding. In this research at first, open coding method is used. It involves line by line coding where key phrases and concepts are

identified and highlighted. The data from each interview participants are continuously compared and analysed for similarities and differences. Similar codes are grouped together to form different subcategories. Within these subcategories, categories are developed. Axial coding method is used where a range of relationships and connections are identified among the categories. Finally, core-category is identified which methodically connects to other categories. Categories are integrated and grouped together to form theory. The method allowed the researcher to identify and analyse similarities and differences in the perceptions of the interview participants and identify and discuss patterns, classes and sequences grounded in the collected interview data. The data was completely de-identified after the completion of data processing.

3. Literature review: climate change adaptation policies, roles, and responsibilities

Australia has a multi-level government structure; starting from federal or commonwealth government at the top, next the six state and territory government authorities including the state of Queensland and, finally the local government organisations at the bottom. This chapter will discuss existing policies, roles, and responsibilities of different government bodies to address climate change risks.

The government response to climate change risks has strong links and interactions with many areas including primary industries and food sectors, biodiversity, environment, public infrastructure, social and economic activities. Primary industries, including agricultural and food industries, are one of the most vulnerable sectors to the effects of climate change (DEHP, 2017; QG, 2022b). Both the federal government of Australia and the state government of Queensland have taken steps to increase the sector's understanding regarding the effects of climate change and to bridge the gaps between adaptation policy and the feasibility of implementation actions on ground (DA, 2021). Supplying adequate water and managing water supply security for primary industries including the agricultural sector is predominantly the responsibility of various bulk water authorities operating under the state government agency with appropriate support from local government organisations. (DEWS, 2014) Local urban water supply is primarily the responsibility of the local councils, local water distribution authorities, and regional government bodies.

The tropical region of Queensland is known to have unique biodiversity supporting a diverse range of ecosystems. Biodiversity hotspots in the region include the iconic Great Barrier Reef and the northern wet tropic region. The state and local government organisations in Queensland have taken a few notable initiatives to help the local ecosystems adapt to climatic change including the expansion of the protected areas; appropriate vegetation management; protection measures for the Great Barrier Reef; and a comprehensive biodiversity strategy including climate change corridors to protect the state's unique biodiversity especially in tropical Queensland (DEHP, 2017).

The local government response has strong links and interactions and potential synergies with many other sectors including primary industries and food sectors, biodiversity, ecology and local environment, human health, social and economic activities. Local government organisations deal with infrastructure and development activities in their jurisdiction, coastal hazard management and planning, local water supply security in the face of climate change, urban and commercial activities, the management and preparation for major climatic events such as cyclones, droughts, and floods, and management of community perception and acceptance on climate change.

A Coast and Climate Change Council was established, in 2009, by the Australian federal government to help in developing a reformed national regulatory framework on climate change mitigation and adaptation. Due to changing political scenarios and conflicting targets and requirements, the council's term concluded in December 2011. The productivity commission of Australia submitted a report to the commonwealth government that recommended the national government have a limited, supporting role and responsibility in climate change adaptation (Productivity Commission, 2012). More recently, the National Climate Resilience and Adaptation Strategy (2021–2025) released by the commonwealth government of Australia outlines a high-level approach towards a climate resilient Australia (DA, 2021). The strategy targets four key domains for climate change adaptation, including: natural environment; man-made infrastructure; and social and economic aspects to drive adaptation practices. The purpose of the strategic document is to set out what the Australian government will do to support other levels of government, industry, community, and businesses to anticipate, manage and adapt to the impacts of climate change.

The commonwealth government is found to pay more attention to strategic planning and development matters in the areas which are of significant national environmental importance such as the Great Barrier Reef, national heritage sites and threatened species etc. (DA, 2021). Their role is mainly limited to developing different climate risk policy documents at a national level and granting limited funding for state and local government organisations and influencing them to develop and follow different policy guidelines on climate risk mitigation and adaptation (Coag's, 2012). The government also responds to climate change by providing funding to investigate the science behind climate change and understanding potential adaptation pathways for Australia in general. A major commitment towards climate change adaptation implementation on ground is lacking from the federal government.

The state and territory governments have a responsibility in dictating and developing appropriate legislation and policy instruments to prepare local government authorities to deal with climate change risks. Whereas local governments are responsible for managing, maintaining, and planning for local development, local community participations and engagement, local government infrastructure, and also, the resiliency of this infrastructure for current and future timelines in the face of climate change (Coag's, 2012; Scott and Moloney, 2022). In the state of Queensland, uncertain policy positions and direction caused some confusion in the last decade. The state government played an important role between 2008 and 2012 vigorously supporting climate change risk mitigation and adaptation using different policy documents. The Queensland Coastal Protection policy (2012) suggested several measures for local government organisations relating to climate change adaptation. This includes allowing a certain sea level rise factor in infrastructure planning and modelling, preparing coastal adaptation strategies that includes climate change impact adaptation, technical guidance, and pathways for climate change adaptation and relevant directives for local government organisations. In 2012, due to the changing focus of state government authorities, many climate change adaptation policy instruments were updated in coastal protection policy. Initially in 2008–2012, the state government took more interest in climate change adaptation, provided guidance for local government organisations, and outlined a few statutory requirements. Later, in 2013–2014 the state policy was amended to allocate most of the climate change adaptation responsibilities onto local government organisations (Williams, 2013). The recent Queensland Planning Act 2016 , the Queensland Coastal plan (2012) and the current State Planning Policies () encourage local government authorities to develop and implement their own separate climate change adaptation policies based on local conditions, community expectations and local climatic features. (Coag's, 2012;CoastAdapt, 2021;DEHP, 2017) Under the Qcoast2100 programme, the state and the Local Government Association of Queensland (LGAQ) formed a partnership programme to better collaborate with each other to progress and prepare for climate change within the coastal parts of Queensland. As part of the program, $12 M was allocated over three years to support local government organisations to develop a coastal hazard adaptation strategy (CoastAdapt,2021; DEHP, 2017). The implementation of these strategies is primarily the responsibility of local government organisations. Climate change adaptation guiding principles and policy directions, the roles, and responsibilities of different

levels of government agencies and organisations in the case study region are summarised in Fig. 3.

International organisations such as Intergovernmental Panel on Climate Change (IPCC) provides global climate change projections, existing climate change adaptation practice, what has been done and what needs to be done globally to face and prepare for climate change. Global adaptation plans are challenging to define and implement due to opposition from powerful states, institutional fragmentation, and budgetary constraints (Dellmuth and Gustafsson, 2021; Persson, 2019). In Queensland, Australia local government organisations are responsible for taking the leading role in the implementation of climate change adaptation practice on the ground. The state government (QLD) agencies are primarily responsible for developing climate transition policies and guidelines and provide financial aid to help support local government organisations. The commonwealth government takes a supporting role and is primarily focused on understanding the science behind climate change, as well as the assets of national significance such as the Great Barrier Reef. As local governments play a critical role in climate change adaptation, research on climate change adaptation practices by local government authorities, views of local government professionals and understanding their scepticism towards climate change are crucial for success. In addition, climate change adaptation challenges faced by regional local government organisations are expected to be different from the large urban centers due to lack of political interest, remote locations, inadequate resources, financial implications, local climatic conditions, and other relevant challenges associated with regional contexts. As part of this study interviews were conducted with local government practitioners identified from the tropical region of north Queensland and the key findings are summarised in the next few chapters.

4. Qualitative research: results and analysis

This section presents the key results and findings obtained from the interviews. The interview topics were focused on climate change adaptation practices at local government organisations in the northern tropical region of Queensland, actions taken by these organisations, implementation status, success parameters of climate change adaptation measures, opportunities, and challenges. The overall theoretical outline of this chapter and interaction among different elements of climate change adaptation practice at local authorities is shown in Fig. 4 below.

In line with the overall theoretical framework of this research (Fig. 4), section 4.1 presents climate change risks, climate change response and adaptation work priorities at local government organisations in the case study region. Section 4.2 presents local government actions currently being undertaken and what has been accomplished to date. Section 4.3 and 4.4 outlines key findings about adequacy of existing policy and planning frameworks, available resources, and external supports. Section 4.5 highlights different enablers and success parameters to facilitate climate change adaptation in local government authorities in the Queensland tropics.

4.1. Climate change response and adaptation work priorities in tropical queensland

The respondents were asked about potential climate risks in tropical Queensland and to rank these climate risks using scale parameters starting from 1 (low risk) to 5 (high risk). As shown in Fig. 5, rainfall

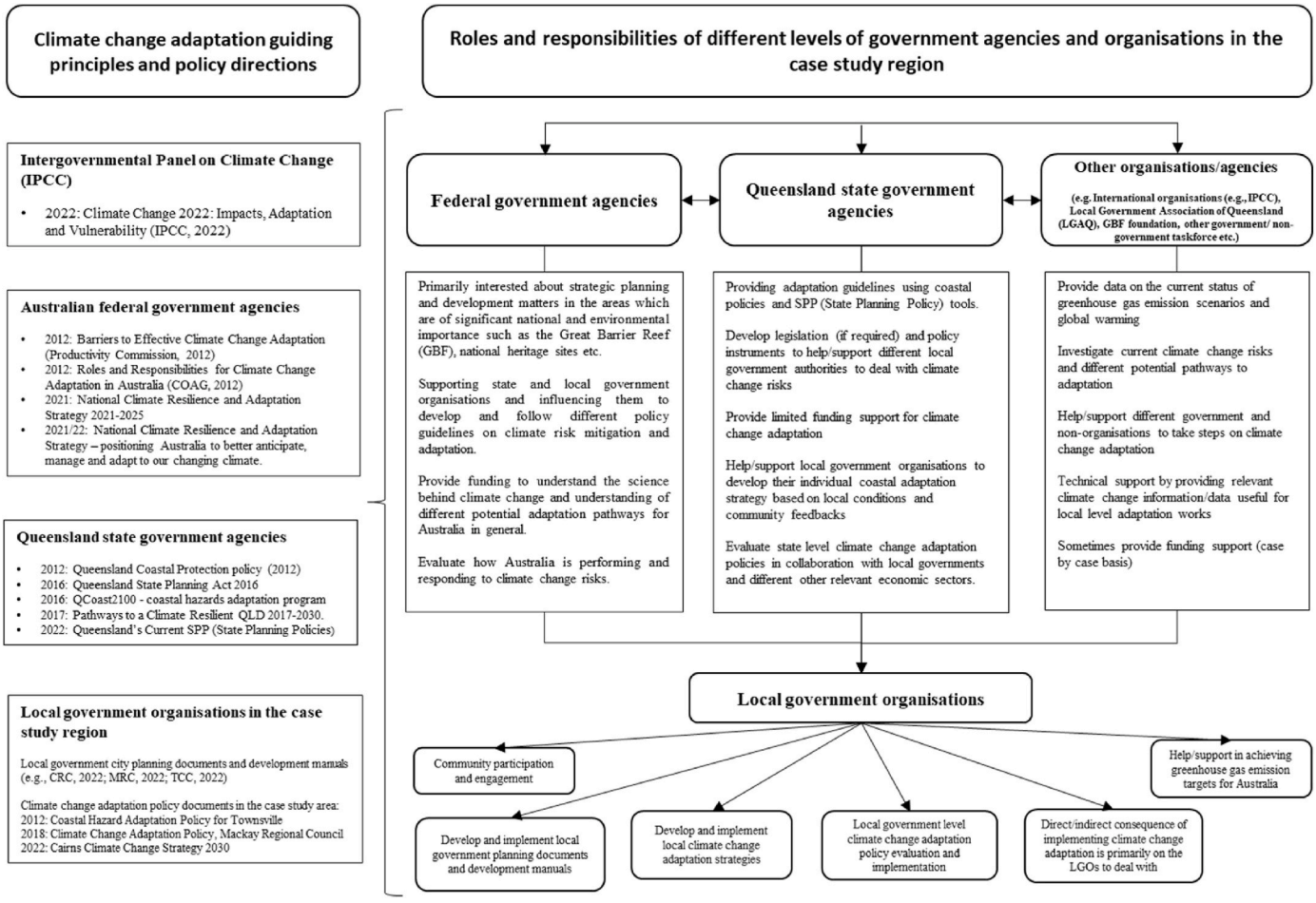

Fig. 3. Climate change adaptation policies and guiding principles, roles and responsibilities of different levels of government agencies in the case study region.

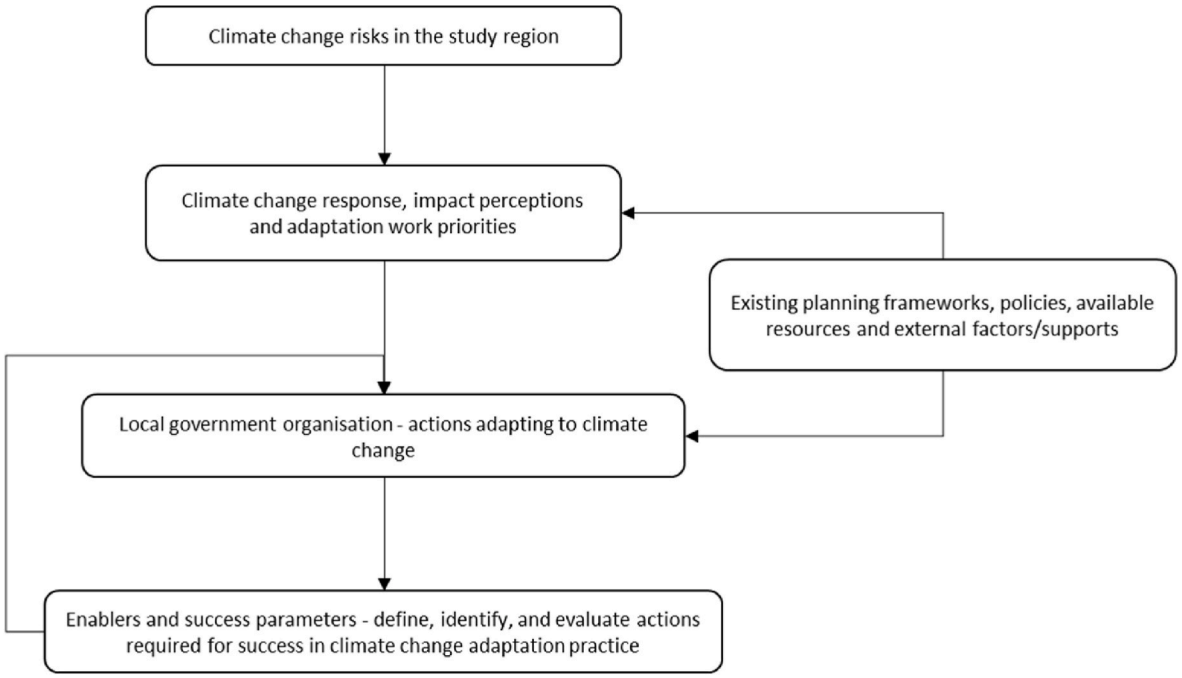

Fig. 4. The overall theoretical outline of the proposed research.

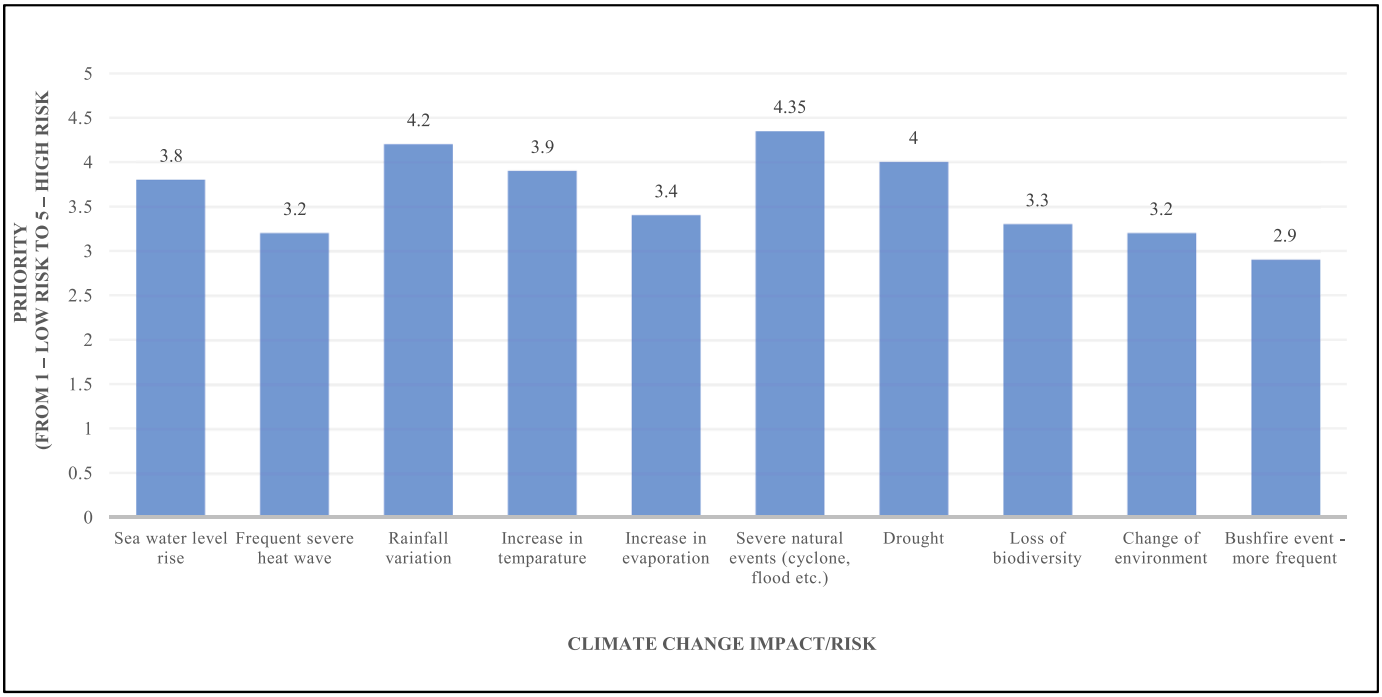

Fig. 5. Climate change risk in the tropical Queensland.

variation, prolonged drought and severe more frequent climatic events were considered as high-risk (score ≥4) impacts whereas changes in evaporation, severe more frequent heat waves and bushfire events, environmental effects and loss of biodiversity were given a lesser risk priority (≤3.5) compared to the others. In addition, sea level rise and increase in temperature also received a notable risk impact score.

The study region is projected to face more hot days and fewer cold days, further sea level rise, increased drought frequency, rainfall variations and severe cyclones (CSIRO and Bureau of Meteorology, 2015; QG, 2022a). Many of these climate change risks are also perceived as critical by the interview respondents. Sea level rise was given higher priority especially in the coastal local government areas and coastal hazard adaptation policy is recognised as an important policy document. Rainfall variations and increased heavy rainfall intensity was found to be a concern for the northern wet tropic areas as it plays a critical role in the local water supply security and flooding. The interview participants from dry tropic region showed a different result giving higher priority on rainfall decrease and increase in evaporation. This region is projected to face changes in rainfall patterns resulting in prolonged drought events, and it has experienced a drought in recent past (2014–2018) (CSIRO and

Bureau of Meteorology, 2015; TWST, 2018). Natural disasters such as cyclones, flooding etc. Were given high importance considering their immediate effects felt by the community in the last few decades. In summary, climate change risk perceptions are found to vary based on local climatic conditions, local climate change projections and climatic threats faced in the past.

The interview participants were asked about the existing climate change response plans developed by different city councils and regional local government bodies. From a local government professionals' perspective, the organisations are primarily targeting climate change adaptation as part of their climate change response and there is no notable/visible action plan to reduce and manage their carbon footprints. Some local practitioners identified this as one of the major limitations of current practice and they perceive mitigation actions should also be part of a long-term climate change adaptation plan. As adaptation and mitigation policies were suggested to be integrated by the interviewees, further questions were raised on how the interview participants like this to be done. It appears that there is poor understanding among the interview participants on how this can potentially be implemented at local government level organisations. According to the interviewees, instead of developing climate change adaptation policy directions and implementation plan separately, the policy document should address climate change risk as a single unit addressing both mitigation and adaptation plan and execution framework. This is expected to make the process more attractive to different levels of stakeholders in local government authorities. From a local government professional's viewpoint, the local authorities should set an emission target, investigate, and adopt renewable energy options where appropriate, buy carbon offsets for the organisation's carbon emissions, set minimum energy efficiency targets for public assets, and finally develop and adopt appropriate land use planning and coastal hazard management policies supporting climate change risk management and mitigation. Additionally, use of energy efficient devices is recognised to be important for local government organisations to reduce operating cost and eventually contributing to climate change mitigation. Although state and federal government organisations encourage local authorities to take part in mitigation, it is currently advisory in nature. It is important to develop mandatory policy instruments and directions for local government organisations. The participants also recognised the importance of further policy level research on how adaptation and mitigations actions can be integrated at local authorities, what they can and cannot do. A large scale of investigation was suggested for this purpose. Although it is one of the findings of this research, it is slightly out of scope of this paper to investigate this matter further in depth. It can be recognised as one of the limitations of this paper. The perceptions of the local government professionals on current climate change adaptation practices are primarily reported in this paper.

Priority levels for adaptation initiatives play a vital role and this needs to be decided based on local constraints including financial challenges, political influence, and other stakeholders' responses. The interview participants were asked to score ("High priority", "Medium priority" and "Low priority") different climate change adaptation process measures in the region and the results are outlined in Fig. 6.

A few notable relevant comments received from the respondents are outlined in Appendix C(Comments 1–5).

To manage and adapt to climate change risks, the local government authorities are currently dealing with several challenges such as uncertainty in the decision-making process, developing suitable emergency measures, managing community response, legal responsibilities, and feasibility of development restrictions in vulnerable areas etc. As identified from the interviews emergency response, robust planning decisions, uncertainty in climate change adaptation measures and development restrictions are considered high priority works (high priority score ≥14). Although the local government authorities are aware of climate change risks, the adaptation works are done in fragments and the effectiveness of many of these works are not evident. The participants are concerned that development is still happening in the vulnerable areas and in many cases, there is a wide range of political pressure and community expectation that influence this to continue. Among the other adaptation priorities, community engagement and behavioral change, changes in population growth, managing economic impact associated with climate change received a lower priority score than the others. Some respondents (<10) are sceptical about climate change risks as climate change uncertainty is a challenging subject matter to define and it depends on many things outside of human control. Legal liability of the local government organisations received lowest priority score as

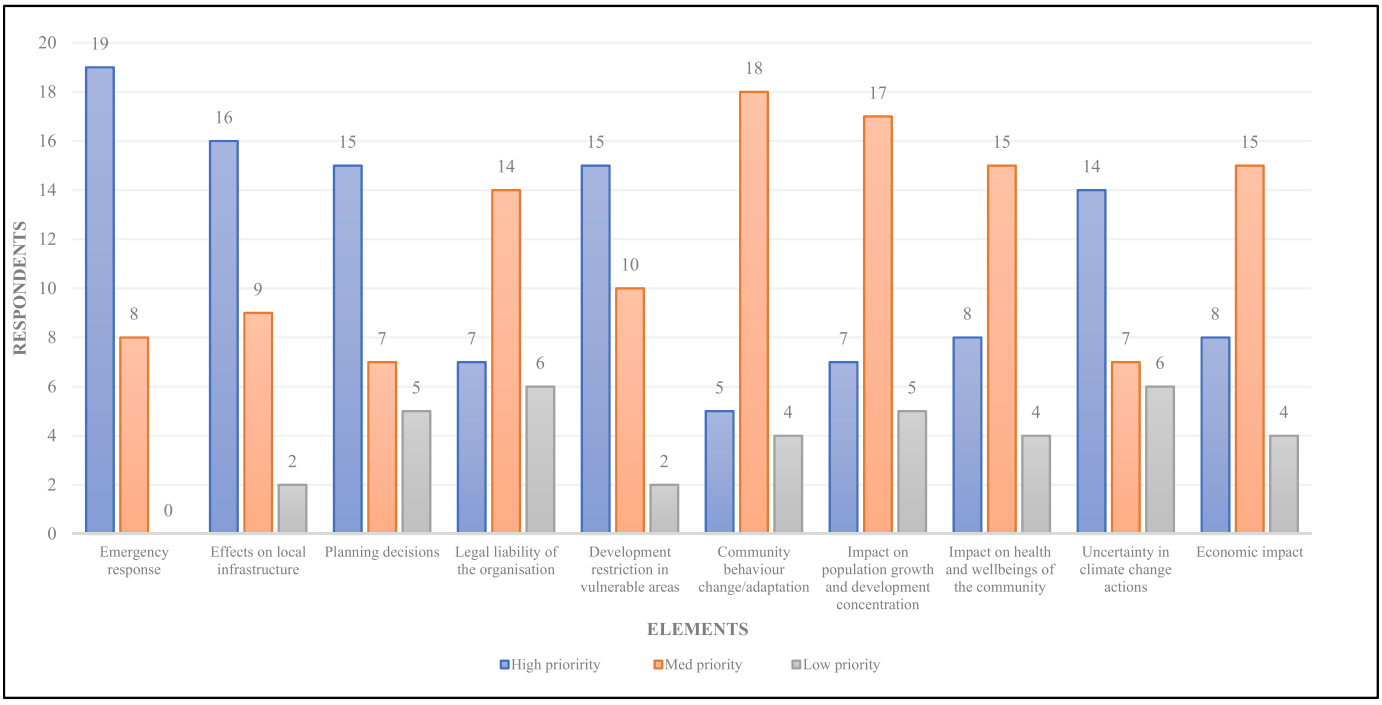

Fig. 6. Climate change impact perception and adaptation priorities in the Queensland tropics.

there is currently no notable legal bindings to address climate change risk in the region. There is a consensus that community consultation on climate-preparedness is important but the long-term impacts of climate change on community lifestyle and wellbeing has not been communicated well resulting in a lack of a long-term response to climate change.

4.2. Local government actions adapting to climate change

In the previous section 4.1, questions were asked about climate change risks, climate change response and adaptation work priorities. To understand climate change preparedness in local councils, questions were asked to understand what has been accomplished to date. The results are summarised in Fig. 7.

A few notable relevant comments received from the interview respondents are outlined in Appendix C(Comments 6–11).

As shown in Fig. 7, although climate change impacts have been assessed in the local government organisations, some council professionals (<10) perceive that climate change impact assessment should be the responsibility of state government agencies as local councils do not have enough resources for this. Climate risk vulnerable areas are identified in most councils and appropriate development restrictions are applied considering local climatic risks such as sea level increase and flood risks. The respondents are concerned that although climate change is considered as an element in planning and in decision making processes, in many cases due to community expectations and pro-development governments, policies and relevant decisions are getting overruled.

Although community engagement plans are implemented to prepare for emergency response, long term climate adaptation measures are not communicated with the community as such. Infrastructure maintenance and asset management strategy does not include any climate risk adaptation parameters, as from a local government professionals' viewpoint there is no specific guideline or policy for this purpose. Although there are high level climate change adaptation plans, they lack critical information about what actions are required and, how these can be evaluated and monitored. In addition, interview respondents recognise the importance of financial liability assessments. However, due to the range of stakeholders and levels of government which would need to be involved to create these assessments, they do not exist.

4.3. External support for climate change adaptation

It is important to understand what external support local authorities receive from external organisations as part of their climate change adaptation planning and implementation. The interview participants were asked about what external support their organisations received in the last decade. The results are summarised in Fig. 8.

A few notable comments received from the respondents are outlined in Appendix C(Comments 12–15).

The practitioners were asked about the adequacy of the external support they have received. There is a consensus that the external support is significantly lower than what is required. Additionally, smaller councils are lagging to get external support due to inadequate manpower to develop and submit relevant application documents. As shown in Fig. 8, out of 27 respondents, 15 mentioned that local councils have received some funding either from state government or from commonwealth government agencies in the last decade for climate change adaptation. Some respondents (≤8) mentioned about funding from other external agencies (local government association, independent environmental agencies, etc.) received by their organisations. From a local government practitioners' viewpoint, regional local government authorities are not getting good external support compared to large cities. In many cases, state government agencies helped local councils by providing climate change impact assessment results developed using different climate change modelling tools. This helped smaller local councils to understand the risks of climate change on their infrastructure needs. In addition to financial and technical support, support from political members and local community is also critical. Support from the local community and politicians is perceived to be lacking resulting in a lack of urgency in developing and implementing climate change

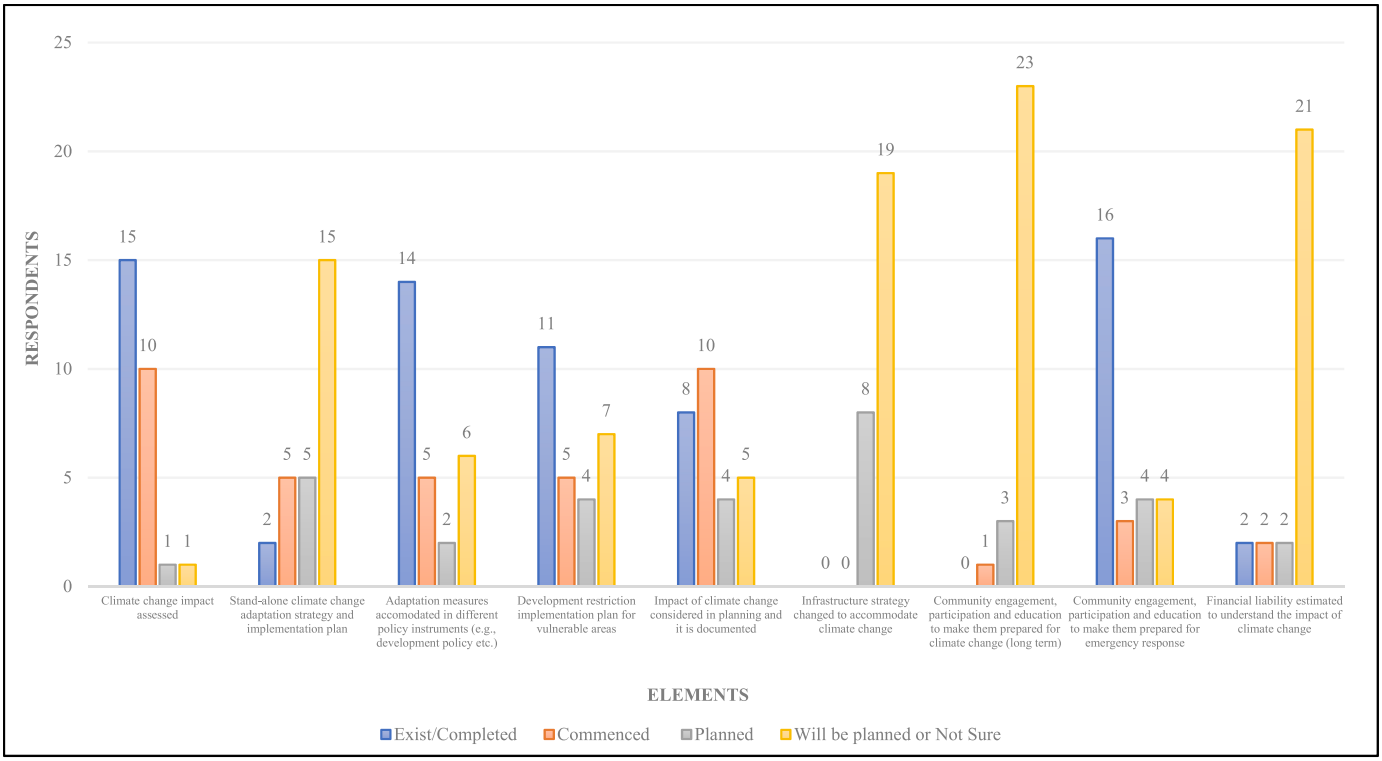

Fig. 7. Local government actions to climate change.

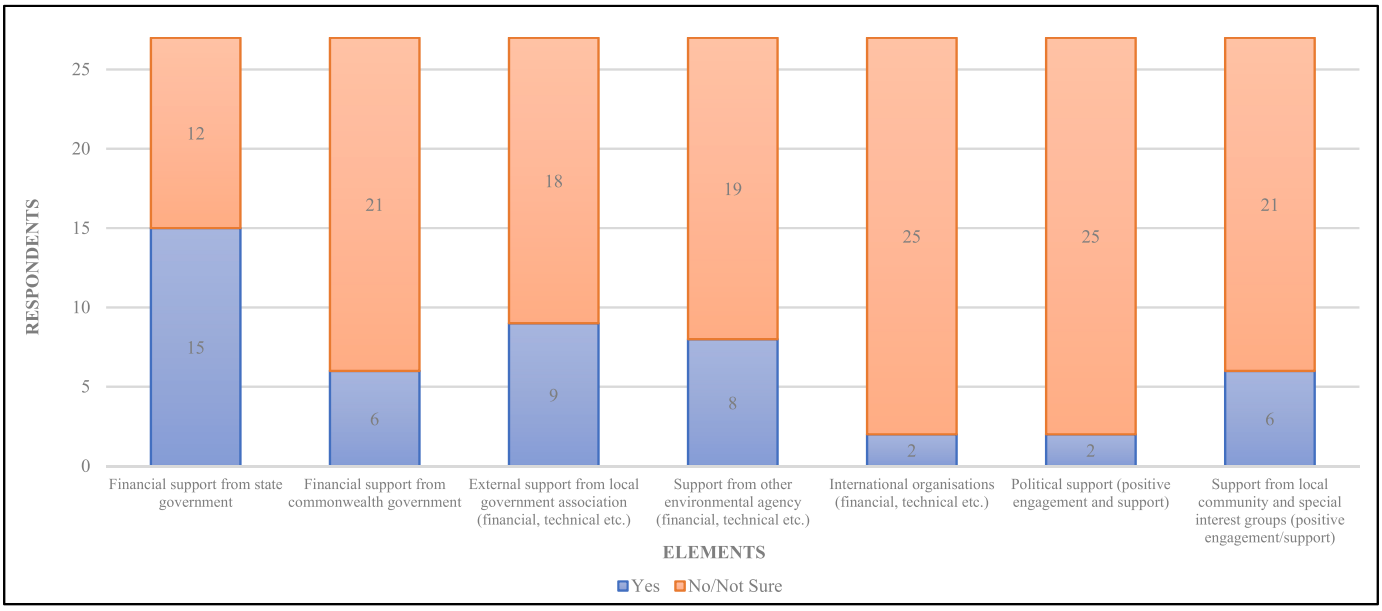

Fig. 8. External support for climate change adaptation.

adaptation practices in the region.

4.4. Planning frameworks and standards for climate change adaptation

A series of questions were asked on the suitability of different policy instruments and formulated design standards for adapting to climate change. The results are summarised in Fig. 9.

A few notable relevant comments received from the interview participants are outlined in Appendix C(Comments 16–19).

Although climate change adaptation exists in local government authorities at a varying level of detail, in many cases it is embedded in city plan documents and development manuals. In local planning frameworks, several measures are taken as part of climate change adaptation such as restricting development in vulnerable areas, assessing and comparing flood risks and allocating building levels based on the projected inundation. Lack of autonomy in decision making processes by local councils and lack of transparency in state government policy decisions are also evident. Infrastructure design standards and codes poorly address climate change concerns, and these lack detailed guidelines on how to adapt to the impacts of climate change risks. Among the policy documents and standards, coastal management policies and relevant development guidelines are found to address climate change concerns better than other documents and standards. From a local government practitioner's viewpoint, state and commonwealth government policies are inconsistent and lacks clear directions, although this has improved considerably in recent times.

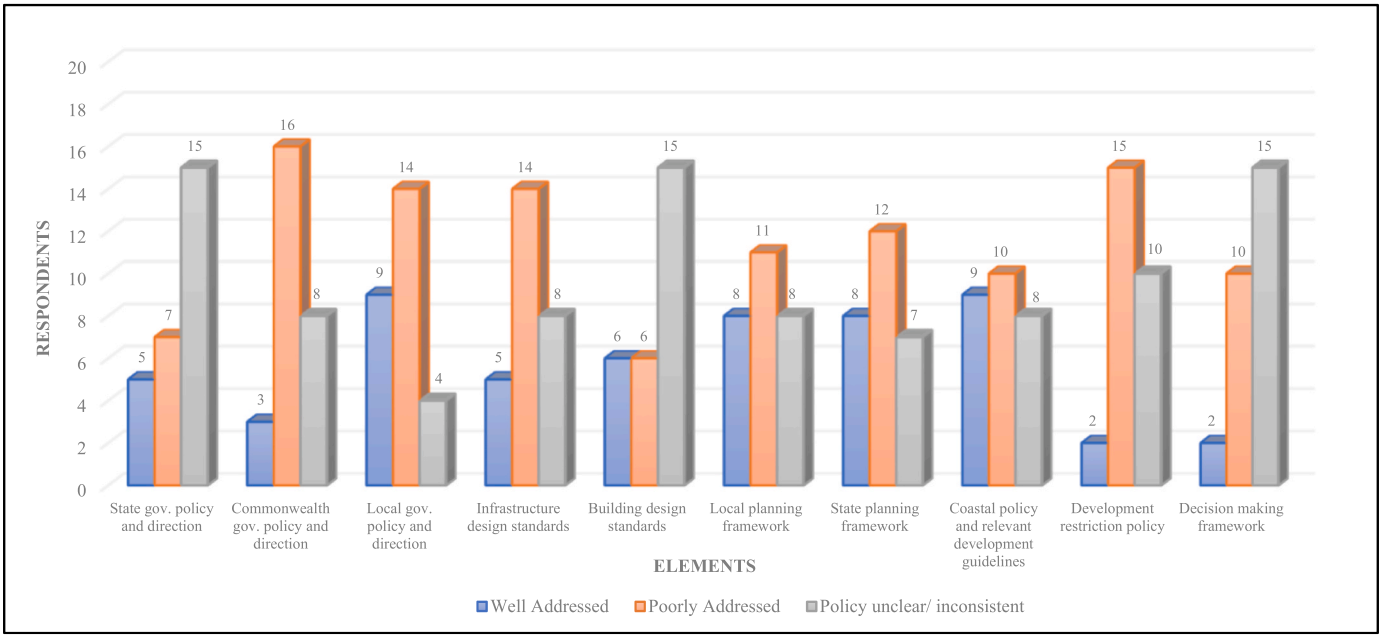

Fig. 9. Adequacy of current policy documents, planning framework and design standards for climate change adaptation.

4.5. Enabling climate change adaptation in local government organisations

Local council professionals were asked to highlight the areas they perceive as being most beneficial to facilitate climate change adaptation in local government authorities in the Queensland tropics. As shown in Fig. 10, respondents believe that stronger commonwealth and state government policy and direction is very important, which is currently lagging in focus and consistency.

A few notable comments received from the respondents are outlined in Appendix C(Comment 20–24).

Local governments are given responsibilities to develop and implement climate change adaptation strategies, but the available resources, especially available funding, is not adequate to develop and implement a robust climate change adaptation strategy. The funding available is significantly lower than what is required and there is no guideline on how the financial liability can be assessed and shared. Some interview participants perceived that state and federal governments are primarily driven by large metropolitan cities with lesser importance are given to regional cities and regional local government authorities. In addition, political support on climate change adaptation varies from one council to another and lack of political interest is identified as one of the most critical barriers in the region. From local government professionals' viewpoints, the lack of a quantified or measured definition of the term climate change adaptation has led to a significant research gap in the implementation of climate change adaptation practice and transparent decision making. There is wide range of variability in actions due a to lack of established guidelines and tools. In addition to these, appropriate methods of community participation and engagement to increase the resilience of local communities in the face of climate change is perceived to be highly important but it is currently lacking.

The interview respondents were asked questions on the implications of inadequate implementation of climate change adaptation in the case study region such as impact on environment, impact on community lifestyle, effects on water security, impacts on economic activities and food supply etc. The results are summarised in Fig. 11 below.

As outlined in Fig. 11, both the water sector and local economy will face the highest impacts if climate change adaptation actions are not implemented adequately at local government level in the study region. The respondents identified that some works have been done to identify flood prone areas and a few policy documents exist that accommodates sea level rise in planning practice. It is interesting to note that although food supply is highly dependent on water supply, the practitioners perceived this to be impacted less compared to the water supply and economy. Although the local government authorities sometimes deal with food industries and agricultural sectors, their responsibilities are limited as they work in collaboration with other bulk-water authorities and stakeholders when dealing with these industries. The local government authorities are primarily responsible for local residential, industrial, and commercial water supply. This can be one of the reasons why food supply is not taken seriously or overlooked by the respondents. One of the key limitations of this research is it primarily targets the perceptions and viewpoints of local government practitioners. There are other areas including agricultural sectors, local business and commercial entities who will need to play a significant role to make climate change adaptation a success. To achieve a better understanding, it is highly essential that a large-scale investigation and research study be conducted to include these stakeholders.

5. Discussion

Australia is one of the developed countries with the largest per-capita contribution to Greenhouse Gas Emissions (Cunningham et al., 2019). Although the state and federal government agencies in Australia have ambitious targets to reduce greenhouse gas emissions, the local authorities at this stage are focused on climate change adaptation. The state and federal government policy documents encourage local governments to reduce their carbon footprints, but the encouragement is primarily advisory in nature rather than mandatory. From a local government practitioners' viewpoint, the current local government's actions in the case study region largely focused on adaptation rather than mitigation. This finding is consistent with previous research that reports that climate change actions in different parts of the world are primarily focused on either adaptation or mitigation actions (Reckien et al., 2018).

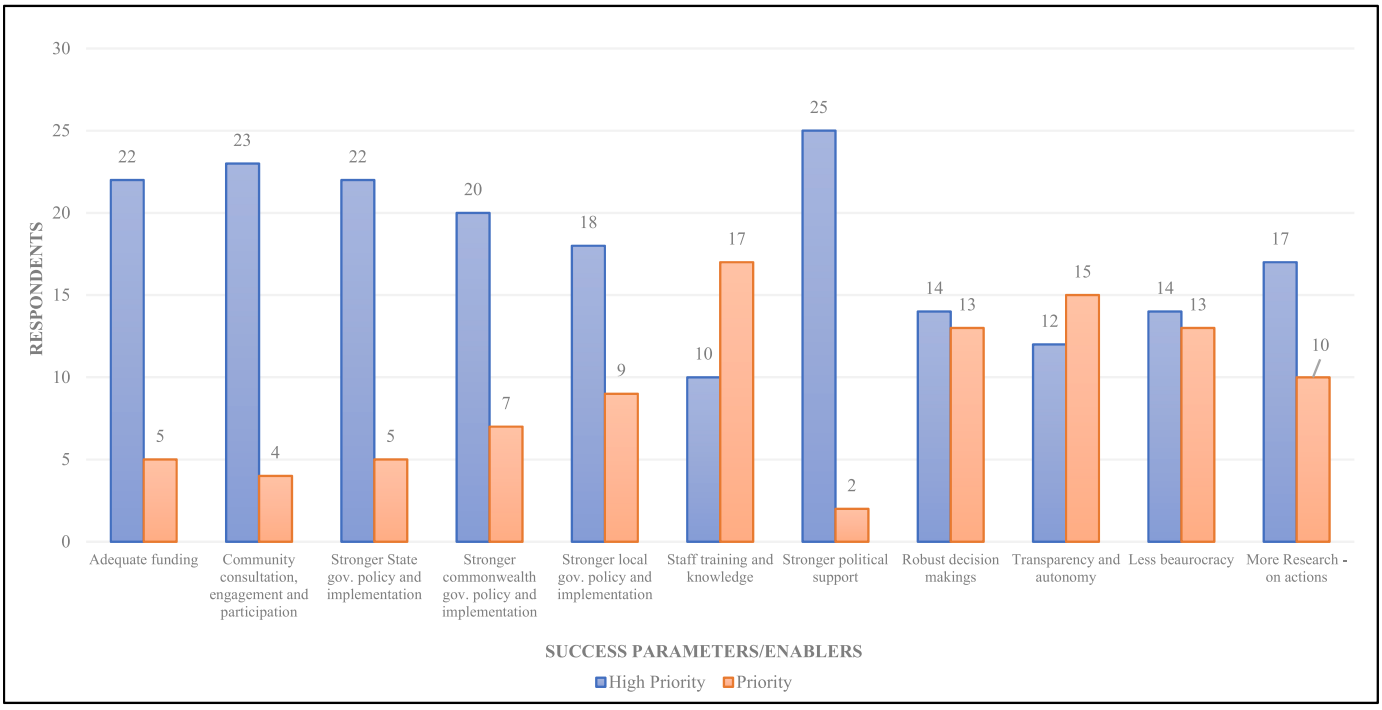

Fig. 10. Enabling climate change adaptation at local government level.

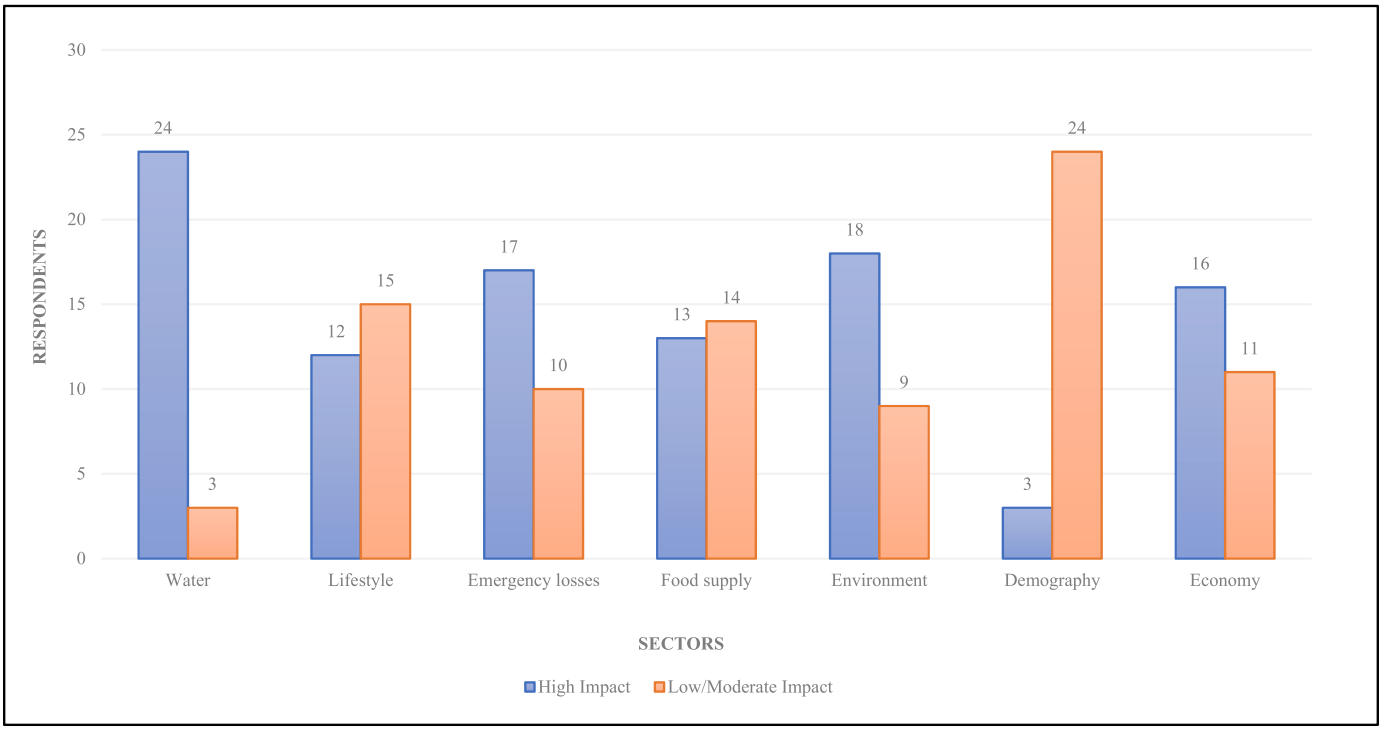

Fig. 11. Sectors that will face the impacts of inadequate actions on climate change adaptation.

Some recent studies strongly suggest local authorities include and integrate both climate change adaptation and mitigation works (Hurlimann et al., 2021; IPCC, 2022). This approach was strongly supported by some of the local government practitioners interviewed. When it comes to climate change mitigation, land use planning and policy or design guidelines are important for emission reductions and adaptation activities and local governments play critical role in these areas. According to local government practitioners, climate change risk should be treated as a single unit where both mitigation and adaptation plans and execution frameworks are outlined and implemented. As there are uncertainties in the achievements of climate change adaptation plans (Seto et al., 2014), it is important that further large-scale investigation is conducted on how climate change mitigation and adaptation plans can be integrated for local government authorities. The existing research efforts on how this can be done at a local government level organisations are limited. (Hurlimann et al., 2021; Reckien et al., 2018). Although it is one of the important findings of this research, further in-depth analysis is required for this purpose.

In Australia, the local government authorities were identified at the forefront of climate change adaptation planning and implementation, and it is currently their responsibility to develop appropriate strategic plans for climate change adaptation that are suitable and acceptable to the local community. The Australian national and state government policies cannot be generalised for local government organisations as the purpose and responsibilities vary at different levels of governance. This result seems to be in line with previous research conducted elsewhere in the world. This research shows central governments develop high level climate change policies and declare their commitments to deal with climate change, whereas the real actions are being taken by local government authorities (Forino and von Meding, 2021; Lesnikowski et al., 2021; Szpak, 2021). Federal and state governments are currently found to provide high level policy directions whereas local governments are responsible for several functions which are critical for climate change adaptation including land use planning and regulation, infrastructure asset management and planning, emergency response and management. Several studies identified local governments as the primary actor in climate change adaptation as climate change impacts are often context specific and in most cases the response to these impacts needs to be locally led (Sinay et al., 2020; Scott and Moloney, 2022; Mfitumukiza et al., 2020). Although some local government professionals perceive that climate change adaptation should be led by state and federal government agencies, research into the barriers to climate change adaptation suggest localised community led actions are expected to work better that the federal, top-down approaches (Aguiar et al., 2018; Biesbroek and Lesnikowski, 2018) Although local governments are perceived to be closer to their communities and are expected to be in a better position to lead this process, some studies are found to criticise this approach as they (LGO) are not free to govern and take decisions autonomously and in many cases their actions are constrained by multi-level governance structures, critical funding arrangements, rules and regulations. (Nalau et al., 2015). The local councils in the study region are having significant resource constraints and external support from state and federal government is lower than what is required. This results in the practitioners perception that the implementation of climate change adaptation plans can potentially be better led by either state or federal government unless responsibilities are shared, and appropriate cost-share mechanisms are put in place.

In Australia, regional local government authorities play a prominent role in managing and planning for local developments and government infrastructure for regional communities. There are few funding options available for local authorities that can be accessed from external government and non-government agencies to assess climate risks and to develop high level strategy for climate change adaptation. The implications and the economic consequence of climate change adaptation practice has rarely been addressed. Larger councils are better prepared to tackling climate change as they have more resources, and funding options available from different external agencies. Smaller councils are suffering due to lack of resources. The interview practitioners perceive that the large metropolitan cities are getting a significant amount of financial and technical support from state and federal government agencies, whereas regional cities are typically ignored when it comes to adaptation to climate change risks. The practitioners identified that many state level policies are developed by state government agencies targeting large metropolitan cities which are in a different climate zone.

This results in many of these policies not being applicable to regional areas. Although it is an interesting point and deserves proper acknowledgement, it also needs to be noted that in many cases support from the state and federal government agencies is evident. For example, when a prolonged drought hit the regional city of Townsville resulting water crisis, a water security taskforce was formed among state, federal and local government bodies to identify long term solutions and funding was allocated for these (TWST, 2018). In addition, when cyclone Yasi caused extensive damage in the case study region in 2011, restoration costs were shared among different levels of government. (Schernewski et al., 2018). In most cases, this funding is arranged for emergency climatic events on a reactive basis. Funding for adapting to long term climate change risks are identified as a critical challenge for regional local government authorities to access and manage.

To implement climate risk adaptation plans, all levels of stakeholders including local community, local industries and businesses need to cooperate and be actively involved with local government organisations (Szpak, 2021). Cooperation and collaboration with national and international institutions is also key for success. One of the important findings of this study is: there is lack of political support and willingness to accept climate change and undertake adaptation measures. It may be more evident in the regional centers as the regional towns depend on primary industries, and in many cases mining and fossil fuel-based industries, to survive. The interview respondents are found to be aware about climate risks, and they agree that climate change adaptation should be given much more priority, but opinions vary on who should take the lead role and how to collaborate to get maximum outputs. Standards and guidelines on infrastructure design and planning lack adequate information on climate change and this is mainly due to confusion on who is doing what and up to what extent. A comprehensive analysis is required on several factors including, for example, what is the financial implication of development restriction in vulnerable areas, what will be the financial benefits if climate adaptation is holistically implemented, who will share what cost, the economic implication of climate change if there is no adaptation in place and finally a robust cost benefit analysis. At this moment it is not clear how this can be done. Funding was allocated to develop different high-level strategies, but these documents are mainly qualitative in nature, and they lack investigation into financial implications, cost/benefit analysis and easy to understand terminology that community and local political members can understand, digest and implement.

There is scepticism on climate risks, especially in the regional areas where economy is driven by primary industries and mining products. There is no easy-to-follow climate change adaptation planning framework at eitherthe state or local government level. The process is ambiguous and varying levels of interpretation of different policy terminologys lead different of decision-making processes at different levels of governance with no holistic approach in place (Forino and von Meding, 2021). Local community prefers to avoid development restrictions imposed due to climate change, as these restrictions have considerable impact on property values. Political members normally support community views to gain immediate mileage in local elections rather than taking a long-term approach. So, short term emergency response is encouraged by the stakeholders, including politicians, but long-term climate change adaptation is ignored due to major financial implications and political consequences.

Although planning and policy instruments are important for climate change adaptation, implementation of these policy is critical for success otherwise it will only remain in documents. Implementation of climate change adaptation works and monitoring and evaluation of these are important steps that complete the adaptation planning cycle. It helps to identify what adaptation plan works, and in what context, helping the authorities to define successful adaptation. The respondents perceive that there is a lack of research and there is poor understanding on how the climate adaptation concept can be implemented on-ground, measured, tracked, and managed by the local level government authorities. Although a wide range of research targeted adaptation planning processes, there is hardly any research on policy implementation, policy evaluation and monitoring (Mathew et al., 2016; Baker et al., 2012). In the case study region, climate change adaptation works are implemented in fragments with no holistic plan put in place. This results in a lack of policy evaluation and monitoring plan to follow. A study done by Scott and Moloney (2022) identified that monitoring and evaluation of adaptation works is challenging for local government bodies to define and manage. The study identified several barriers to developing a robust implementation, monitoring and evaluation plan including lack of resources both human and financial, lack of leadership and competing priorities. Although local government authorities have added climate change adaptation plans in their policy documents, it is not known how these policies are leading to a successful adaptation. (Biswas et al., 2022b; Scott and Moloney, 2022). In many parts of the developed world, although local governments are increasingly becoming aware of their role in dealing with climate change, it is concluded as being too early to assess the implementation of their plans and strategies as they were adopted very recently (Szpak, 2021). Our knowledge about barriers and enablers of climate change adaptation plan evaluation and implementation is still very limited as in most cases implementation of these adaptation measures and evaluation and monitoring of these are not yet clearly understood. These results seem to be in line with the recent IPCC (2022) reporting that more research on implementation and investment in adaptation strategies is expected in the future as it is gaining importance throughout the world. The interview respondents agree that a comprehensive climate change adaptation implementation plan needs to be developed that will take into consideration a holistic collaborative approach, financial implications and, finally, a thorough implementation strategy over time. The implementation strategy should also outline who will bear what cost and how the progress can be monitored. Although both the state and federal governments have made some progress in developing better climate change adaptation policies, the local government professionals perceive that a lot more needs to be done especially in implementation.

6. Conclusions

This study initially discusses the roles and responsibilities of federal, state, and local government organisations in the northern tropical region of Queensland, Australia by reviewing current policy documents, governments policy directions and other relevant literatures. Local government organisations are responsible for taking a leading role in climate change adaptation, whereas state and commonwealth government agencies are primarily responsible for developing climate transition policies and guidelines, as well as providing limited financial aid to help support the local government organisations. Interviews with local government professionals were conducted to analyse the measures adopted by the stakeholders in charge of government policy development and implementation to minimise the impacts of climate change.

Although Australia has ambitious targets to reduce greenhouse gas emissions, from a local government practitioners' viewpoint, the current local government's actions in the case study region largely focus on adaptation rather than mitigation. The interviewed participants suggest the local government authorities need to take appropriate steps to integrate adaptation and mitigations works to face and prepare for climate risks. Although it is one of the key findings of this research, no further analysis was carried out on how climate change mitigation and

adaptation plans can be integrated for local government authorities. Instead, the perceptions of the local government professionals on current climate change adaptation practices are primarily reported in this study. This is one of the key limitations of this paper and further research needs to be conducted on this subject matter to better understand the process.

Although all government bodies have made progress in developing better climate change adaptation policies, the local government professionals identify that a lot more needs to be done specifically in implementation, including devising and implementing relevant action plans, economic assessments, stakeholder participation and engagement. The local councils in the study region have significant resource constraints for this to be conducted holistically. External support from state and federal government is lower than what is required resulting the practitioners perception that it is a significant burden for local authorities unless responsibilities are shared with state and federal government agencies, and appropriate cost-share mechanisms are put in place. There is no doubt that implementation of climate change adaptation works and monitoring and evaluation of these are important steps that complete the adaptation planning cycle. Although there are numerous studies done on challenges of climate change adaptation planning, our knowledge about barriers and enablers of climate change adaptation plan evaluation and implementation is still limited as in most cases implementation of these adaptation measures and evaluation and monitoring of these is not yet clearly understood and implemented by the stakeholders in charge of this.

There are currently no notable legal bindings to address climate change risks in the study region. In addition, financial liability assessments due to climate risks and cost-share mechanisms among different levels of stakeholders and government authorities to face and prepare for climate change impacts hardly exist although the interview respondents recognise their high importance. The respondents believe that there is lack of research and there is poor understanding on how the climate adaptation concept can be implemented on-ground, measured, tracked, and managed by the local level government authorities.

Credit author statement

Rahul Ray Biswas: Conceptualisation, Data Collection, Formal analysis, Investigation, Writing – Original Draft, Writing – Review & Editing. Anisur Rahman: Writing – Review & Editing, Supervision.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

The data that has been used is confidential.

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APPENDIX A. Interview contributors

Interviewee Code	Local government professionals - department
IAP1	Infrastructure asset management & planning
IAP2	Infrastructure asset management & planning
IAP3	Infrastructure asset management & planning
IAP4	Infrastructure asset management & planning
IAP5	Infrastructure asset management & planning
IAP6	Infrastructure asset management & planning
IAP7	Infrastructure asset management & planning
IAP8	Infrastructure asset management & planning
IAP9	Infrastructure asset management & planning
IAP10	Infrastructure asset management & planning
IAP11	Infrastructure asset management & planning
IAP12	Infrastructure asset management & planning
IAP13	Infrastructure asset management & planning
PDI1	Policy development and implementation
PDI2	Policy development and implementation
PDI3	Policy development and implementation
PDI4	Policy development and implementation
PDI5	Policy development and implementation
PDI6	Policy development and implementation
PDI7	Policy development and implementation
DPA1	Development planning and approval
DPA2	Development planning and approval
DPA3	Development planning and approval
DPA4	Development planning and approval
DPA5	Development planning and approval
DPA6	Development planning and approval
DPA7	Development planning and approval

APPENDIX B. Interview questions

No.	Interview questions
1	Tell us about the actions currently being undertaken as part of climate change adaptation?
2	Tell us about the key barriers to climate change adaptation in local government organisations?
3	Tell us - what actions need to be undertaken for a successful climate change adaptation practice at local authorities?
4	Do you believe that the current planning framework and design standards are adequate for climate change adaptation? Why or why not?
5	Tell us about different types of external supports available for climate change adaptation?
6	If climate change adaptation is not seriously considered, which areas will face the immediate impacts?
7	Further "How" or "Why" type questions to get better understandings on the perception of the local government professionals.

APPENDIX C. A few notable relevant comments received from the interview respondents

No.	Interview comments
1	The local government is starting to consider engagement with community on flooding risk … so, indirectly we do some works on climate change adaptation …. It happens in bits and pieces …. Emergency measures are given more priority … I have not seen any long-term strategy for a long-term climate change effect … (IAP1)
2	I think they have got the climate change risks … mapping done … we can see the local government areas that will be more stressed ….. Most of the priorities are on emergency response ….heat stress, tsunami, flood, cyclone …. That is primarily targeting the impacts of climate change rather than adapting to climate change …. (PDI1)
3	I am aware that the council is aware of climate change risks …. You can see some references to it … in policies and guidelines …. We are aware of … flood risk … sea level rise … resulting planning scheme to have … floor level criteria … but I am not confident … about the effectiveness of incorporating climate change in current documentation ….. It is the politicians, …..the communities …. They need to be aware of it ….it is not beneficial unless implemented correctly …. (PDI3)
4	the most important point here is …. Community engagement and pollical backlash ….. Sits with the local governments to face with ….. Community does not like …. To deal with something which is going to happen after a long time …. (IAP5)
5	the main challenge is funding … and resource … we have only one bucket of money … we are getting money for critical infrastructure … reactive works ….and the works related to climate change adaptation is competing with the other critical works ….. (PDI4)
6	Our actions are primarily in the areas of developing policies …. We are developing policies on coastal hazard adaptation works … trying to identify what changes we will need to have …. We are currently trying to build something … on ground we have not done a lot of works …. But we are trying to understand what areas will get impacted … but again … physically we have not implemented many things …. Primarily we are trying to understand the impact and what we will need to do …. Then we can take implementation steps …. (IAP11)
7	You can't leave everything on the local governments to deal with …. I think we need a coordinated approach …. A lot of money involved … all levels of governments need to be involved ….state government needs to be more involved …. Probably also need more buy-in from federal government … there is nervousness when it comes to funding … we need a collaborative funding model …. We are still at policy stage …. Implementation still not defined well … (IAP9)
8	I am not certain whether climate change is really a problem or not …. That's how scepticism playing big role ….. There is no confirmation whether it is really happening or not ….. (DPA3)
9	People are not really worried about climate change in asset management ….. Not much expertise to incorporate climate change into infrastructure asset management and planning ….. (IAP10)
10	we have critical infrastructure … built within the coastal hazard area … some of these areas will be under water in the next 50 years …. What we can do … it is going to cost millions of dollars ….. I don't think we are doing planning well … we are still allowing development in the vulnerable areas ….. It is extremely complex issue … we don't like dealing with it … as we don't like complex thing …. (PDI4)
11	Implementation is really hard … …when I say you can't develop in certain area …. There is economic impact ….. It is really hard to implement …. There is lack of knowledge … there is political influence ….. It is hard to adapt to …. (IAP8)
12	I don't actually think there is a lot of support … ….I am sure big cities get lot of funding …. It does not trickle down to us well … to the regional cities …. (PDI12)
13	I don't think external support is enough … I think the directions should come from the top …. From state and federal government …. If you don't have support or directions from the top …. It becomes a failure … in federal government there is no good consensus …. State government is just making one policy after another …. (DPA4)
14	I guess at a local government level …. You can make a difference …. You can make a direct impact ….but we need state government's support for implementing …. It makes us "the bad guys" ….as we need to say that you can or can't develop …. Responsibilities need to be shared …. (IAP4)
15	Coastal hazard adaptation document we developed is funded by the state government … the works that is required to implement it … well, it is a different challenge …. The funding is not available yet … I don't know how this can be funded … it has a lot of things … (IAP11)
16	I think in the current documents and design standards, …there are many gaps ….not adequately addressing climate change adaptation ….current planning tools and policies have not been supported by adequate research evidence and results … … it has not been developed based on robust and reliable data and foundation …..more research needs to be done …. (IAP1)
17	the current documents take some parts of climate change ….. The policy does not have mandatory rules …. It is up to us for interpretation ….. (IAP6)
18	The planning and design document has incorporated climate change as an element …. The thing is they are not clear enough for us to implement ….. (DPA7)
19	In the state level, some research works done …. Unfortunately, at federal level .. I don't think there is enough effort ….at state level, lot of research works are being conducted … but at ground level ….not much happening ….at local governments, good works are being done … with the limited resource and technology ….smaller councils … are not able to do enough work …. Primarily broad overarching works are being carried out ….. (PDI5)
20	Organisations … not necessarily have the flexibility to adapt to climate change easily We are on a journey …. We need to convince people and stakeholders ….it takes time It is not something that can happen quickly …. It is the biggest barrier …. More efforts are being applied in bigger cities …. But here … the regional areas … lesser importance given …. Less information and action plan … (IAP13)
21	We need to understand what the scientific community is saying …. We also need leadership …. It is challenging to take a consolidated action plan …. (IAP12)
22	State government is primarily driven by southeast Queensland and south-east Queensland is a temperate climate not a tropical climate …. Lot of their policies are really not applicable here in tropics ….. (PDI2)
23	The climate change adaptation should be led by federal government … funding needs to come from federal and state government …. We also need an implementation plan, how we are going to adapt ….we will need full cost benefit analysis … (PDI6)
24	climate change is a long-term thing …. Political cycle is short term …. So it is hard to take decision … some difficult discussions on funding arrangement is needed ….who pays for it … there is always people out there who believe climate change does not exist the science behind climate change …. It is not a perfect analysis …. This is a barrier … we are dealing with …. Climate change ….is a global issue …. It is complex ….to resolve … politically a difficult one …. It is difficult to convince community on something that is going to happen after a long time …. (IAP9)

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