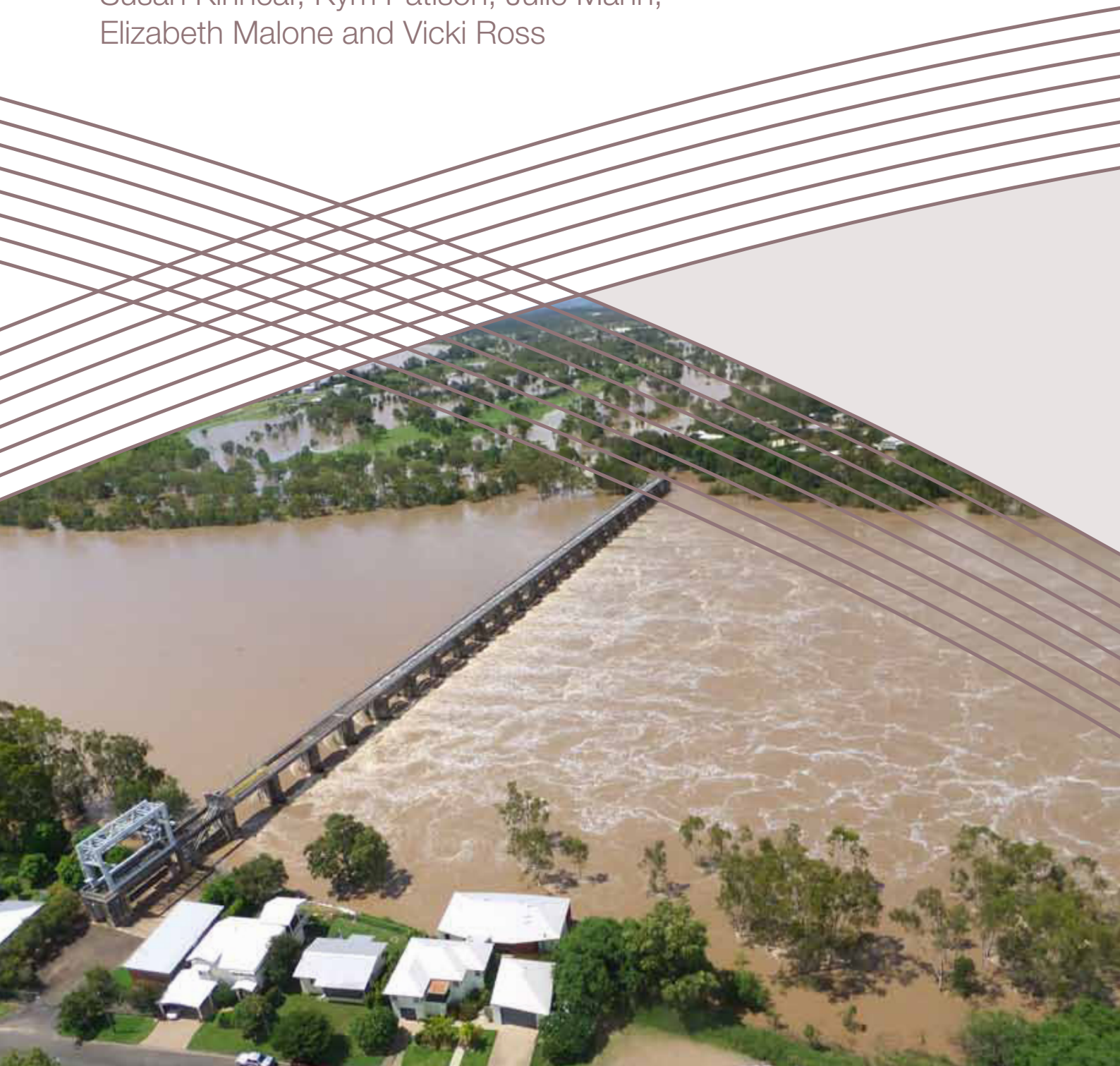


Network governance and climate change adaptation: Collaborative responses to the Queensland floods

Final Report

Susan Kinnear, Kym Patison, Julie Mann,
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Network governance and climate change adaptation: Collaborative responses to the Queensland floods

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LIST OF ABBREVIATIONS

AU	Australian
AVA	Australian Veterinary Association
BCC	Brisbane City Council
BMA	BHP-Mitsubishi Alliance
C&I	Community and industry (organisational sectors)
CCC	Capricorn Conservation Council
CDM	Criteria Decision Methods
CEO	Chief Executive Officer
CHDC	Central Highlands Development Corporation
CHRC	Central Highlands Regional Council
CHRRUP	Central Highlands Regional Resources Use Planning Committee
CQ	Central Queensland
CQU	CQUniversity Australia
DDMG	District Disaster Management Group
DEEDI	Department of Employment, Education, Development and Innovation
EMD	Emerald
EMQ	Emergency Management Queensland
FTE	Full time equivalent
GIS	Geographic Information Systems
Govt	Government
GSP	Gross State Product
HACC	Home and community care
IPCC	Intergovernmental Panel on Climate Change
LDCC	Local Disaster Coordination Centre
LDMG	Local Disaster Management Group
na	not applicable
NCCARF	National Climate Change Adaptation Research Facility
NGO	Non-government organisation
NRT	National Response Team
PWC	Price Waterhouse Coopers
QDC	Queensland Design Council
QFCoI	Queensland Floods Commission of Inquiry
QLD	Queensland
QWC	Queensland Water Commission
RACQ	Royal Automobile Club (Queensland)
RC	Regional Council
ROK	Rockhampton
RRC	Rockhampton Regional Council
RSPCA	Royal Society for the Prevention of Cruelty to Animals
SDMG	State Disaster Management Group
SEQ	South East Queensland
SES	State Emergency Service (Queensland)
SEWPaC	Department of Sustainability, Environment, Water, Population and Communities
SNA	Social Networks Analysis(es)
US	United States
WTC	World Trade Center

ABSTRACT

This research examines ways to build adaptive capacity to climate change, through a case study of organisations that participated in the response to Queensland's major flood disaster in Queensland in 2010/11. The research applied a network governance approach, including social network analysis and qualitative investigations, to the communities of Rockhampton, Emerald and Brisbane. The study was designed to compare social networks across a range of different geographical; functional; and institutional and regulatory contexts.

Primary data were obtained from organisations involved in disaster management and water management, through a telephone survey conducted March – September 2012. The network analyses examined collaboration and communication patterns; changes in the network structure from routine management to flood operations; similarities and differences between the geographic regions, and whether collaboration was correlated with trust. A cultural values analysis was then performed to identify the key values of the network actors in each region. Two workshops were conducted in Rockhampton and Brisbane to disseminate the findings to stakeholders, as well as to obtain feedback through group activities.

A total of 63 organisations participated in the study. As the network analyses and visualisations indicated that the Rockhampton and Emerald networks were tightly interconnected, a single 'Central Queensland' (CQ) network was used for all subsequent analyses. In both Brisbane and CQ, slightly higher levels of collaboration amongst organisations were recorded during flood periods compared with routine operations; and organisations tended to provide, as well as receive, information and/or resources from their collaborators. Overall, both networks appeared to feature high trust, with only a low level of difficult ties (problematic relationships) being reported.

The cultural analyses identified patterns of common values amongst participating organisations. In Brisbane, respondents placed a high value on shared information systems and resources; shared communication and language; as well as on collaboration and flexibility. In the CQ network, there was a greater emphasis on local solutions, community wellbeing and longitudinal issues (such as post-disaster supply chains for recovery). The workshop activities suggested that the current structure of Local Disaster Management Groups was heavily influential on broader network participation; and that defining an 'effective' disaster response was a complex issue.

This study has demonstrated that a network governance approach can provide new ways of understanding the core elements of adaptive capacity, in areas such as enablers and barriers to adaptation, and translating capacity into adaptation. The key implications for policy and practice include the need for stakeholders to drive adaptation to climate change through collaboration and communication; the need for stakeholders to share a common goal and language; the need for better engagement with community, diversity and Indigenous organisations; the need to establish collaboration outside of disaster events; and the need for network governance systems to play an important role in helping to facilitate climate change adaptation. The areas identified for future research included further methodological development and longitudinal studies of social networks, understanding effective modes of communication, and the influence of the changing nature of regional Australian communities on climate change adaptation.

EXECUTIVE SUMMARY

This report presents the key findings from the NCCARF-funded project 'Social networks analysis: bridging degrees of separation to enhance climate change adaptation'. The research team was led by Central Queensland University and included researchers from the University of Melbourne, Griffith University and the US Pacific Northwest National Laboratory. The research set out to investigate the collaboration and communication networks that existed amongst organisations involved in disaster management and water management during the 2010/11 major flood events in Queensland. The principal goal of the research was to understand the collaboration and communication network structures, with the aim of assisting organisations find ways of coordinating more effectively for climate change adaptation. Specific project objectives included:

- to collect qualitative and quantitative data on the adaptive responses to increased climatic variability, through case study examples of (a) responding to flooding caused by extreme rainfall events and (b) managing supply/demand pressures on municipal water supplies due to changes in flows;
- to use social network analysis techniques to study climate change adaptation behaviours, such as the transmission of the above information between organisations;
- to workshop the findings with government, industry (water authorities) and the community in order to identify practical measures for increasing climate change adaptation; and
- to demonstrate how the findings might inform policy development regarding institutional interactions relevant to climate adaptation.

The study was undertaken over approximately 14 months between November 2011 and December 2012, and was based on a mixed-method approach to understanding network governance. Both quantitative (binary network data) and qualitative (open-ended response) data were collected through a series of telephone interviews conducted with water management and disaster management organisations in the three case study locations (Brisbane, Rockhampton and Emerald). The project team conducted two workshops (in Rockhampton and Brisbane) to relay the project findings to a broad range of stakeholders, as well as to collect further information about preferred options for membership of Local Disaster Management Groups; and the criteria by which a disaster response could be assessed as being 'effective'.

A total of 63 organisations participated in the study, including those from the three tiers of government, water entities, commerce and industry, and community organisations. These groups were involved in a range of water and/or disaster management operations, including communication, monitoring, direct response efforts, support services and policy development. Respondents indicated that the opportunities to share information and expertise were key drivers for collaborating with other organisations, followed by the need to satisfy policy or regulatory compliance.

The network analysis and visualisations (network diagrams) indicated that in Brisbane, organisations collaborated with an average of four and five key partners during routine and flood operations, respectively, indicating that a slightly higher level of interaction occurred amongst organisations during the flood response period. There was a strong tendency for organisations to provide, as well as receive, information and/or resources from their collaborators; and the network overall was one of generally high trust, with only a low level of difficult ties (problematic relationships) being reported.

The network analysis and visualisations showed that organisations from Rockhampton and Emerald were closely interconnected; so much so that it was not possible to identify a separate network for each case study location. Rather, the analyses were conducted based on an integrated 'Central Queensland' (CQ) network. Similar to Brisbane, the CQ network during flood operations were associated with slightly higher levels of collaboration (e.g. each organisation reported an average of 6 and 7 key partners, for routine and flood operations, respectively). The CQ network was also characterised as a high-trust system, with these ties often being associated with the provision and/or receipt of information and/or resources.

Based on an examination of centrality measures in both the Brisbane and CQ network, the organisations that were members of the local disaster management group (LMDG) were typically very 'popular' (in standardised value) as network partners. The increased number of ties that occurred during flood operations appeared to be extensions of routine ties: this indicates the importance of building collaborative relationships during non-crisis periods, which can then be drawn upon during acute response phases.

Cultural analyses indicated that a series of common values were important to the organisations participating in the two networks, but the types of values varied by organisational type as well as by the network location. In Brisbane, respondents placed a high value on shared information systems; shared resources, shared communication and shared language; as well as on collaboration and flexibility. In the CQ network, there was a greater emphasis on local solutions, community wellbeing and longitudinal issues (such as post-disaster supply chains for recovery). In general, government organisations appeared to be more strongly linked with values relating to a clear network structure ('command-and-control' environments), whereas community organisations and industry preferred inclusivity and flexibility.

With respect to collaboration, being contactable and having effective shared information systems, common goals, trust and knowledge were cited by respondents as the key characteristics of effective partnering organisations. Conversely, a 'siloed' mentality, problems with bureaucracy, and absence from key discussions (such as LDMG meetings) were recorded as making collaboration more difficult. More than half the participating organisations expected their collaborative arrangements to increase in future years, given the likelihood that climate-related disasters would also increase.

The first workshop activity provided insight into the preferred membership of LDMGs, which tended to be heavily based on the existing structure (as governed by the *Disaster Management Act*), with strong representation by local and state government. However, an important finding was the recognition that community and not-for-profit organisations could also play an important role in the network. The second workshop activity examined how an 'effective response' might be characterized; this brought a number of issues to bear, including common goals, roles and responsibilities, community capability, and expectation management.

From a theoretical base, this study has demonstrated that a network governance approach can provide new ways of understanding some of the core elements of adaptive capacity, such as the enablers and barriers to adaptation, as well as translating capacity into adaptation. The practical outcomes of this research include making new information available to (a) participating organisations within each of the two networks and (b) policy-makers in the realms of water management and disaster management; together with guidance on how this may be applied to achieve better climate change adaptation outcomes.

With respect to the latter, the key recommendations arising from the research were:

- the need for stakeholders to drive adaptation to climate change through collaboration and communication;
- the need for stakeholders to share a common goal and language;
- the need for better engagement with community, diversity and Indigenous organisations;
- the need to establish collaboration outside of disaster events; and
- the need for network governance systems to play an important role in helping to facilitate climate change adaptation.

Areas for ongoing research were also identified, including further methodological development and longitudinal studies in the field of social network analysis, understanding effective modes of communication, and the influence of the changing nature of regional Australia on climate change adaptation more broadly.

1 INTRODUCTION

Effective communication and strong collaboration amongst organisations are essential tools in responding and adapting to climate change. This research project focused on the use of social network analysis (SNA) to study how organisations communicate and share information, with a focus on water resources and disaster management in the context of major flooding in three communities in Queensland. The SNA technique has already been successfully used to help manage other complex problems, including in natural resource management as well as disaster management (e.g. the Victorian bushfires), but the application of SNA specifically to flooding remains in its infancy.

1.1 Research aims and objectives

The principal aim of this research was to examine how organisations collaborated and communicated in situations of flooding caused by extreme rainfall events. The research also examined the interactions between organisations that occurred during routine operations, such as managing supply and demand pressures on municipal water supplies. A network governance perspective was used to help understand the system of organisational collaboration in each of the case study locations.

Specific objectives of the research included to:

- develop a network-based survey to collect both qualitative and quantitative data on types and patterns of collaboration;
- analyse these data using social network analytical methods; and
- collaborate with the relevant organisations, including government, industry and community groups, to find ways to optimize network governance systems in the management of various climate change adaptation responses in the water sector.

With respect to informing policy development, the aim of this research was to assist government, business/industry and the community, to consider the design of network governance systems as a platform to help identify the best ways to respond to relevant climate adaptation issues (particularly in the context of water supply and disaster response).

2 RESEARCH CONTEXT

2.1 Climate change in Australia

2.1.1 Impacts on water resources

The impacts of global climate change on the water sector are pervasive: climate change will affect both the quality and quantity of global water supplies; and it is also expected to affect the function, operation and reliability of key water infrastructure (Bates *et al.* 2008). The latter will include storage and distribution networks, hydropower, flood defenses, and drainage and irrigation systems – as well as effects on demand for water (both in terms of quantity and in geographic location).

Given that Australia already experiences a highly variable rainfall regime, human-induced climate change is likely to have a significant effect upon national water systems over the coming decades. There is already a large and comprehensive literature that describes the predicted long-term climate trends, and their likely impacts, on Australia's social, economic and environmental outcomes. It is outside the scope of this report to review and present those here; detailed descriptions of the nature and extent of impacts on water resources, water infrastructure and services in Australia can be found in NWC (2012). Climate modelling already suggests that mean annual rainfall across Australia will decline by 2 to 5% by 2030, although some northern areas may trend towards an increase in rainfall, particularly during the summer months (NCCARF 2012a). Increased precipitation intensity and variability are projected to increase the risks of flooding and drought in many areas (Bates *et al.* 2008). Increases in the frequency and intensity of flooding events and tropical cyclones are also likely, and this has important implications for the management of water infrastructure, as well as social and economic impacts within affected communities.

With the expectation of more extreme events, such as flooding, water management systems will need to be adaptive for times of regular management as well as those for disaster management.

2.1.2 The need for cross-sectoral adaptation to climate change

Given the large scope of effects that climate change will have in the water sector, there are a variety of temporal, spatial and governmental issues that must be considered as communities develop adaptive responses to climate change. 'Climate change adaptation' is a term used to describe management or other measures that can be used to reduce or avoid the adverse effects of climate change, and/or to take advantage of beneficial opportunities (SEWPaC 2011).

With respect to the water sector, the key strategies that will be needed to reduce the impacts of climate change (and therefore, to form an appropriate adaptive response) include:

- reducing the vulnerability of human populations to shifts in meteorological trends (both variability and extreme events);
- closing the gap between water supply and demand;
- managing key water infrastructure appropriately (and across the gamut of collection, storage, treatment, transport and supply networks); and
- ensuring the protection and restoration of natural water assets.

This breadth of responses will be necessary to address supply/demand issues across the domestic/municipal, agricultural, industrial and business spheres. Furthermore, climate change that leads to dramatic shifts in water resource management will also

require adaptation measures to be undertaken in ‘companion’ activities and programs – for example, disaster management.

This research project will examine the stakeholder interactions relevant to formulating and delivering adaptive responses to the effects of climate change, with a focus on water management and disaster management. The process of engagement between stakeholders across multiple sectors in which there are no formal contracts or agreements is known as ‘network governance’. Governance frameworks can be highly effective for natural resource management by encouraging both cooperative and competitive relationships not traditionally seen within markets and centralised government systems (Provan and Milward 1995). Social networks analysis (SNA) is the method by which information flows and relationships within governance frameworks can be investigated. Here, relational connections between stakeholders can be examined by analysing the structural properties of the network.

2.2 Social network analysis – an introduction

A social network comprises ‘social actors’ – social entities such as people or organisations that are involved in various actions; and ‘network ties’ that characterise social relationships of various types amongst the actors. For instance, social network studies involving human individuals have included relationships such as friendship, work collaboration, kinship, acquaintanceship, economic exchange, trust, cooperation and conflict. Organisational relationships may include communication, collaboration, resource exchange, trust, formal alliance, competition and so on. The choice of which particular types of relational ties to investigate in a research study depends on the context and the nature of the research question. The links among actors, their characteristics and patterning can yield important insights about the social processes that occur within the network. A basic unit in a social network is a *dyad*, a pair of actors; and the basic unit of analysis is the ties between two actors (including the possibility that there may be no ties between them). Ties may represent various types of relations, such as friendships, work partners, business transactions, collaboration etc., so it is important to distinguish between them. Ties may also differ in strength, may represent formal or informal relationships, or express a positive or a negative relationship. The accumulation of the patterns of these pair-wise relationships forms the *network structure* (Wasserman and Faust 1994).

A *directed* tie is expressed from one actor to another, such as reporting relationship from an employee to a manager. A business alliance, on the other hand, is an *undirected* tie, because it necessarily involves two partners. (Contrast this with *wanting a business alliance*, which would be a directed tie, as in *I would like a business alliance with organisation X*, a statement that can be made irrespective of whether X wants an alliance or not.) If a directed tie is reciprocated, then the tie is sometimes referred to as *mutual*. The information inferred from a tie must be considered with caution, as not all ties imply reciprocation. For example, a friendship is often thought of as necessarily mutual, although empirically respondents in surveys do not always agree with one another about whether they are friends or not (Robins *et al.* 2010). Similarly, organisations may not always be consistent in the nominations of collaboration partners. This does not mean that organisations are necessarily misunderstanding the situation. Rather, organisation A may consider collaboration with organisation B as crucial to its activities, but organisation B may see the relationship with A as less central to its own aims. Accordingly, A will list B as a major organisational partner but B will not list A. In this case, although conceptually *collaboration* is a relationship that necessarily involves multiple partners, it is better to treat the tie as directed. The data then contains information about the importance that organisations attribute to one another as collaboration partners.

Social networks can be visualised in graphical form, and network data can be analysed using various network techniques, known as *social network analysis*, including statistical models and mathematical graph theory. Social network analysis is distinctive from other forms of data analysis in emphasizing network ties, rather than focusing on the importance of individual attributes. Within a social network, the actions of each actor may be interdependent upon those around it (Wasserman and Faust 1994). The potential outcomes from such investigations may involve identifying influential actors and studying the effect of the network on their behaviour, understanding the evolution of behavioural strategies at the individual and population level, and discovering how information is communicated within a network of actors (Croft *et al.* 2008).

Social network data can be collected via several methods, such as surveys, interviews, data archives and experiments (Wasserman and Faust 1994). In this project, organisational informants were interviewed about their organisation's collaborative activities, as described in Section 4.3 below.

2.2.1 Network measures

Centrality measures are used to describe the importance of an actor in the network based on the actor's location and connections with others. There are various centrality measures, but this report focuses on *degree* centrality and *betweenness* centrality. The degree of an actor refers to the number of ties it has within the network, and degree centrality provides an indication of popularity or activity (Freeman 1979) as well as potential for power and influence (Kapucu 2005). Betweenness centrality indicates how often an actor lies between other pairs of actors; being between two actors indicates a sense of dependence and influence, as the actor has the potential to control information flow (Kapucu 2005). In contrast to degree centrality, high betweenness centrality indicates that an actor is important in keeping the network together. Often, but not always, high degree actors are the same as high betweenness actors. Typically, high degree actors are quite publicly visible (after all, they have many ties), whereas high betweenness actors with low degree may not be well recognised for how important they are to network structure.

2.2.2 Network governance and natural resources

The term 'network governance' is used to describe the process of engagement between organisations involved in managing a collective resource; and for which there is no obvious central body that exercises dictatorial control, although some organisations may be more important than others in the system of governance. Whilst network governance arrangements may be based on formal legislation and contracts, this is not necessarily always the case. For instance, two subcontractors may each have formal agreements to complete a specific job, but there is no formal contract in place to define the relationship between the subcontractors (Jones *et al.* 1997). The term 'co-management' is thus sometimes used to describe the informal arrangements between stakeholders (Bodin and Crona 2009).

Governance is contrasted with *government*, as the latter implies a sole, formal governing body; and governance is also sets it apart from *management*, which refers more explicitly to the processes and outcomes pertaining to the resource itself (Bodin *et al.* 2011). The opportunity for stakeholders to form cooperative relationships that enhance competition and effectiveness also sets network governance frameworks apart from traditional market and centralised governments systems (Provan and Milward 1995).

Natural resource management is a good example of a system in which stakeholders interact within a network governance framework to achieve a common goal relating to the resource. Natural resources often span large areas, crossing multiple boundaries and jurisdictions, thus multiple stakeholders including both environmental and developmental sectors are involved in the management of the resource (Schneider *et al.* 2003). These stakeholders may operate at various levels, including governmental, organisational, and individual.

Governance of water resources is often referred to as watershed management or partnerships, whereby cooperative agreements are made between stakeholders involved in the use and preservation of a water body. This may include government agencies, agricultural producers and other local organisations (Lubell *et al.* 2002). Water resources, as for most natural resources, are complex systems characterised by unpredictability; and their public availability can also lead to over-exploitation and degradation (Lubell 2004). A network governance perspective can provide an alternative way of approaching these problems compared with traditional management systems. For example, watershed management systems are often formed in response to a weakness in the existing government system, such as environmental issues that are not being effectively managed by the current environmental policy, or institutions that are performing inefficiently (Lubell *et al.* 2002). The value of network governance frameworks is their potential to deal with issues are either outside of, or not effectively managed by, current policy. Here, partnerships to provide effective control over some environmental features can work in combination with existing policy; however, a prerequisite for their formation and effective function is that sufficient human, social and economic resources are available to outweigh the transaction costs (Lubell *et al.* 2002).

The efficient management of watershed partnerships is driven by shared environmental and economic interests between stakeholders who perceive that they will receive benefits from the collaboration. The social characteristics of the stakeholders also contribute to the effectiveness of a natural governance system. For example, the stakeholder set will often span a more diverse group of organisations and individuals with a wider range of expertise than can be seen with sole governing bodies; this situation has the potential to reduce uncertainty and promote collaborative relationships (Schneider *et al.* 2003). In addition, stakeholders involved in a partnership are likely to interact more frequently, leading to greater levels of trust and consensus within the network, again promoting collaboration and cooperation (Schneider *et al.* 2003). Collaborative agreements also exhibit greater levels of conflict resolution than centralised governance systems, primarily due to mediation provided by the overall framework and shared information (Lubell 2004). Such partnerships have resulted in a greater number of environmental issues being addressed than traditional governance systems by including more stakeholders, prioritising a larger range of environmental issues, and limiting interference from non-stakeholders (Lubell 2004).

Within governance networks, stakeholders are connected to others via formal and informal relationships, with each stakeholder having the potential to influence the entire network through behaviours, attitudes, policies and opinions. The network of relations represents a structured system on different levels including the community or organisation level; the network of stakeholders or agents; and the level of individuals or participants in the network (Provan and Milward 2001). Each level is interconnected with all others, and as such, each level cannot be considered outside the context of the network.

Evaluating effective network governance is a complex process, and to date only a limited number of studies have addressed this issue (Provan and Milward 2001). Early work by Jones *et al.* (1997) used transaction cost economics and social network theory

to describe structural features of governance networks that relate to efficiency via enhanced cooperation and exchange. The use of SNA to investigate social processes has also provided some useful insight into the function and outcome of governance networks based on their structural characteristics (Bodin and Crona 2009). For example, Bodin *et al.* (2006) related several network measures (including centrality and betweenness) with important features of a natural resource governance system, such as trust, learning and leadership. These findings have also been supported by Stein *et al.* (2011), who used SNA to describe the complex governance system of the Mkindo catchment in Tanzania. Berardo and Scholz (2010) proposed that optimal network structure for water management depended on the risk contingencies associated with decisions, although to date there is little empirical work to examine this proposition.

2.2.3 Networks and disaster management

There are various views on the actual definition of a disaster and whether it refers to social disturbance rather than a physical occurrence (Quarantelli and Dynes 1977, Quarantelli 1995). Nonetheless, a broad definition of a natural disaster is an event that brings disruption to social and physical systems (Stephenson and DuFrane 2002); this definition covers events such as earthquakes, tropical storms (e.g. hurricanes, cyclones), volcanic activity and floods (Alexander 1997). Disaster management generally involves four stages of activity: prevention, preparedness, response and recovery. During a disaster, multiple agencies respond to the situation at hand from both specialist and non-specialist organisations (Doreian and Conti 2012). Disaster response networks are formed by these organisations that communicate information and coordinate response activities with each other in an attempt to take control of the situation (Comfort 2007). The networks are therefore based on social interaction and relationships between and within organisations. Although there has been increasing attention to network studies of disasters, there is still a limited base of empirical work.

Emergency response networks are, or can be, analysed for various network characteristics, such as the number of agencies involved, key agencies and their activities, and social processes such as coordination and information transfer; all of which can be indicated by network measures, e.g. centrality (degree, closeness, betweenness) (Kapucu 2005). However, network studies investigating the interactions that occur during disaster response periods are rarely undertaken longitudinally (over time); rather, data are reported for certain snapshots in time, such as pre-, during, or post-disaster, with specific network characteristics compared against time, such as density and in-degree (Varda *et al.* 2009). Recent studies have developed statistical approaches to analyse longitudinal data; for example, Butts (2008) developed a relational event framework to analyse radio communication events during early stages of the World Trade Centre disaster. Butts analysed the radio sequences to determine patterns of interaction regularities between actors using time stamped association data. Similar approaches have been used to analyse social data outside of disaster scenarios (e.g. Brandes *et al.* 2009, de Nooy 2010).

There are, however, some difficulties faced using SNA when evaluating disaster response networks. Real time data are not always recorded or accessible; thus data are often collected at a later date, post-event. This may affect the accuracy of information from respondents, and complete networks are difficult to compile if not all personnel involved in the disaster response can be traced (McMaster and Baber 2012). Groups do not always have formal structures with clear boundaries (Varda *et al.* 2009). Quarantelli and Dynes (1977) use Red Cross as a prime example: multiple groups operate under the one name but yet each group may not have the same number of personnel or cover the same amount of area as groups in other geographical locations; thus, the organisational structure does not follow a traditional format (Quarantelli and

Dynes 1977). Additionally, it can be difficult to obtain reliable information to establish what the pre-disaster network looked like. This is particularly the case where the information used for SNA is based on human perception and recall, as opposed to that obtained through more objective (e.g. physical) measurement.

Nevertheless, several studies have used SNA to understand the emergency response by professional and non-professional response organisations to natural disasters. Much attention has been given in the social networking literature to devastating events such as Hurricane Katrina (e.g., Comfort and Haase 2006), while less attention has been paid to understanding the dynamics of social networks during flooding events (e.g., McMaster and Baber 2012).

3 WATER AND DISASTER MANAGEMENT IN QUEENSLAND

This Section provides a brief introduction to the regulatory framework under which water management and disaster management is undertaken in Queensland. Understanding these settings was very important in identifying organisations that were likely to be key actors in the flood response networks; and in being sensitive to the issues that may be experienced by different organisations as a result of the major flooding in Queensland in 2010-11, and, later, the Queensland Floods Commission of Inquiry. It was also important to acknowledge the operating frameworks around the water and disaster management sectors, in formulating practical recommendations arising from the research.

3.1 Water management arrangements

In Australia, water management differs by state and territory, with up to five levels of water management being possible at the national, cross-border, state/territory, regional and local scales. There is also a broad range of functions within water management, including pricing and economic regulation, planning and management, markets, supply and services, and management of water quality (NWM 2012). Various government agencies, water authorities and water utilities are involved in the delivery of these functions, of which many are outside the scope of this report.

Outside of the south-east corner, the Queensland government owns and operates an irrigation infrastructure provider, which delivers water across the state (NWM 2012); whereas local governments are responsible for the operation and maintenance of municipal water and sewer assets. In some cases, this is handled through the operation of separate business entities (such as Fitzroy River Water in Rockhampton Regional Council area). By contrast, the water management sector in south-east Queensland (SEQ) is a complex and crowded field, both in the regulatory sense and in terms of the number of entities involved. There, the Queensland Water Commission (QWC) was established under the *Water Act 2000* as the independent, statutory authority responsible for achieving safe, secure and sustainable water supplies in SEQ. Specifically, the QWC is charged to ensure sustainable water supplies through long term strategies, establishing the regional water grid, water restrictions, managing demand, reforming the water industry and providing advice to government.

The *South East Queensland Water (Restructuring) Act 2007* delivered major reform in the management of water services in SEQ via a two-stage process. The first stage prompted the restructure of the bulk water supply and transport businesses, which were previously owned by 25 different entities serving 17 retail businesses. Phase two involved the establishment of three new retail businesses. The SEQ water grid was also created to provide a network of treatment facilities and two-way pipes to allow water to be transported from areas of surplus to areas of demand. However, water infrastructure was later re-examined by the Queensland Government in 2009, with the responsibilities reallocated under new ownership arrangements. Whereas the ownership and responsibility for water infrastructure had previously rested with local government authorities (city and shire councils), the current situation is now for local government authorities to own the distributor-retailers, whilst the state owns the remaining entities. Hence, three state-owned bulk water authorities are now in operation (SEQWater, LinkWater and the SEQ Water Grid Manager), which interact with the council-owned retail distribution businesses (for example, in the Brisbane region, this is represented by Queensland Urban Utilities).

3.2 Disaster management arrangements

The *Disaster Management Act 2003* (Queensland) forms the legislative basis for disaster management activities and arrangements within all levels of government in Queensland, including:

- establishing disaster management groups for the State, disaster districts and local government areas;
- detailing planning requirements at each level; and
- providing for the conferring of powers on selected individuals and groups.

Queensland’s whole-of-government disaster management arrangements are based upon partnerships between State and Local governments, as well as government-owned corporations, non-government organisations (NGOs), commerce and industry sectors and the local community (DCS 2010). This framework recognizes that effective coordination of planning, services, information and resources at each level of the disaster management arrangements must grow from a collaborative environment. To this end, four principal structures are used to make up the state’s disaster management arrangements (Table 1). These arrangements are flexible and scalable, enabling escalation of support and assistance through the local, district, state and Australian government arrangements required. They are also premised on an all-hazards approach – that is, using the same arrangements to respond to any event, be it a natural or human-made disaster – and are underpinned by the comprehensive approach of prevention, preparedness, response and recovery.

Table 1 Structure and function of key groups within the Queensland disaster management arrangements

Adapted from DCS (2010)

Structure	Function
<i>Disaster management groups</i>	operate at local, district and state levels and are responsible for the planning, organisation, coordination and implementation of all measures to mitigate/prevent, prepare for, respond to and recover from disasters
<i>Coordination centres</i>	operate at local, district and state levels that support disaster management groups in coordinating information, resources, and services necessary for disaster operations
<i>State government functional agencies</i>	Manage and coordinate the responsibilities of the State in relation to disaster management and specific threats
<i>Australian government committees and agencies</i>	provide support to Queensland as required

Within these arrangements, local governments are the focus group for managing disasters within their own communities. State and district groups are created to provide additional resources, support, assistance and expertise as required. Both the local and district level groupings are of greatest relevance to this project, since these represent the basic network of key stakeholders involved in disaster response operations. These include *local disaster management groups* (LDMGs) that are convened to support local government disaster management activities, generally within local government boundaries, with the Mayor or other elected member of Council usually acting as the chairperson.

According to DCS (2010), the functions of a LDMG include:

- to develop, review and assess effective disaster management;
- to assist the local government to prepare a local disaster management plan;
- to ensure the community is aware of ways to mitigate the adverse effects of an event, as well as prepare, respond to and recover from a disaster;
- to identify and coordinate the use of resources for disaster operations; and
- to manage disaster operations under the policies and procedures of the State group.

District and state disaster management groups (DDMGs and SDMG) also operate, which allows for escalation of issues where required.

LDMGs are required to meet (and be quorate) at a minimum of once every six months, with the frequency and location being at the Chair's discretion. The membership of LDMGs is governed by Section 22 of the *Disaster Management Act* (Queensland) and is comprised of:

- the Chair (the Mayor or councillor);
- the Deputy Chair;
- the Local Disaster Coordinator (a delegated local government staff member);
- representatives of the various functional areas of local government;
- local representatives of the police and emergency services;
- a regional representative from Emergency Management Queensland (EMQ) (membership role, not coordination of response);
- local industry and community representatives as applicable; and
- other members as deemed applicable (DCS 2011).

Membership can include both 'core' organisations as well as 'advisory' members; the former undertake decision-making whereas the latter are generally limited to rights of audience and debate.

3.3 Responding to flooding

Natural disasters are a regular occurrence in Australia, and in Queensland, floods, severe storms and cyclones have been identified by Gentle *et al.* (2001) as the most common, as well as the most expensive, natural disaster events, costing on average more than \$AU238 million of insured losses alone. There have already been several pieces of research that have examined flood events with reference to climate change adaptation. Most notably, Apan *et al.* (2010) have developed an extensive literature review covering aspects of flood management in Australia, including social and economic impacts, relevant legislation and planning instruments, and issues of disaster preparedness, resilience, vulnerability and adaptation. Given that this work was funded by the NCCARF, and used to frame a study of the 2008 Queensland floods, there is considerable overlap between Apan's *et al.* coverage and that required for this study. Rather than duplicate this work, readers are directed to Apan *et al.* (2010), with only new material (i.e. that relevant to the 2010 floods, rather than the 2008 event) being considered below.

3.3.1 The 2010-11 major flooding in Queensland

In the summer of 2010-11, a combination of floods and cyclones affected Queensland. The flooding in December and January, followed by the crossing of Cyclone Yasi in February, is estimated to have affected 70% of Queensland and around 60% of the state population (PWC 2011). Several lives were lost, and there were large personal

and social impacts in many communities, although few studies have documented the latter. In the aftermath of the floods, there was remarkable and unprecedented community engagement whereby thousands of public volunteers undertook a range of tasks to assist communities across the State to return to normal patterns of life as quickly as possible (QDC 2011). This large volunteer workforce significantly eased the financial burden of the floods and cyclone. Nevertheless, significant impacts to both civic and commercial infrastructure and housing occurred, including damage to roads, damage and to more than 50,000 homes and other infrastructure across the State, major interruptions to coal production and exports, and losses in agricultural production (Rolfe *et al.* 2012). In economic terms, these natural disasters reduced Queensland's 2010-11 Gross State Product by around 2.25%, or \$6 billion (Queensland Government 2011).

3.3.2 The Queensland Floods Commission of Inquiry and regulatory amendments

The Queensland Floods Commission of Inquiry was established under terms of reference that identified seven matters for examination, arising out of the 2010/11 floods:

- preparation and planning for the floods by governments, agencies and the community;
- the adequacy of the response to the floods;
- management of essential services;
- the adequacy of forecasts and early warning systems;
- insurers' performance of their responsibilities;
- the operation of dams; and
- land use planning to minimise flood impacts (QFCoI 2011).

An interim report was released in 2011, followed by the final report in March 2012, with detailed recommendations under some 17 different areas of flood management and response.

On 28 October 2011, the *Disaster Readiness Amendment Act 2011 (Queensland)* received Royal Assent by the Queensland parliament. This Act implemented Queensland's legislative response to the Queensland Floods Commission of Inquiry Interim Report and brings into effect other improvements to the disaster management framework to improve the state's disaster preparedness. For example, amongst the changes in this Act is the recognition that the ultimate decision for responding to supply levels of dams in South East Queensland is one for the accountable Minister, who will seek advice of the chief executive of the dam operator, as well as consider meteorological forecasts and the public interest. The chief executive, in turn, must consult with other relevant entities (such as SEQWater and the Water Grid Manager) regarding the potential impacts of any alteration of dam levels. The *Water Act 2000* and the *South East Queensland Water (Restructuring) Act 2007* have also been amended.

Given the scale and breadth of effects that the major flood events had on the people and businesses of Queensland – most notably, the deaths that occurred within the south-east Queensland region – the activities and findings of the Commission came under intense scrutiny during 2011 and 2012, which coincided with the primary data collection for this research. This included a period when the Commission was required to re-convene to make further examinations about the operations of dam infrastructure, particularly with respect to the release of waters from key facilities in the south-east corner.

3.4 Project framing

Given the scale of flooding that occurred across the state, including the multiple locations and multiple organisations that were involved in the response and recovery phases, the 2010-11 Queensland floods provided an excellent opportunity to conduct a case study of network governance, for possible application of informing better climate change adaptation behavior and policy in the future. Other key reasons for the study included:

- regional climate change predictions, which suggest that a greater incidence of severe events can be expected across Queensland in future years; and
- population growth pressures in many Queensland centres, and the flow-on impacts of these on urban and peri-urban development, land-use planning, and the management of community needs during and after a disaster event.

It is very important to note that it was **not** the intent for this research project to collect information about an **individual** organisation's effectiveness or performance with regard to any of seven elements covered by the Commission of Inquiry. Rather, this study was focused on understanding the types of inter-organisational collaboration, communication and information flows that occurred within the *overall social networks* at each of the study locations, and where possible, to use the research results to develop suggestions for how network governance arrangements and policy might be improved.

4 METHODOLOGY

4.1 Selection of case study sites

The selection of case study sites (Figure 1) was designed to allow social networks to be compared across a range of different geographical; functional; and governance, institutional and regulatory contexts. To achieve this, the organisational collaboration and communication that occurred in response to extreme flooding events were studied in:

- the regional service centre of Rockhampton (central Queensland), which typically has ample warning (> week) of impending flood heights, but is a concentrated population area and is also a strategic transport hub for the state;
- the rural community of Emerald (also in Central Queensland), where river heights typically rise rapidly (hours, days) and residents are more dispersed; and
- the highly urbanized centre of Brisbane (in south-east Queensland), where there is typically a focus on municipal supply pressures, compared with flood-related flows, with the results that adaptation issues are typically of much longer standing (e.g. months and years). Whilst the focus of the original research was the broader south-east Queensland (SEQ) region, it was decided to limit the case study to the Brisbane local government area, given the substantial number of water entities and other utilities relevant to the research, as well as the large geographical and population size of SEQ.

The comparison in table 2 below highlights the key differences between these case study locations. The spread of case study locations provided for analysis of rural, regional and urban settings; as well as examples where adaptation involves a range of different entities (for example, local, state and federal government; commercial entities (business and industry), community and not-for-profit groups). Being the state capital, Brisbane provided a good contrast to the rural and regional settings of Emerald and Rockhampton, due to difference in factors such as planning frameworks, governance, and regulations.

The study also took the approach of comparing the social networks of the 'flood period', contrasted with 'routine water management operations'. The respondents defined both information and resource flows with other network organisations (that is, practical ties), as well as ease or difficulty of collaboration (that is, cognitive ties).

Table 2 Key features of the case study locations in Queensland

Township	Local Government Area	Nature of locality
Rockhampton	Rockhampton Regional Council	Urban regional
Emerald	Central Highlands Regional Council	Rural regional
Brisbane	Brisbane City Council	Urban metropolitan

The composition of the LDMG in each of the three case study locations for this research is summarized in Table 3. The membership of LDMGs varies with location, but there is strong representation by local and state government, which reflects the legislative requirements of the group. It is of note that participation by Commonwealth departments is not explicit in the legislation.

Table 3 Summary statistics of Local Disaster Management Group membership at the organisational level in Brisbane, Emerald and Rockhampton

	Brisbane LDMG[^]	Rockhampton LMDG^{^#}	Emerald LDMG^{^*}
Chair	Lord Mayor/ Senior BCC staff member	Mayor of Rockhampton RC	Mayor of Central Highlands RC
Approximate number of member organisations	18	13	17
Organisations with right of audience/support members/associate members	8	21	4

[^] Determining the exact membership of LDMGs is a difficult task, as some organisations may send multiple representatives. Membership is also changeable, and lists are often kept confidential.

[#] As at June 2012;

^{*} As at December 2011.

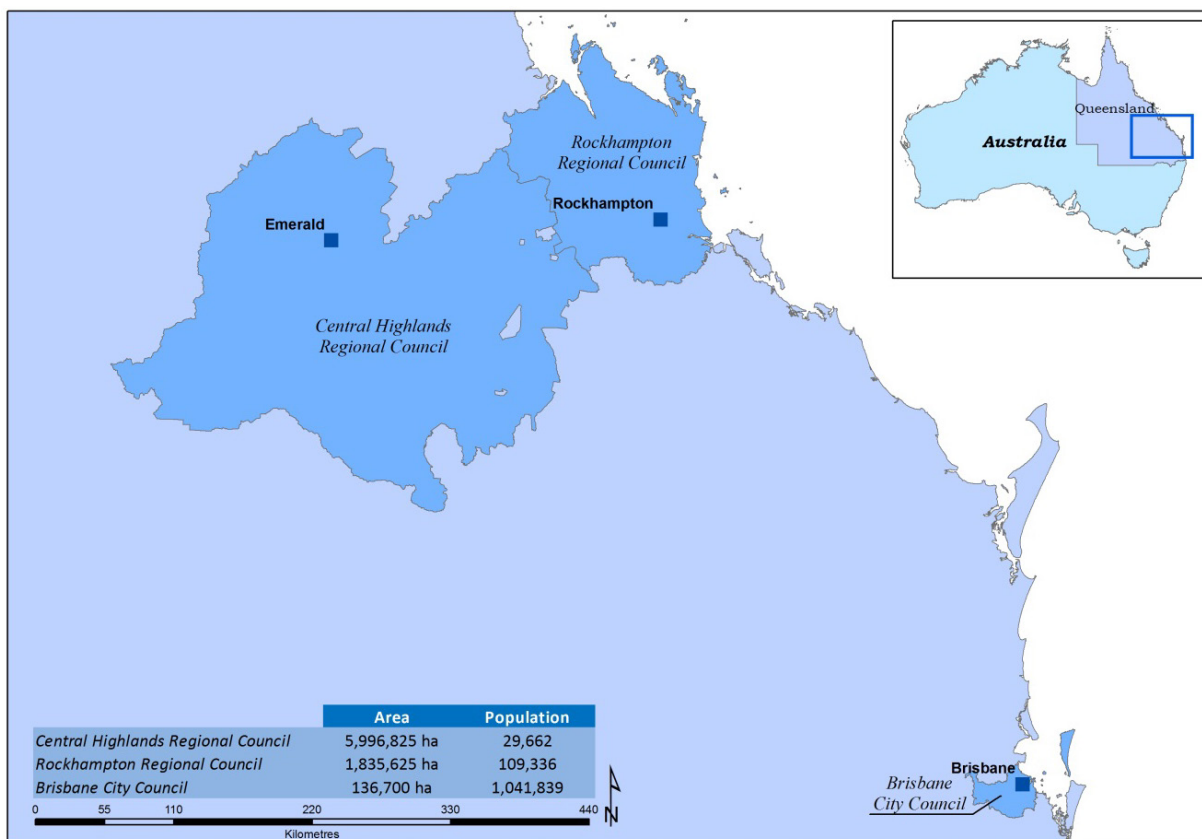


Figure 1 Location of case study sites (Rockhampton, Emerald and Brisbane local government areas) in Queensland, Australia¹

¹ Population and area statistics are for local government (statistical level three) boundaries and the Australian Bureau of Statistics' Quikstats, Estimated Resident Population as at 30 June 2011

4.1.1 Rockhampton

The Rockhampton region experiences one of the most variable climates in Australia, a typically subtropical climate with wet summers accompanied by low winter rainfall. Existing records show that the region has recently experienced an increase in the number of days exceeding 35°C, and a decline in periods where temperatures are below 2°C; combined with a steady decline in total annual rainfall contrasted with increased rainfall intensity (Kinnear *et al.* 2010).

A Central Queensland regional water supply strategy was developed in 2006 to address issues including water supply and demand, water infrastructure, and environmental values, and this includes seven major water supply schemes for bulk users across the mining, industrial, urban and irrigation sectors (DNRW 2006). Within Rockhampton, the town water supply is operated by the local government through a separate business arm, Fitzroy River Water. Fortunately, the township of Rockhampton enjoys a bountiful water supply, with the Fitzroy River being the second-largest exorheic catchment in Australia, and with local government using only around half of the available water allocation. The Fitzroy River Barrage is the offtake point for municipal supplies to the centres of Rockhampton, Mt Morgan and the Capricorn Coast, as well as supplying to industrial users such as the Stanwell Power Station.

Somewhat less fortunately, the Rockhampton community has experienced several major flooding events since records began in 1859, with the most severe events being in 1918, 1954 and 1991 (Table 4). The flooding in 1991 occurred as a result of heavy rain from Cyclone Joy which is estimated to have caused a total of \$300 million worth of damage to the communities between Ingham and Rockhampton (Baddiley 1991). In 1991, road and rail access from the north, south and west to Rockhampton was closed for 21 days and access by air blocked for 12 days. In contrast, the 2011 flood resulted in air and road closures of several weeks, at an estimated total economic cost of approximately \$35 million for the local government area alone (Rolfe *et al.* 2011).

Table 4 Details of previous flood heights in Rockhampton

Adapted from Rolfe *et al.* (2011)

Year	River height at city gauge (meters)	No. days above 8 m
1918	10.11	26
1954	9.4	13
1991*	9.3	13
2011*	9.2	Approximately 18

* The heights of the 1991 and 2011 floods cannot be directly compared to previous levels as the construction of the Fitzroy River barrage in 1970 changed the floodplain characteristics (Baddiley 1991; Department of Main Roads 2009).

4.1.2 Emerald

The town of Emerald in central Queensland is on the Nogoa River which is situated in the Fitzroy catchment. The Emerald region (also known as the Central Highlands) experiences a sub-tropical climate with approximately half of its annual rainfall occurring in the summer months of December through to February. Similar to the region of Rockhampton and the majority of Queensland, climate models predict that more intensive rain will occur during summer periods (QFF 2008).

Being part of the wider Central Queensland, the Central Highlands is also covered by the CQRWSS (as described above). This includes the Nogoa-Mackenzie Water Supply

Scheme operated by SunWater, which largely provides for irrigation users; as well as the municipal supply for Emerald township, managed through the Central Highlands Regional Council. A supply/demand analysis for the Comet-Nogoa-Mackenzie subregion suggests that an annual shortfall of some 4000 megalitres will occur by 2020, with coal mining development and urban growth acknowledged as key pressures on the already fully-allocated supplies in this system (DNRW 2006).

The Emerald community has experienced major flooding since records began in 1950 with three major flood peaks prior to the 2010 flood. Major flooding in Emerald happened in December 2010, with a record peak of 16.05 m on December 31.

The 2010 flood saw thousands of homes impacted from flooding, the Emerald hospital was physically isolated from the rest of the town and a strong presence from the Australian Defence Force was warranted.

4.1.3 Brisbane

The city of Brisbane, located in SEQ, is the state capital of Queensland and has a subtropical climate with temperatures on an annual average of 16 to 25 °C (Queensland Government 2009).

The water management arrangements for the broader south-east Queensland region, including Brisbane, have already been described in Section 3.1. The Wivenhoe and Somerset Dams located in the Brisbane River basin provide urban water supplies, as well as flood mitigation to Brisbane and other areas potentially impacted by flood flows along the Brisbane River. Given its dual-purpose and location above the city of Brisbane, the Wivenhoe Dam has been described as the “at once the most valuable and dangerous piece of public infrastructure in Queensland” (Queensland Floods Commission of Inquiry 2011). The timing of the 2011 floods occurred just after a prolonged SEQ drought highlighted ongoing conflicts of interest regarding water releases (i.e. retain water for storage, versus release to preserve space for flood mitigation purposes).

Little accurate information is available for floods that occurred early in the settlement of the Brisbane area, and this is complicated by the changes in the river that have occurred in the years since European settlement, such as river widening and dredging, and the construction of Somerset and Wivenhoe Dams (Babister and Retallick 2011). Nevertheless, significant flood events occurred in Brisbane in 1893, 1898, 1974 and more recently, 2011 (Table 5).

Table 5 River heights of significant flood events in Brisbane

Adapted from Babister and Retallick (2011)

Year	River height in Brisbane city (m)
1893 (5 February)	8.35
1893 (19 February)	8.09
1898	5.02
1974	5.45
2011	4.46

4.2 Participants and procedure

This research project adopted a network governance perspective, through studying organisational network ties relating to collaboration and communication among key organisations. A central aim was to examine the possible impacts of geographic, functional, governance, institutional and regulatory frameworks on the social networks occurring at each of the case study locations. Thus, research data were obtained from one or more representatives of each identified organisation, department, company, group or other entity. It is important to note that participants were responding on behalf of their organisation, and not personally. The research was conducted with a diverse range of organisations from both the disaster management sector and water management sector. In some instances, where the organisation was large and responsible for a variety of roles, more than one representative per organisation was interviewed; where possible, the research team sought to access the senior staff of target organisations for participation.

The research team collected primary data through a semi-structured telephone survey, which was conducted March – September 2012. The target organisations were selected using a strategic analysis of the key stakeholders involved in the water and disaster management sectors for each case study site. This included members or affiliate members of the relevant LDMGs, as well as a diverse range of organisations known or expected to have played a substantive role in the flood response and recovery. Research staff liaised with councils, key agency staff and LDMGs to ensure the appropriate organisations were identified. Institutions were also identified through the research teams' professional networks and "snowballing technique" where interviewees nominated other potential participants through their own experience and knowledge (Polkinghorne 2005). Where possible, organisational representatives from each of these were then interviewed to obtain information about major organisational collaborations, with each organisation treated as an actor. Data collection focused on key informants purposefully selected from the key categories of federal, state and local government; commerce and industry; and community organisations.

Initial contact with potential interviewees was made by telephone or email. Information regarding the purpose and scope of the research, including assurance of anonymity, was provided to participants in a project information sheet prior to the interviews. All research activities were carried out under ethical clearance from the CQUniversity Human Research Ethics Committee (certificate #H12/02-021)².

Leading up to, and during much of the data collection period, many water and disaster management entities were subject to participation in the Queensland Floods Commission of Inquiry, established to examine the 2010/2011 flood disaster (refer Section 3.3). After consultation with the CQUniversity Human Research Ethics Committee, to protect participants and their organisations from any potential legal or employment issues resulting from the inquiry, the following phrase was included in the project information sheet:

"There may be important legal or employment issues that need to be considered by you, or your organisation, before participating in this research. We suggest that you send this information sheet to an appropriately authorised person within your organisation to discuss and approve your participation, before you schedule an interview time with us. If any questions arise during this

² This included reciprocal coverage by the Griffith University Human Research Ethics Committee (GU Ref No: ENV/26/12/HREC); and the University of Melbourne Ethics Committee (ID 1237973.1).

process, or you would like a project representative to talk with, please contact a research team member using the information above.”

Before beginning the survey, participants were required to confirm that they were prepared to answer the survey on behalf of their organisation, and where necessary had sought advice on participation with their management. Interviewers recorded the participants' responses to each question as they worked through the interviews. The individual interviews typically took 30 to 60 minutes to complete, although some participants generously gave more than one hour to complete their responses.

During the interview process, if any new actors were identified as major collaborators by several others, an interview was also sought with a representative from that organisation. Organisations with few (less than four) nominations were not interviewed. In this way, the core region of the network of collaborations could be identified, and for the most part, only organisations from the core were interviewed. However, some core organisations were not available for interview; and several non-core organisations were later identified in the dataset.

In approaching this study, the research team acknowledges that the use of the survey technique – including the recruitment of individuals to speak on behalf of their organisation – has some constraints. For example, responses may be confounded by subjectivity or worldviews on the participant's behalf; rather than being a true record of the 'organisational reality'. This difficulty is faced in many social surveying models, and the possibility of this influence was handled through this study by the use of senior officers as respondents where ever possible, as well as clear directions to respondents about providing data on their organisation's behalf. Nevertheless, careful interpretation needs to be made of the data and the conclusions that can be drawn from it.

4.3 Interview schedule

An interview schedule, specific to the needs of this project, was developed to collect both quantitative and qualitative data. This consisted of a combination of questions with Likert scale, tick box, and open-ended qualitative responses. Respondents were required to provide information on their organisations' policies, roles, responsibilities and relationships relating to both day-to-day operations and flood event disaster management. In addition, participants were asked about how their organisation shared and accessed data and information, and/or collaborated with other organisations in the water management and/or disaster management sectors. To obtain information about key collaborative ties, respondents were asked to nominate the organisations that were essential to collaborate with, both in routine operations and in flood events. For each entity listed, participants were then asked to respond to a series of statements, on a five point scale from "strongly agree" to "strongly disagree", about the nature of the relationships between these entities (e.g. sharing of information and resources, levels of trust, and ease of collaboration).

The open-ended qualitative questions provided enough consistency across interviews for points of comparison, while still being able to elicit in-depth responses. Participants were asked to identify any gaps in information or collaboration that were a problem for their organisation and/or network of collaboration in previous flood events. They were also asked about how they would collaborate in the future, and with whom, and to suggest ways that the network of collaboration in their location could be improved to better manage flooding events in the future. In addition, respondents were required to list the characteristics that make organisations effective to collaborate with, and difficult to collaborate with, during a flood event. The interview schedule was reviewed and

refined by colleagues experienced in the fields of water management and research design before use. A copy of the instrument is provided in Appendix A.

4.4 Data analyses

The research data were analysed using two main approaches: social network analysis, used with the network data provided in response to survey questions 2, 6, 8, 9, 10, 17, 18, and 20 (see Appendix A); and broader thematic analysis, which was used to collate and examine the remaining information, as captured by the open-ended and (Likert) scale responses given by participants.

4.4.1 Social network analyses

The network analysis was conducted using UCINET 6 for Windows, and focused on:

- examining the network of collaboration and communication to identify the organisations that were essential to the network, both during routine times as well as during a flood;
- determining how network structure changes from routine to flood operations;
- exploring the level of reciprocity in the network by investigating the extent to which organisations agree they collaborate and provide information and resources; and
- evaluating if ease of collaboration was correlated with trust.

Initial data processing involved defining the boundaries of each network. The factors that separated the surveyed organisations from each other were their primary function and geographic location. Function was a defining factor between organisations based in Brisbane and those based in Rockhampton and Emerald (as targeted by the sampling methods), with the majority of organisations surveyed in Brisbane being water-based entities, whereas those based on Rockhampton and Emerald were typically involved with disaster preparedness, response and recovery. Geographic location was also a clear distinction between the organisations participating in the study, although, as it turned out, a distinction between Emerald and Rockhampton was not as clear (see results in Section 5.2). The research team obtained more than one respondent for several organisations with multiple roles. Their responses were aggregated, so that each organisation was treated as one unit. In aggregating, the most extreme values/cases were taken for all variables; for example, if one respondent said their organisation was involved with rainfall monitoring whilst another did not, it was recorded the organisation was involved in rainfall monitoring. With trust and ease of collaboration variables, the aggregated responses taken were the minimum level of trust and ease of collaboration, with the reasoning that this could check levels of distrust and collaborative difficulty.

4.4.2 Qualitative analyses and identifying cultural themes

The data from the open ended qualitative questions were analysed using thematic analysis, a method for identifying, analysing and reporting patterns and themes within data (Braun and Clark 2006). For the first phase of the qualitative analysis, a deductive or top-down approach was applied, where the data were systematically coded into key themes that linked to participants' responses to the qualitative open ended questions. These themes and the key issues that comprise them are discussed in more detail in Section 5.7. The data were then further refined into a set of cultural values by applying a discourse analysis. Using this method, the research team identified the values expressed by respondents. This involved identifying a particular value set; preparing a definition for it; and identifying the trigger words or phrases that appeared in participant's responses (thus confirming that an organisation 'expressed that value').

The team then re-examined each survey and coded it according to the number and type of values that were expressed. Through this process, it was possible to map the cultural values for each participating organisation, as well as to group these by organisation type and location (region). Data were normalised for sample size to correct for unequal numbers of participants across organisational type and region. The first-stage analyses treated all surveys separately rather than blending the results when two or more people answered for the same organisation; rather, these are treated as 'replicates', because the thematic analysis was by sector/location, not necessarily by organisation. Bubble charts were developed that show the strength of values for particular regions, types of organisations, and sectors.

4.5 Stakeholder workshops

The stakeholder workshops provided an opportunity for the project results to date to be relayed to local government, disaster management co-ordination groups and water management entities; as well as an avenue for further data collection. At each of the two workshops, the SNA results and broader (thematic) analyses provided a basis for active discussions with the participants. During the workshop activities, outlined below, research participants were asked to reflect on how newly developed information strategies and collaborative activities might shape their actual adaptive responses. Participants were also asked to undertake two specific workshop activities, as described below.

4.5.1 Activity 1: Nominating the LDMG membership base

The purpose of this activity was to ascertain from participants what the 'ideal' membership of the LDMG might look like. The intention was to encourage participants to consider how the research results may change their perceptions of collaboration within the LDMG environment. A card game was played at both the CQ and Brisbane workshop events. Participants were supplied with a numbered list of key organisations across five sectors (as described in Table 6). Organisations appearing on each list were identified from the network data collected during the survey phase. Initially, 130 organisations were identified from the CQ surveys and 47 from Brisbane; these totals were considered too large for workshop participants to work with, given the allocated time. Separate lists were therefore refined for each region by (a) including only those organisations who received more than four network ties³ and (b) collapsing organisations with similar roles into broad categories, such as electricity providers and multicultural groups. The participants were then given a deck of 40 blank cards, and asked to select from the list those organisations who they believed should have LDMG membership, and write the name (or number) of each organisation on a separate card. Participants were free to determine the overall size of the membership (i.e. as if the legal requirements did not exist). Participants were also allowed to incorporate 'wild cards' (organisations other than those provided in the list).

³ Here, it is important to note that organisations with less than four ties could be still included, through the use of 'wild cards'.

Table 6 Summary description of key stakeholder lists provided to participants

	Brisbane	Central Queensland
Federal Government	3	3
State Government	15	14
State Government (water)	7	na
Local Government	5	6
Community and Industry	5	na*
Commerce and Industry	na [#]	2
Community Development	na [#]	9
TOTAL	35	34

[#] In Brisbane, 'Community and Industry' includes both 'Commerce and Industry' and 'Community Development';

* In Central Queensland, 'Community and Industry' was disaggregated into two categories, 'Commerce and Industry' and 'Community Development.'

Participants were then asked to deal the cards into two piles: those organisations who should 'definitely be' a member, and those who might 'possibly be' a member; with no limit on the number of cards or types of organisations in the piles. An asterisk was used to indicate the organisation that should be responsible for chairing the group, and the sorted piles were labelled by the participant's organisation. Approximately 10 to 15 minutes was allocated for the task. During the activity, participants were asked to disregard the existing legislative requirements for LDMG membership is, but focus on their own LDMG experience as well as the research findings were to date. Some organisations were represented by more than one participant; if so, multiple responses were condensed so there was only one list of nominations per organisation.

4.5.2 Activity 2: Defining an effective disaster response

For this activity, participants were asked the question: "we will know that a flood has been responded to effectively when ...?" and asked to formulate responses by working with others at their table. The purpose of this activity was to enable participants to define what the 'application' or 'end result' of an effective network structure might be, and in doing so, identify a shared purpose. Group discussion was allowed for 5 to 10 minutes, after which each table reported back to the group, with the key themes captured on a whiteboard. For the Brisbane workshop only, where more time was available with the respondents, a second question was also posed: "the LMDG will be working effectively when ...?", with the same methodology being applied as the first question.

5 KEY RESULTS

The results of the study are presented here in order of the social network visualizations and measures for the case study locations, followed by the cultural themes data, which demonstrate the complementarity between the network analysis and the qualitative dataset. Then, the remaining qualitative data are presented, including the supplementary data collected from the workshop exercises.

Please note that Queensland underwent a state election during the course of this research project, which resulted in a change of government, accompanied by restructure and re-naming of many state government portfolios. However, as the research was focused on data relating to 2010/11, given that not all stakeholders were readily able to identify these departments by their new names, this document reports the departments under their pre-2012 titles and structures.

5.1 Stakeholder participation and representation

The survey responses were based on mostly even representation across each of the study locations, as well as across organisational types. A total of 63 organisations participated in the research across the three case study areas. This consisted of 17 organisations in Brisbane, 29 in Rockhampton, 14 in Emerald and three in Central Queensland (defined where participants represented both Rockhampton and Emerald) (Table 7). Of the 85 organisations approached, 21 declined to participate, representing a response rate of 75 per cent. A full list of participating organisations is provided in Appendix B (herein referred to as 'respondents'). Not all nominated organisations were surveyed (herein referred to as 'non-respondents') and different levels of participation occurred between the network and qualitative components (Table 8 and Table 7) due to the following reasons:

- the potential implications arising from the Queensland Floods Commission of Inquiry meant that several respondents from the Brisbane case study were unable to respond to all questions on the interview schedule. These missing data had some impact on the Brisbane network analysis, as it was not possible to capture all of the key collaborative ties; and
- the nature of the network analyses was that of an organisational-level network governance study. This meant it was necessary to condense multiple respondents from the same organisation into one entry, which was not done for the qualitative component.

Table 7 Summary of participating organisations for the provision of qualitative data

Region	Number of approached organisations	Number of organisations interviewed	Declined/unable to participate
Brisbane	21	17	4
Emerald	23	14	9
Rockhampton	39	29	10
CQ	3	3	0
TOTAL	86	63	23

Table 8 Organisational summary for the provision of network data

	Brisbane	Central Queensland
Respondents	17	44
<i>Emerald</i>		14
<i>Rockhampton</i>		27
<i>Central Queensland region[^]</i>		3
Non-respondents	30	86
Total	47	130

[^]Denotes organisations that operated in both the Rockhampton and Emerald case study locations.

Table 9 Organisational characteristics for research participants in Brisbane and Central Queensland

Sector	Brisbane	Central Queensland
Commerce and Industry	1	11
Community Organisations	1	10
Federal Government	2	2
Local Government	3	8
State Government - water	5	-
State Government	5	15
LDMG		
Core member	8	20
Advisory member	6	15
Not a member	2	11
Not sure	1	0

5.1.1 Organisational demographics

When recruiting participants for the study, there were no constraints or targets set in regards to obtaining organisations of a defined size or age (length of operating history). Nevertheless, the respondent organisations showed a diversity of both organisational sizes (including between salaried staff and volunteers) as well as the length of time that organisations had been operating in the community. For example, approximately 43% of the organisations were small to medium-sized, operating with 1 to 50 staff; whereas 30% were large organisations (200+ full time equivalent employees), mostly being represented by large state government departments (Figure 2). Three of the participating organisations had no paid staff, but instead operated entirely through volunteering; and a large proportion of the organisations in this research had no volunteers at all (Figure 2). With regards to operating history, approximately one quarter of respondents indicated that they had been established for 20 years or less, whereas a similar number indicated that they had been in existence for 80 to 100 years or longer (Figure 2).

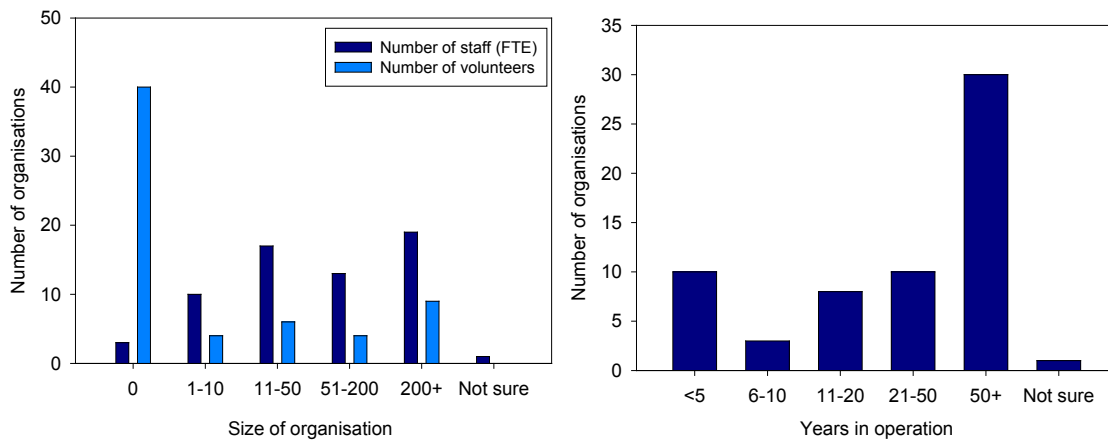


Figure 2 Summary information for the size of respondent organisations, by number of staff and volunteers (left) and the length of operating time for respondent organisations (right). Note: organisations with zero ‘staff’ are run entirely by volunteers.

With respect to functional roles, the organisations included in the study were those involved with both water management and disaster response. The most common functions that were indicated by respondents in the ‘water management’ area were involvement with communication, policy development, water quality monitoring and rainfall monitoring (for water management); whereas those in ‘disaster management’ indicated involvement with communication, emergency response, monitoring, recovery and rescue and support services.

A cluster analysis is a means of grouping a set of data into meaningful classes based on their similarities whilst maximising their differences (Burns and Burns 2008). K-means cluster analyses based on the responses to survey questions 9 and 10 were used to identify distinct clusters, based on respondent’s self-reported activities. An interpretation of these clusters and a list of the organisations for each are shown in Table 10.

Table 10 Respondent organisations grouped by cluster analysis

Clusters were classified by the collection of roles that that comprise each cluster.

Cluster 1: Water and disaster management generalists	Cluster 4: Support for emergency operations
Central Highlands LDMG	Brisbane Transport
Central Highlands Regional Council	Capricorn Enterprise
QLD Health (Brisbane)	Capricornia Correctional Centre
Rockhampton LDMG	Central Highlands Development Corporation
Rockhampton Regional Council	CQ Multicultural Society
SES (Emerald)	Centrelink
	Department of Community Safety
	Department of Transport and Main Roads (Emerald)
	Emerald Chamber of Commerce
	Emergency Management QLD (Brisbane)
	Emergency Management QLD (CQ)
	Ergon
	Hastings Deering
	Maritime Safety QLD
	Origin Energy
	QLD Department of Communities (Emerald)
	QLD Department of Communities (Rockhampton)
	RACQ CQ Rescue Helicopter
	RSPCA
	The Morning Bulletin
Cluster 2: Policy and information providers	
AgForce	
Aurecon	
Bureau of Meteorology (Brisbane)	
Bureau of Meteorology (CQ)	
CQ News	
Dam safety unit	
DERM (Brisbane)	
Fitzroy Basin Association	
Fitzroy River and Coastal Catchments	
SEQ Water Grid Manager	
Cluster 3: Natural resource management	Cluster 5: Planning and delivery of emergency response
DERM (CQ)	Brisbane City Council
Fitzroy River Water	Centacare
Link Water	CQ Indigenous Development
QLD Urban Utilities	DEEDI
SEQ Water	Defence force
Stanwell Power Station	Department of Education Training and Employment
SunWater	Department of Transport and Main Roads (Rockhampton)
	Local Government Association QLD
	QBuild
	QLD Ambulance Service
	QLD Fire and Rescue Services (Brisbane)
	QLD Fire and Rescue Services (CQ)
	QLD Health (CQ)
	QLD Rail
	Red Cross (Brisbane)
	Red Cross (CQ)
	Rockhampton Airport Operations
	Salvation Army
	SES (Rockhampton)
	Yeppoon Coastguard

5.1.2 Organisational policies and practices

Some 88% of respondents indicated that formal communication and/or collaboration policies were in place within their organisation. When asked about aspects of flexibility and/or innovation within the organisation, respondents were more likely to indicate that their organisation was conservative (that is, it ‘relies on pre-existing, proven policies and procedures’); compared with ‘experimental’ (for example, trying new communication technologies) (Figure 3). Approximately 80% of organisations indicated that they were ‘somewhat or very much’ flexible in how they communicated and with whom (Figure 3). This information provides an interesting linkage with the analysis of the cultural values of the respondent organisations (see Section 5.6).

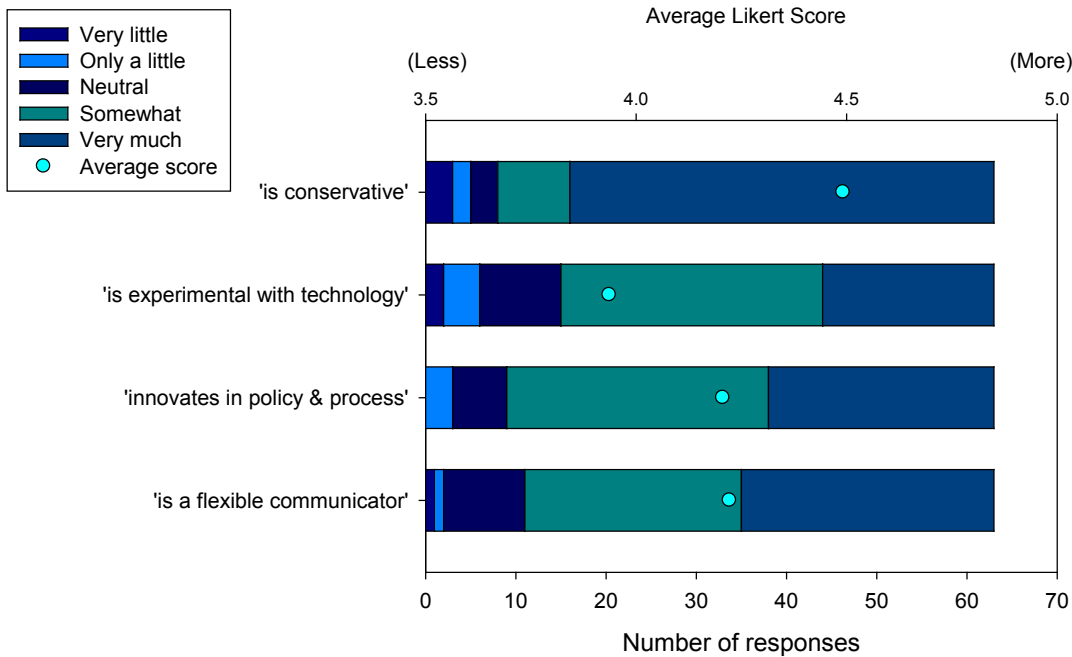


Figure 3 Summary values indicating respondents’ views on flexible and innovative practice within the organisation

Bars show the response to the question ‘Could you please indicate how much your organisation...?’. Horizontal axis labels are in summary format only; please refer to Appendix B for the precise wording of the question.

When asked about the key drivers for collaboration with other organisations, there were generally similar sentiments between routine and flood operations, with most organisations indicating that sharing of information and expertise was a key motivation for working with others, followed by the need to satisfy policy or regulatory compliance (Figure 4). In contrast, access to and/or the sharing of assets (either physical assets or labour) or funding were less likely to be cited as reasons for collaborating.

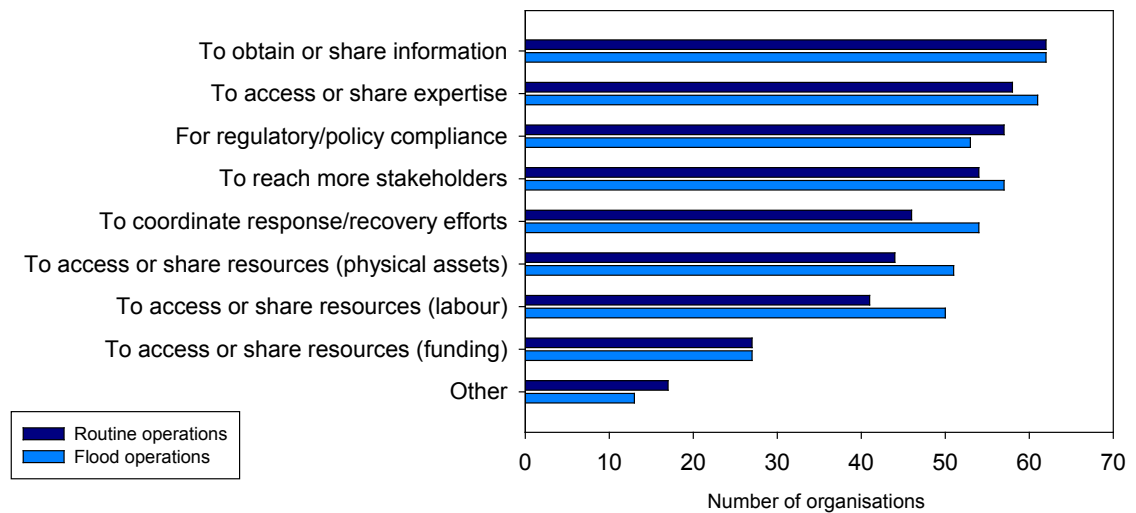


Figure 4 Summary of responses regarding the key drivers for collaboration with other organisations during routine and/or flood management operations

5.2 Social network visualisations

The following sections present two sets of network visualisations for each of the Brisbane and Central Queensland regions, sequenced in the order of:

- the entire network (i.e. including both the respondent and non-respondent organisations), for both the ‘routine’ and ‘flood’ scenarios;
- respondent-only network for information and resource flows; and
- respondent-only network for trust and ease of collaboration.

Summary tables that present information on overall densities, indegree popularity, outdegree activity and between-ness are provided separately in Section 5.3.

On all figures, the organisational attributes are represented by consistent colour and/or shape to identify characteristics such as respondent status, LDMG status or sectoral classification. For the latter, organisations were classified by economic sector to permit public presentation of the data without specifically naming organisations⁴. The three government sector levels were represented as federal, state and local government, as well as groups from the private and voluntary sectors, which were classified as ‘commerce and Industry’ and ‘community organisations’. It should also be noted that four geographic regions were represented by the data (Brisbane, Emerald, Rockhampton and Central Queensland). The Central Queensland (CQ) category was required due to the interconnectedness of the Emerald and Rockhampton regions; several organisations identified their operational area as CQ and could not separate their responses between the two centres. In addition, several Emerald respondents nominated organisations from Rockhampton as their key network partners, and vice versa, thus making it difficult to clearly separate the two collaboration networks, despite a physical separation of some 250 kilometres. The CQ region was therefore composed of organisations based in Rockhampton, Emerald or those that covered the entire CQ area. On all diagrams, the organisation names have been shortened to an abbreviated format; the full names are provided for reference in Appendix C.

⁴ Although ethical clearance provided coverage to enable labelling, in some cases it was considered necessary to provide privacy, given the sensitivities around the Floods Commission of Inquiry.

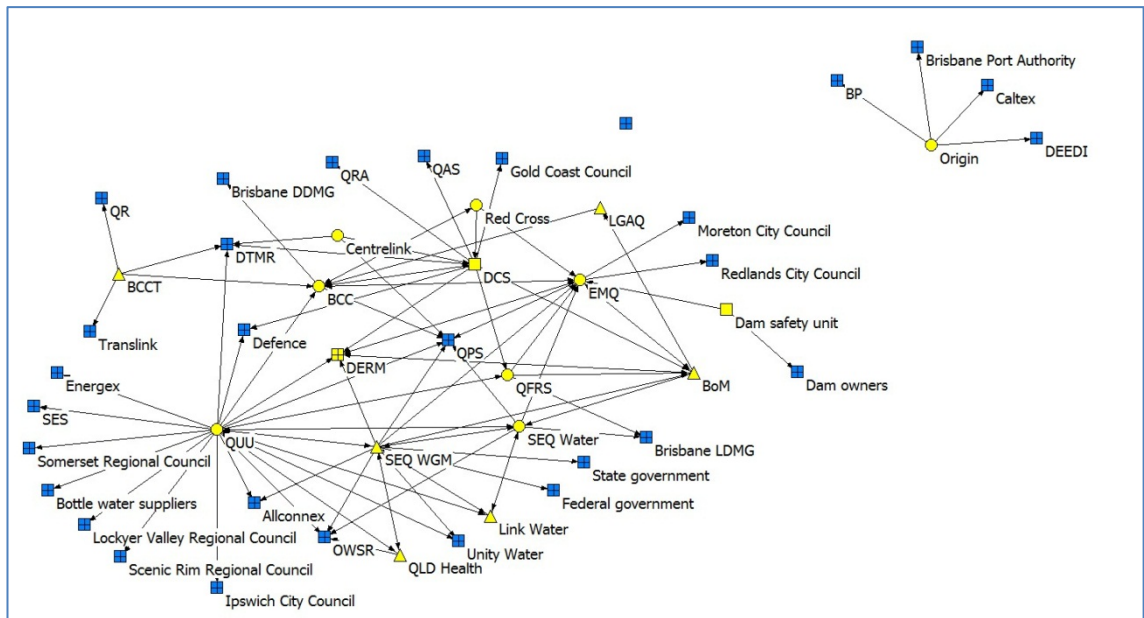
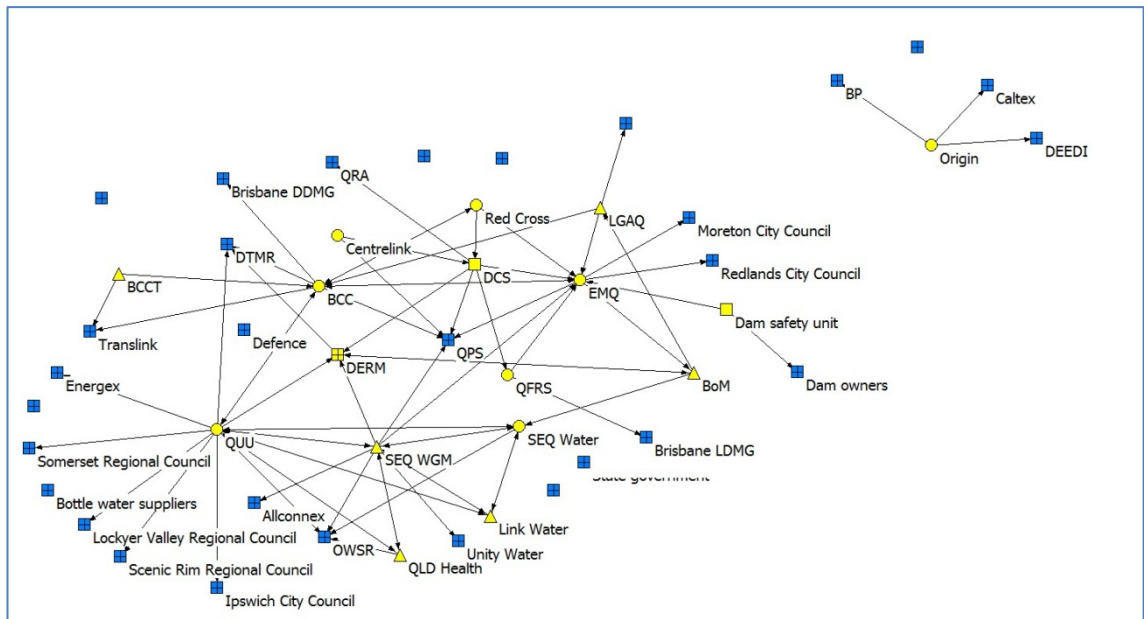
5.2.1 Brisbane

The network visualisations for Brisbane are provided in Figure 5, for both the routine and flood operations. On average, respondents nominated a total of four network partners during routine operations (range 2 to 13), and five network partners during flood operations (range 1 to 20). In general, there was an increase in collaborative activity between routine and flood operations, with most flood ties also being routine ties.

With respect to flows of information, there was a strong tendency for organisations to provide and receive information from collaborating organisations (Figure 6). A similar pattern was also observed in the network for providing and receiving resources (Figure 7), although this was not as strong as for that of information flows. There were also strong tendencies for organisations to provide both resources and information together and to receive resources and information together, to and from collaborating organisations; this indicates a relatively 'close-knit' group in terms of the network. There was also a tendency for the flow of information and resource to be reciprocated (Figure 6 and Figure 7). Whilst this is hardly universal, it does appear that the interviewees were knowledgeable about their organisation's collaborative arrangements (suggesting that they were good choices as informants in the network governance study).

An examination of the difficult and trust ties in the network (Figure 8) indicates that the Brisbane region was a generally high-trust network, and that trust was highly correlated with providing and receiving resources and information.

There was a low level of difficult ties observed in the Brisbane network; however, difficult ties are recorded in almost all networks.



- Colour:**
- = respondent organisation
 - = non-respondent organisation
- Shape:**
- = core LDMG member
 - = advisory LDMG member
 - = LDMG non-member
 - = LDMG membership non-defined

Figure 5 The network of collaboration for Brisbane during routine operations (top) and flood operations (bottom)

Unlabelled nodes represent those organisations that are isolated from other nodes on the network visualisation. Please refer to Appendix C for the full titles of abbreviated organisation names.

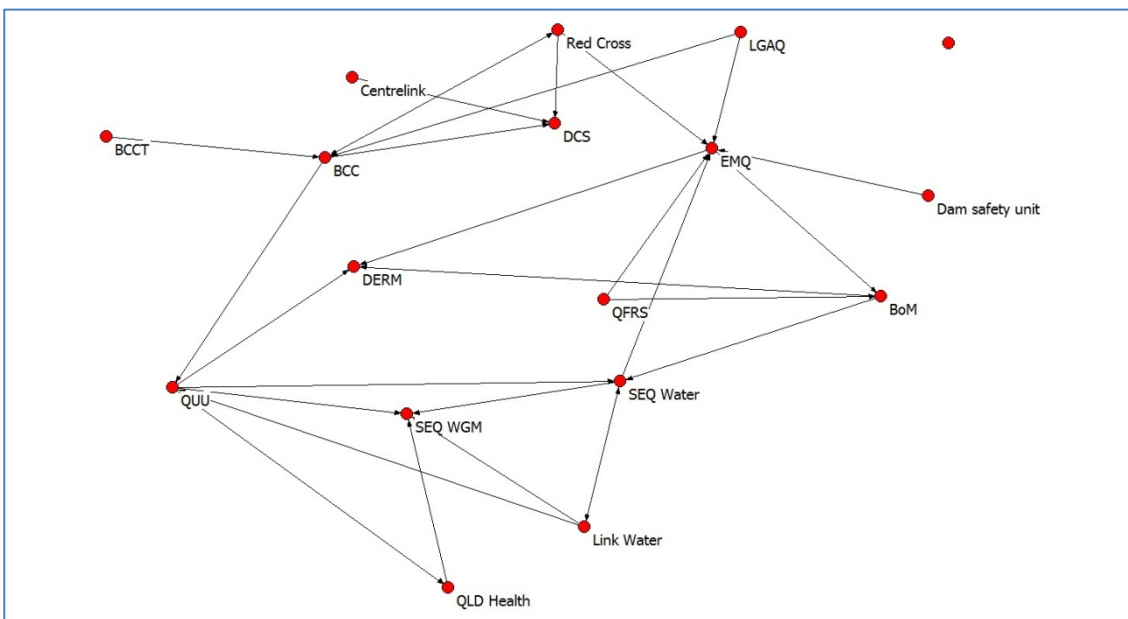
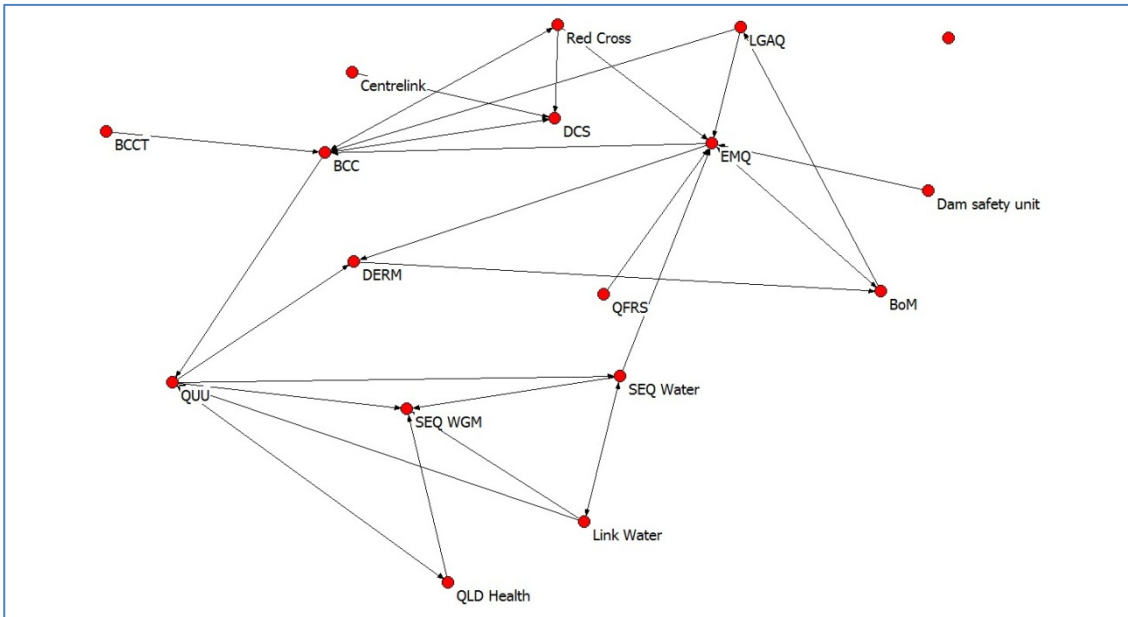


Figure 6 Information flows of respondents only in the Brisbane collaboration network: (top) as reported by ‘sender’ organisations and (bottom) as reported by ‘receiving’ organisations

Unlabelled nodes represent those organisations that are isolated from other nodes on the network visualisation. Please refer to Appendix C for the full titles of abbreviated organisation names.

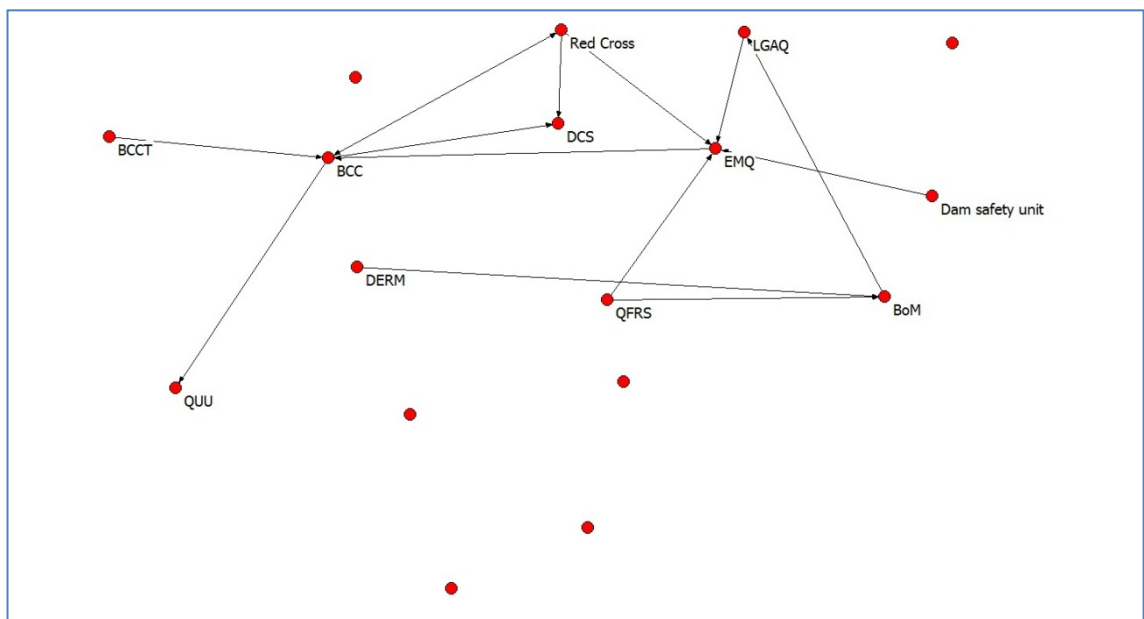
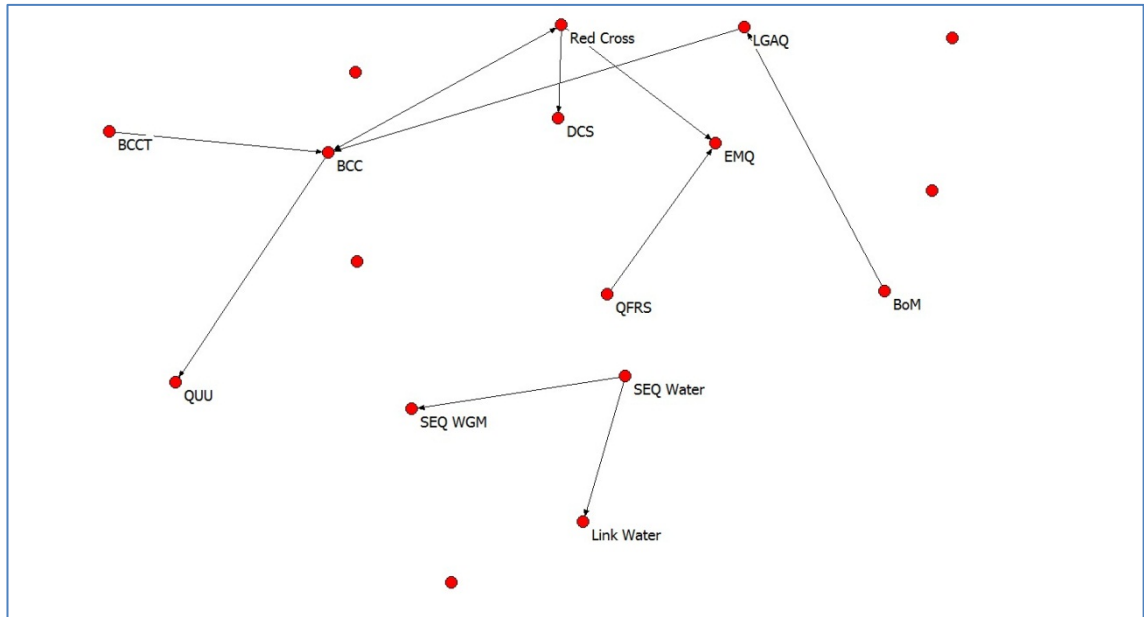


Figure 7 Flow of resources of respondents only in the Brisbane collaboration network: as reported by ‘sender’ organisations (top) and as reported by ‘receiving’ organisations (bottom)

Unlabelled nodes represent those organisations that are isolated from other nodes on the network visualisation. Please refer to Appendix C for the full titles of abbreviated organisation names.

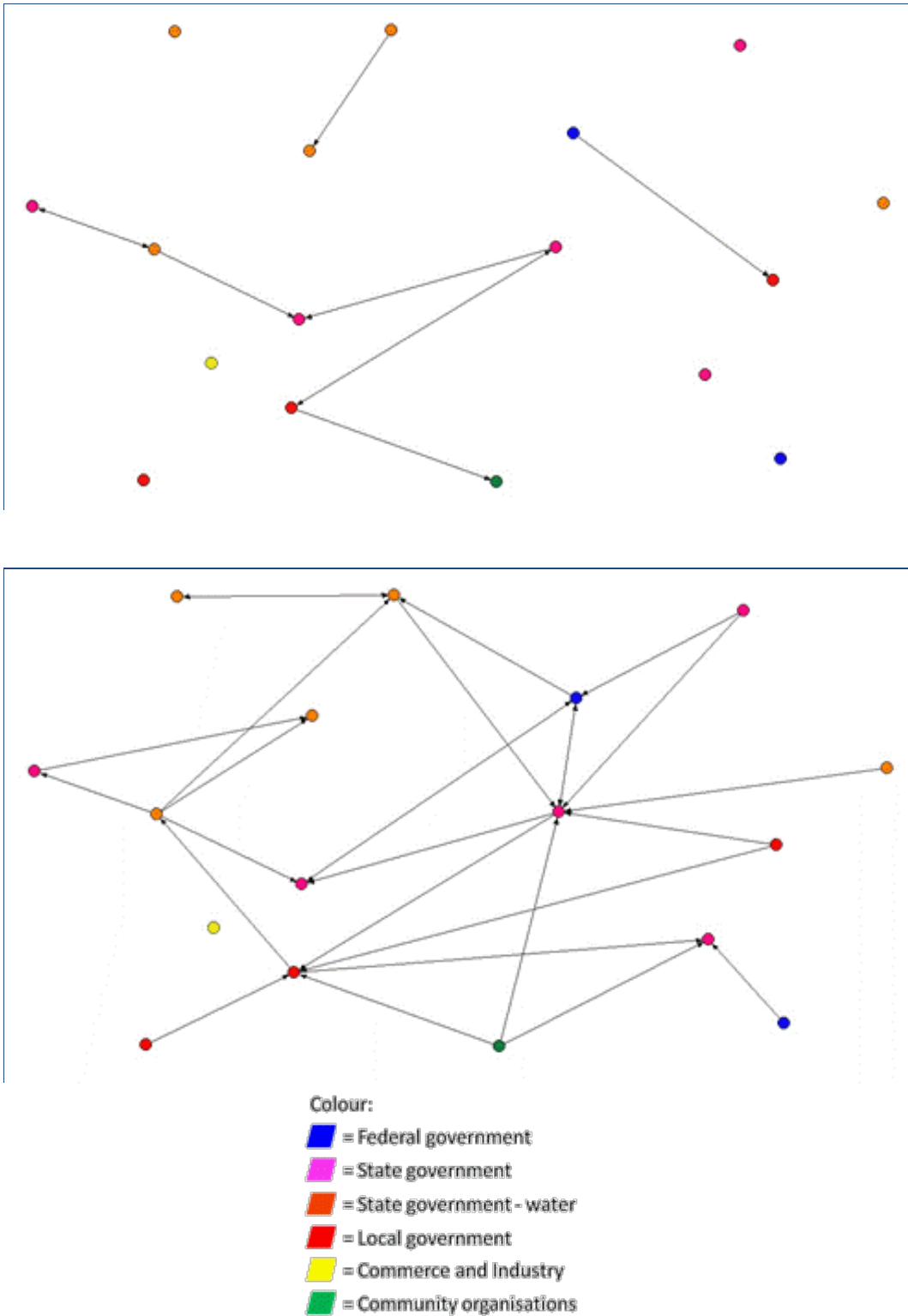


Figure 8 The nature of ties as reported by organisations in the Brisbane network: difficult ties (top) and trust ties (bottom)

Nodes have been left unlabelled due to privacy requirements.

5.2.2 Central Queensland

The network visualisations confirmed that it was appropriate to group the Emerald and Rockhampton organisations into one broader 'Central Queensland' (CQ) network. There was no clear separation between the Emerald and Rockhampton collaboration networks; the networks were so interconnected that it was impossible to identify region-specific systems (Figure 9 and Figure 10).

The respondents from Central Queensland nominated an average of six network partners for routine operations (range 1 to 24), and seven network partners for flood operations (range 1 to 27). These values were similar to those reported for Brisbane (averages 4 and 5, respectively), and again showed the trend for a slightly denser number of ties in the flood network, compared with routine operations. In particular, it appeared that there was a higher level of collaboration between the water/disaster management experts and policy information providers during the flood situation in Central Queensland.

Again in similarity to the Brisbane network, the CQ network was one of high trust, and the trust ties were highly correlated with providing and/or receiving resources and/or information (Figure 11 and Figure 12). A generally low level of difficult ties was observed in the CQ network (Figure 13).

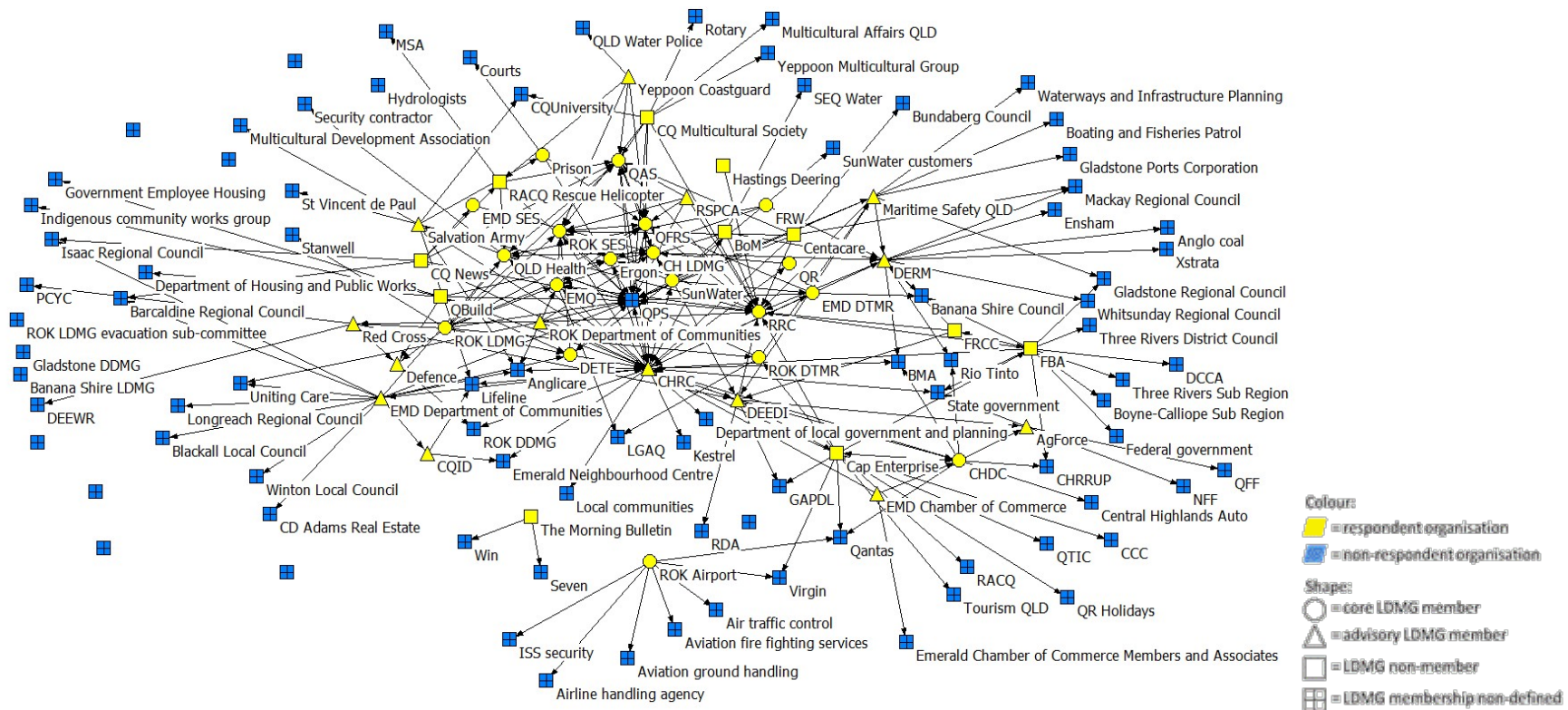


Figure 9 The network of collaboration for Central Queensland during routine operations

Please refer to Appendix C for the full titles of abbreviated organisation names. Unlabelled nodes represent those organisations that are isolated from other nodes on the network visualisation, and are not identified due to privacy requirements.

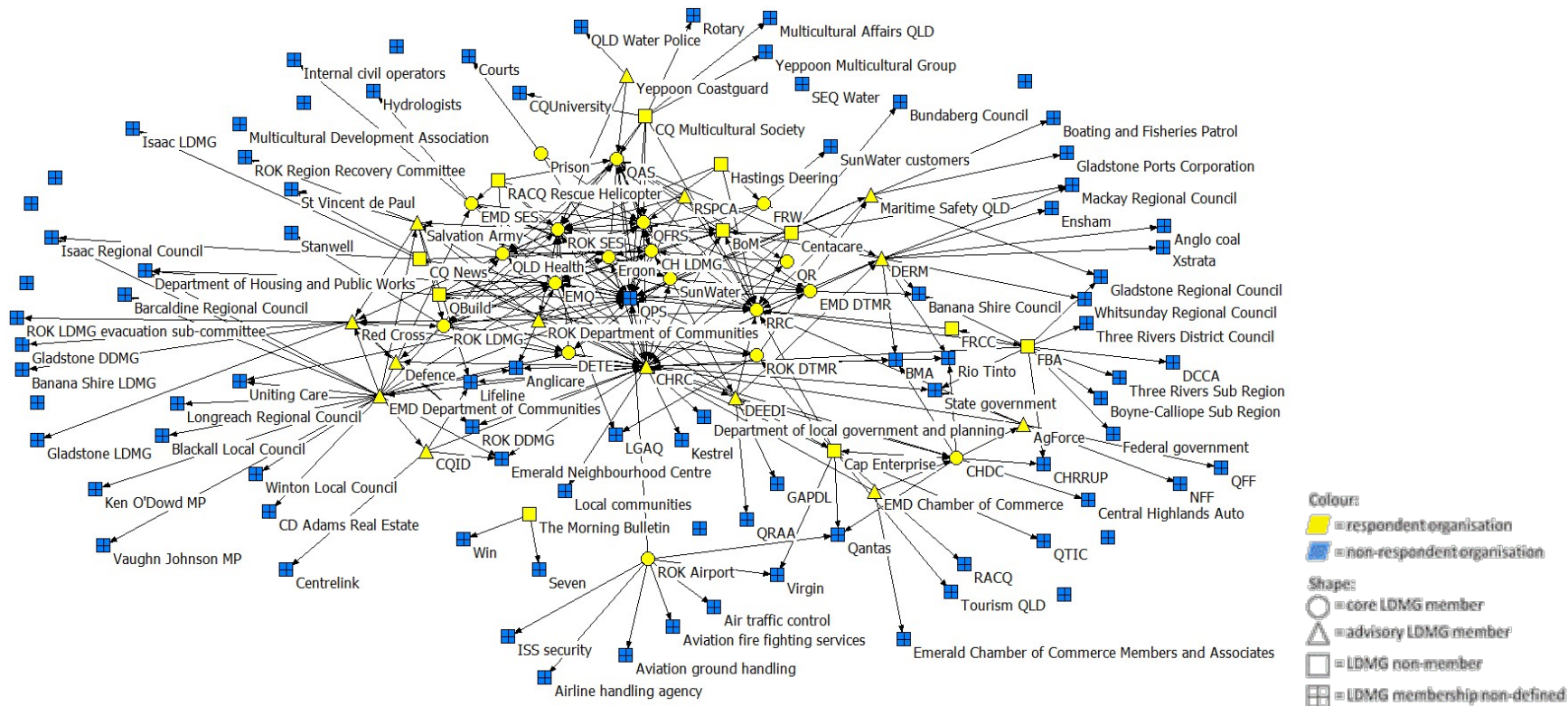


Figure 10 The network of collaboration for Central Queensland during flood operations

Unlabelled nodes represent those organisations that are isolated from other nodes on the network visualisation. Please refer to Appendix C for the full titles of abbreviated organisation names.

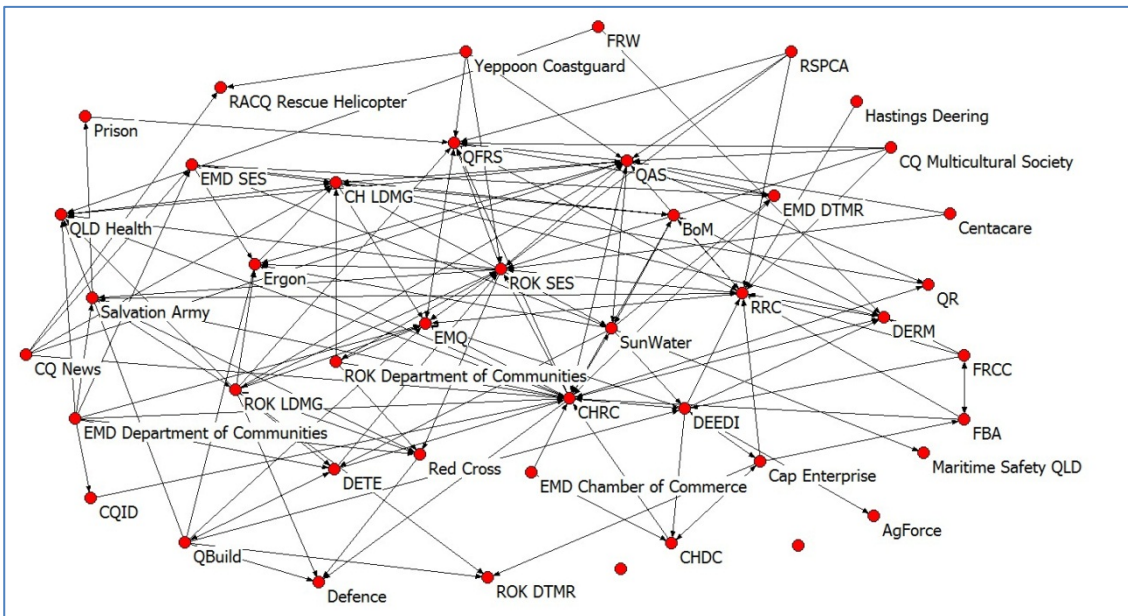
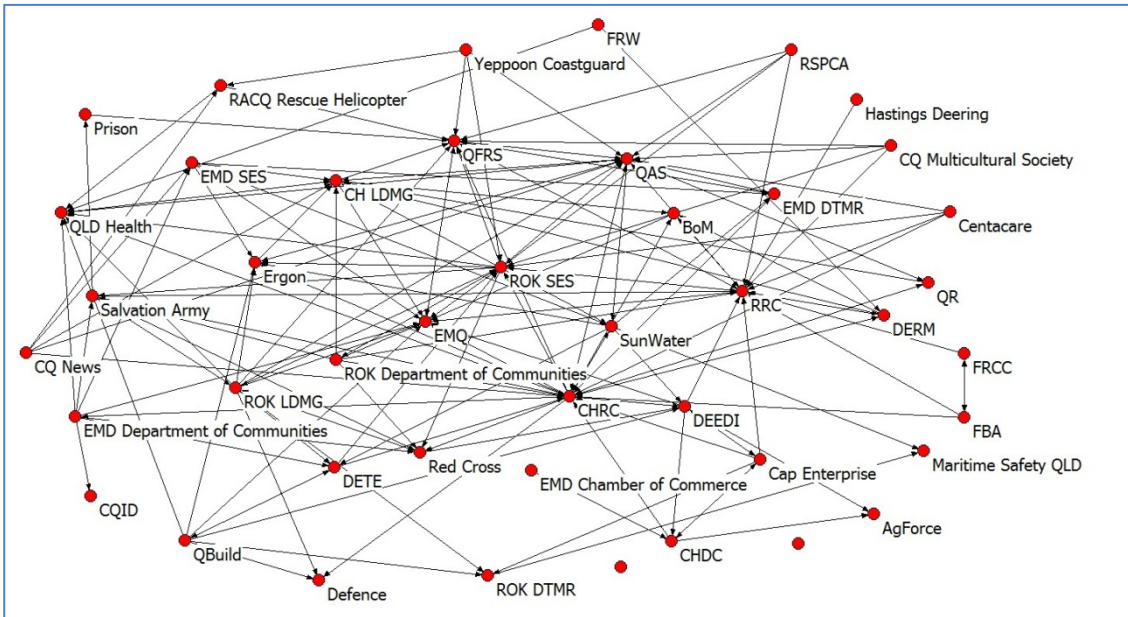


Figure 11 Information flows of respondents only in the Central Queensland collaboration network: as reported by 'sender' organisations (top) and as reported by 'receiving' organisations (bottom)

Unlabelled nodes represent those organisations that are isolated from other nodes on the network visualisation. Please refer to Appendix C for the full titles of abbreviated organisation names.

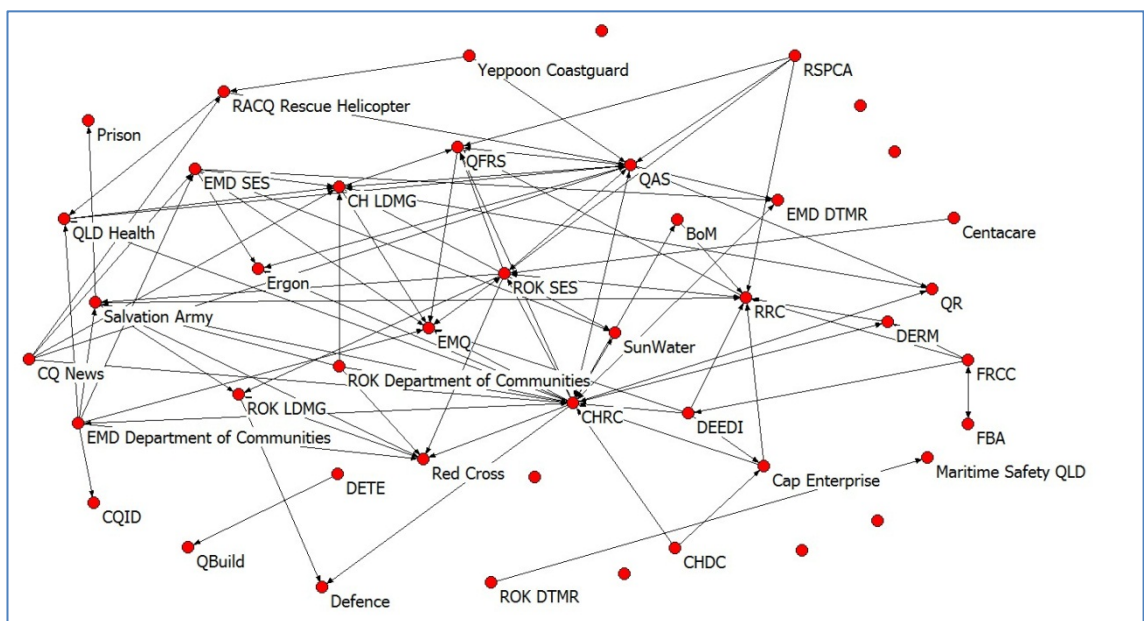
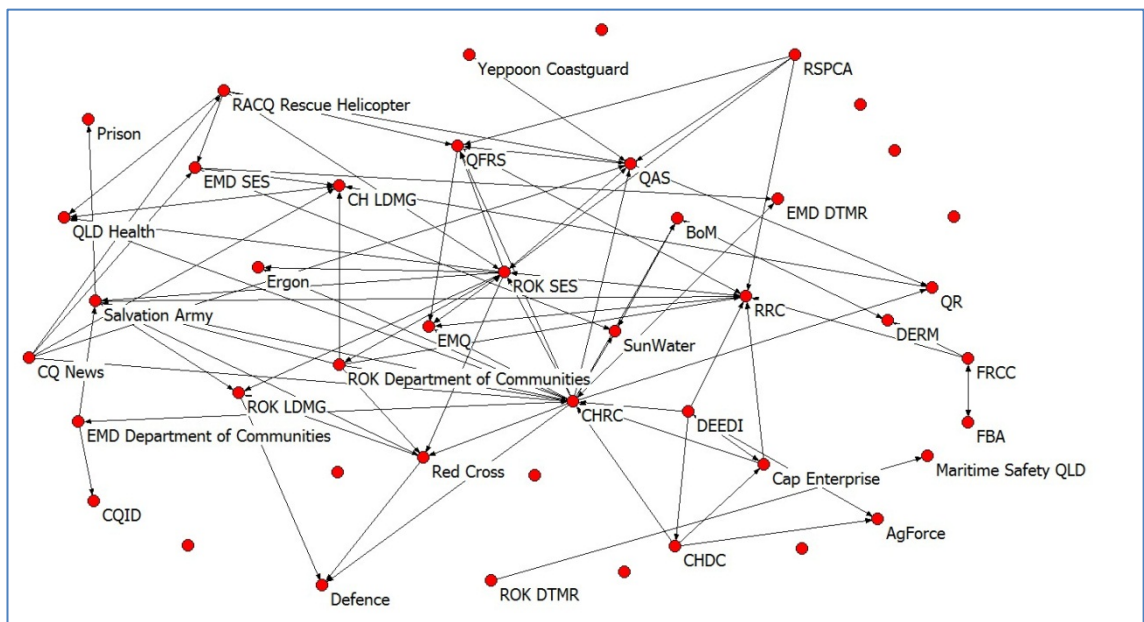


Figure 12 Flow of resources of respondents only in the Central Queensland collaboration network: as reported by ‘sender’ organisations (top) and as reported by ‘receiving’ organisations (bottom)

Please refer to Appendix C for the full titles of abbreviated organisation names. Unlabelled nodes represent those organisations that are isolated from other nodes on the network visualisation, and are not identified to due privacy requirements.

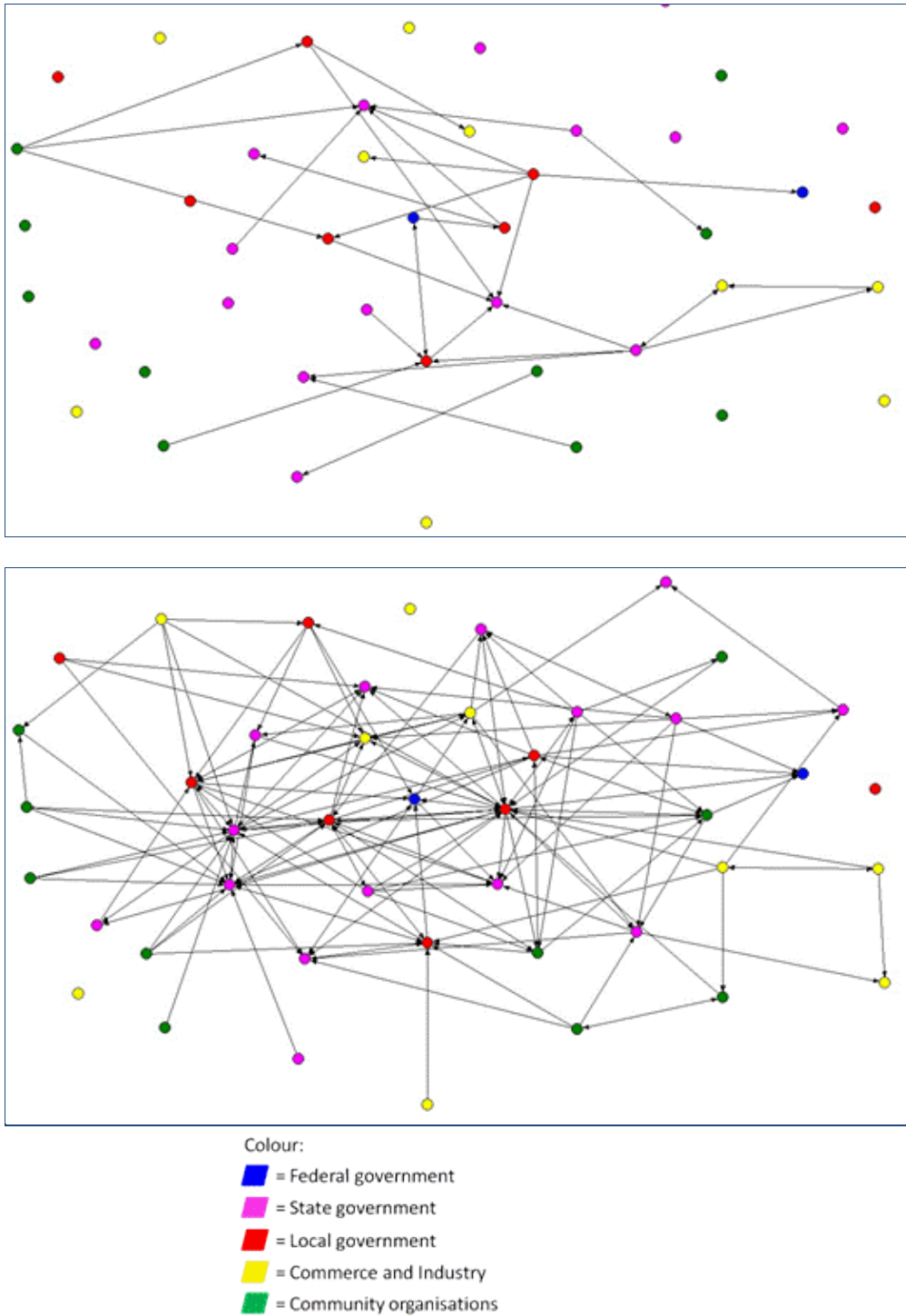


Figure 13 The nature of ties as reported by organisations in the Central Queensland network: difficult ties (top) and trust ties (bottom)

Nodes have been left unlabelled due to privacy requirements.

5.3 Density tables

The density of a network is a proportional measure of the number of reported ties between all actors relative to the number of possible ties. A network with high density indicates that many organisations collaborate with each other, while a low density network indicates few connections exist between organisations. Table 11 describes the densities of the networks presented in the previous section showing higher densities for both networks in flood compared with routine collaboration, a high level of trust ties, and a low level of difficult ties.

Table 11 The density values of the Brisbane and Central Queensland collaboration networks

Network relation	Brisbane network density	CQ network density
Routine collaboration	0.14	0.07
Flood collaboration	0.17	0.09
Provide information	0.10	0.09
Receive information	0.11	0.08
Provide resources	0.05	0.05
Receive resources	0.05	0.05
Trust ties	0.10	0.08
Difficult ties	0.03	0.02

Note: this table is derived for the network of those organizations that responded to the survey. Non-respondent organizations are not included.

5.4 Centrality measures

Centrality measures are used to describe the importance of an actor in the network based on the actor's location and connections with others. Such measures can provide information on the social role that each actor plays in the network and their influence on those around it. The following section describes the centrality measures of the Brisbane and CQ networks, calculated using respondent-only data.

5.4.1 Brisbane

In degree Popularity

The eight most popular Brisbane organisations with respect to flood periods are shown in Table 12. Emergency Management QLD received the greatest number of nominations, followed closely by Brisbane City Council (BCC). Half of the eight organisations are core LDMG members, two are advisory members and two are either not members or unsure of their membership status. The majority of the eight organisations are state government bodies, with the exception of BCC (Local Government) and the Bureau of Meteorology (Federal Government).

The correlation between routine and flood phases for popularity was very high at 0.91, implying that most flood ties are also routine ties. However, the mean indegree during flood times significantly increased from routine operations (mean flood = 0.043, mean routine = 0.033, $t_{(46)} = 3.91$, $p < 0.05$), confirming that there are more ties present during a flood event than there are during regular operations, which are most likely extensions of existing routine ties.

Table 12 The top eight Brisbane organisations in terms of standardized indegree (popularity)^ with respect to flood periods

Organisation	Popularity (flood)	Popularity (routine)
Emergency Management QLD	0.17	0.15
Brisbane City Council	0.13	0.11
Bureau of Meteorology	0.11	0.04
DERM	0.11	0.09
SEQ Water	0.08	0.09
QLD Urban Utilities	0.09	0.11
SEQ Water Grid Manager	0.09	0.09
Department of Community Safety	0.07	0.04

^ Values are standardised with a possible range between 0 and 1 and do therefore not represent the actual number of ties reported in the network.

The Bureau of Meteorology showed the greatest increase in network ties from routine to flood operations; this reflects the importance of the Bureau to other organisations during flood times as they seek both weather and water height data and forecasts, whilst it also highlights the pressures experienced by the Bureau due to increasing demand for services and information during these times.

Outdegree/Activity

The number of nominations reported by an organisation provides an indication of that organisations activity within the network, quantified by the centrality measure 'outdegree'. QLD Urban Utilities listed the greatest number of network partners for both routine and flood periods (Table 13).

Table 13 The top eight Brisbane organisations in terms of standardized outdegree (activity)^ with respect to flood periods

Organisation	Activity (flood)	Activity (routine)
QLD Urban Utilities	0.44	0.28
SEQ Water Grid Manager	0.28	0.22
Department of Community Safety	0.20	0.11
SEQ Water	0.15	0.09
Emergency Management QLD	0.13	0.12
Brisbane City Council	0.11	0.15
Bureau of Meteorology	0.09	0.07
Origin Energy	0.09	0.07

^ Values are standardised with a possible range between 0 and 1 and do therefore not represent the actual number of ties reported in the network.

There was a very high correlation of 0.96 between outdegree during flood times and outdegree during routine times. However, the mean outdegree during flood times significantly increased from routine operations (mean flood = 0.042, mean routine = 0.033, $t_{(46)} = 2.08$, $p < 0.05$), thus organisations who reported high levels of routine collaboration also had high levels of flood collaboration.

Betweenness/Connectedness

The position of an organisation in a network with respect to others and how connected it is in the network is measured by betweenness. Table 14 shows the top eight organisations in terms of betweenness, with SEQ Water and the Bureau of Meteorology showing the greatest level of betweenness during flood operations. The top eight organisations are predominantly State government organisations and all

except the Department of Community Safety are either core or advisory members of the Brisbane LDMG. This reflects that key organisations have an important role connecting the network together. There was a high correlation of 0.81 for betweenness centrality between routine and flood operations. Some organisations increased their betweenness in times of flood, the most notable were SEQ Water and the Bureau of Meteorology; this suggests that these organisations experience increased pressure from other organisations during flood periods when compared with routine operations.

Table 14 The top eight Brisbane organisations in terms of betweenness (connectedness) with respect to flood periods

Organisation	Betweenness (flood)	Betweenness (routine)
SEQ Water	0.09	0.02
Bureau of Meteorology	0.09	0.04
QLD Urban Utilities	0.08	0.08
Brisbane City Council	0.07	0.09
Department of Community Safety	0.07	0.03
Emergency Management QLD	0.06	0.07
SEQ Water Grid Manager	0.03	0.03
QLD Fire and Rescue Services	0.01	0.01

The correlations of betweenness with activity and popularity for the Brisbane network showed that betweenness was relatively high for routine operations (0.81 and 0.68, respectively) but less so during a flood (0.72 and 0.65, respectively). Thus, being popular in either routine or flood periods does not necessarily relate to the importance of connecting the network.

5.4.2 Central Queensland

Indegree/Popularity

The ten most popular CQ organisations with respect to flood periods are shown in Table 15. The local councils received the greatest number of nominations, with the Central Highlands Regional Council being the most popular for both routine and flood operations. This concurs with the observations made on the CQ routine and flood network diagrams. With the exception of Red Cross, all listed organisations in Table 15 are members of the LDMG, with most being core members. The results suggest that LDMG members are perceived as key organisations, particularly during flood periods. While the majority of the top ten are either state or local government organisations, the inclusion of Red Cross and Ergon Energy show that 'community organisations' and the 'commerce and industry' sectors are also represented.

The correlation in popularity between routine and flood operations is very high at 0.92, meaning that routine ties are most likely to also be flood ties. Yet, there is a significant increase in popularity from routine to flood (mean flood = 0.029, mean routine = 0.025, $t_{(43)} = 2.09$, $p < 0.05$), confirming that there were significantly more ties in the flood collaboration network than there were in the routine network, which was also observed in the network diagrams.

Table 15 The top ten CQ organisations in terms of indegree (popularity)^ with respect to flood periods

Organisation	Popularity (flood)	Popularity (routine)
Central Highlands Regional Council	0.42	0.37
Rockhampton Regional Council	0.35	0.35
Emergency Management QLD	0.30	0.16
Rockhampton SES	0.28	0.21
QLD Fire and Rescue Service	0.28	0.26
QLD Ambulance Service	0.26	0.26
QLD Health	0.19	0.16
Ergon Energy	0.19	0.14
Red Cross	0.14	0.05
Central Highlands LDMG	0.14	0.16

^ Values are standardised with a possible range between 0 and 1 and do therefore not represent the actual number of ties reported in the network.

Outdegree/Activity

The ten organisations that nominated the most network partners are listed in Table 16, with the Central Highlands Regional Council being the most active respondent for both routine and flood operations. Multiple respondents were interviewed from the Council and their responses were combined, thus influencing the large number of nominations. However, the data represents several different sections of the council's operations and is thus an accurate representation of their critical role in water management and disaster response.

Table 16 The top ten CQ organisations in terms of outdegree (activity)^ with respect to flood periods

Organisation	Activity (flood)	Activity (routine)
Central Highlands Regional Council	0.37	0.33
Rockhampton LDMG	0.23	0.23
Rockhampton SES	0.21	0.09
QLD Ambulance Service	0.19	0.09
Emerald QLD Department of Communities	0.19	0.09
SunWater	0.16	0.16
Rockhampton QLD Department of Communities	0.16	0.12
DEEDI	0.14	0.12
Rockhampton Regional Council	0.12	0.09
Capricorn Enterprise	0.12	0.14

^ Values are standardised with a possible range between 0 and 1 and do therefore not represent the actual number of ties reported in the network.

Betweenness/Connectedness

The top ten organisations in terms of betweenness are shown in Table 17, with the Central Highlands Regional Council having the greatest level of connectedness, both during routine and flood operations. The top ten organisations are all members of the LDMG, eight of them core members, and mostly represent State and Local Government organisations.

There was a very high correlation of 0.92 for betweenness centrality between routine and flood operations, with no significant difference during routine and flood (mean flood = 0.01, mean routine = 0.01, $t_{(43)} = -0.92$, $p = 0.364$), thus betweenness levels were the same irrespective of operational phase. This result suggests that important

network partners during a flood are those that are also important in structuring the collaboration network during everyday operations.

Table 17 The top ten Brisbane organisations in terms of betweenness (connectedness) with respect to flood periods

Organisation	Betweenness (flood)	Betweenness (routine)
Central Highlands Regional Council	0.30	0.39
QLD Ambulance Service	0.12	0.14
Rockhampton SES	0.09	0.02
SunWater	0.07	0.05
DEEDI	0.07	0.14
Rockhampton Regional Council	0.07	0.05
Emerald QLD Department of Communities	0.05	0.05
Rockhampton LDMG	0.05	0.00
Central Highlands LDMG	0.04	0.04
Department of Education Training and Employment	0.03	0.05

5.5 Network correlations

Comparisons between different networks with the same actors can be made by correlating the patterns of ties between dyads in one network with another. A Pearson correlation was used to measure the level of association between respondent only dyads and the quadratic assignment procedure calculated the significance of the association. Correlations were made between the networks of relations for collaboration ties (routine and flood operations), flow of information and resources, trust and difficulty.

The results were similar for the Brisbane and CQ regions and have thus been combined into the one description. There was a significant correlation between flood and routine network ties (Brisbane $r = 0.78$, CQ $r = 0.75$, $p < 0.001$). Thus most flood ties are also routine ties, which support the results of the centrality measures presented earlier.

The relationships between providing and receiving both information and resources were all highly significant, as follows:

- providing resources and information: Brisbane $r = 0.54$, CQ $r = 0.65$, $p < 0.001$;
- receiving resources and information: Brisbane $r = 0.51$, CQ $r = 0.68$, $p < 0.001$;
- provide and receive resources: Brisbane $r = 0.67$, CQ $r = 0.75$, $p < 0.001$;
- provide and receive information: Brisbane $r = 0.87$, CQ $r = 0.91$, $p < 0.001$.

These suggest a very strong tendency for organisations to see information as an exchange, both providing and receiving information from collaborating organisations. The tendency is less pronounced for resources, but it is still strong. There are also strong tendencies for organisations to provide both resources and information together and to receive resources and information together, to and from collaborating organisations.

The trust networks for both Brisbane and CQ were significantly correlated 0.80 to 0.89 with the networks of providing and receiving information ($p < 0.001$); and 0.47 to 0.60

with the networks of providing and receiving resources ($p < 0.001$). In short, providing and receiving resources and information tends to be associated with trust.

Nevertheless, there were still significant ($p < 0.05$), but much lower, correlations between the difficult tie network and providing and receiving resources in both networks. For providing and receiving information the correlations were of the order of 0.30 to 0.46; for providing and receiving resources, the correlations were between 0.18 and 0.30. So although these exchanges are frequently associated with trust, they can also at times be difficult. Trust and difficulty were also weakly correlated (Brisbane, $r = 0.23$, CQ $r = 0.12$, $p < 0.01$), so that trusting a collaborator does not necessarily mean that the collaboration is easy. These results agree with the network diagram observations presented earlier concluding that trust and difficult relationships exist simultaneously.

In the providing resources network (the provision matrix), A nominates B if A provides resources to B. In the receiving resources network (the receipt matrix), A nominates B if A receives resources from B. Suppose organisation A states that it provides resources to organisation B. For consistency, organisation B should observe that it receives resources from organisation A. In that case, the cell A-B in the provision matrix should match the cell B-A in the receipt matrix. This implies that there should be a correlation between the provision matrix and the transpose of the receipt matrix. There are modest, significant correlations between these two matrices for resources of 0.18 ($p < 0.01$) and for information of 0.22 ($p < 0.01$). In short, if one organisation suggests it supplies information or resources, there is a tendency for the recipient organisation to agree, but this is hardly universal.

The network correlations observed in this study also demonstrate a high level of consistency between participants, which provides some level of assurance that that respondents used in the study were capable of accurate reporting on their organisations' collaborative links, and that the reporting was done in the absence of personal biases.

5.6 Cultural values analyses

The qualitative analyses were conducted on responses from open-ended survey questions (see Appendix A). This section presents a summary of the results of the cultural values assessment, which drew on data from multiple questions; Section 5.7 reports and analyzes information from specific questions about valued elements in collaboration, and the role of collaboration and LDMG membership in future climate change adaptation.

The cultural values analysis resulted in the identification of 26 areas that were then grouped into six macro-themes. Table 18 provides a definition statement for each value area, together with examples of the actual text responses provided by participants for the corresponding value. Bubble plots are also provided (Figure 14, Figure 15 and Figure 16), to show pictorially the 'strength' by which each value was expressed.

It was readily apparent that 'clusters' of cultural values existed, both by location and by type of organisation. These differences that appeared amongst groups may be important in providing insight into the changes that could make the overall social network more effective, both in the structure of the network (who is linked to whom) and in the types of ties needed (e.g. trust rather than similar roles).

Table 18 User definitions for the key cultural values expressed by respondents during open-ended responses

Macrotheme / Theme	Words Used in Responses	Definition statement
1. Information, Infrastructure, Resources and Technology		
1.1 Shared information systems	Information, including shared data systems (info only); Guardian system or other centralized system, GIS mapping	A high value is placed on having information that can be shared through common, centralized systems.
1.2 Internal resources	Internal resources; self-sufficient	Network members who bring their own resources are more highly valued than members who need resources from other network members.
1.3 Shared resources	External/shared resources, including helicopter/airspace management and extra-regional supplies; fly-in of flood barriers	Network members who bring unique resources that can be shared amongst network participants are highly valued, including resources that are located outside of the immediate region
1.4 Timely and accurate data	Timely and accurate data	Data that are timely and accurate have the highest value.
1.5 Enabling technology	Enabling technology (the gadgets themselves, not the service), including damage to infrastructure during floods	High value is placed on the existence and accessibility of technological systems that provide tracking about the disaster itself, emerging problems, and damage.
2. Personal Dimensions, Competence and Communication		
2.1 Communication and shared language	Communication (network)/common terminology/language	Network participants should have a common understanding of key terms and phrases used in disaster management.
2.2 Professionalism and decisiveness	Professionalism (personal) / decision-making / good attitude	Being willing to use one's knowledge to make needed decisions shows a good attitude that is a key attribute of an effective network.
2.3 Human resource management	HR issues (well-being, fatigue management, workforce availability/holidays, liaison officers, valuing your people and the time they commit)	A high value is placed on effective people management, so that workers are available (with known substitutes when staff are on holiday), know they are valued, and are rotated to avoid fatigue.
2.4 Leadership and shared learning	Leadership, including sharing of learnings	Leadership qualities are highly valued, especially when leaders share what has been learned.

Macrotheme / Theme	Words Used in Responses	Definition statement
2.5 Trust and personal networks	Trust / personal relationships/informal networks	Priority is placed on ties that are personal, relationships built on trust rather than on shared knowledge or positions.
3. Goals, Skills and Experience		
3.1 Common goals and priorities	Common goals / priorities	Ties should include a common understanding about what the network should be doing and what the order of priorities is.
3.2 Local expertise and knowledge	Local expertise/knowledge/ tailored knowledge	Valued network members know the area (people, places, likely trouble spots, points of assistance)
3.3 Skills and training	Relevant skill sets/training	Network members need to have skills and training that match the situations and problems they encounter.
4. Network Structure and 'Network Wellbeing'		
4.1 Non-bureaucratic	Non-bureaucratic	Network members should work together as a team to solve problems rather than insisting on going through standard processes and approvals before doing what needs to be done.
4.2 Collaborative, flexible, non-siloed	Non-siloed / collaboration / flexibility	Network members should work across disciplines and job categories to collaborate in ways called for by the situations.
4.3 Contactable, physically present	'face to face'; 'easy to contact'; 'have current contact list of telephone numbers'; present at LDMG	Highly valued network members are physically present during relevant activities, and they can be easily reached via up-to-date contact information.
4.4 Inclusivity of minority groups	'Inclusive' or 'open'; the need to include special groups such as industry, cultural/indigenous groups, animal welfare groups, health/special medical needs, maritime safety, Defence, Centrelink, town planners, and welfare groups, mention of academia or other regional groups	All network members, including minority/ special needs/unique expertise members, need to be included in planning, response, and recovery efforts.

Macrotheme / Theme	Words Used in Responses	Definition statement
4.5 Structure, roles and responsibilities	Clear structure/roles and responsibilities/ command and control (incl. legislation to define the roles; accountability)	A valuable element in disaster response is a clear organisational structure, including identified roles, responsibilities, and command and control nodes on the network.
4.6 Expectation management (network)	Expectation management (network)	Network members need to understand what is expected of them and what they can expect from others.
5. Community Wellbeing		
5.1 Local solutions and community wellbeing	Preference for local solutions, resources, resupply (community resources), building independent community resilience	The ability of local communities to provide solutions, resources, and resupply chains is highly valued as contributing to community-level resilience.
5.2 Effective public communication	Communication (mass media for public dissemination): awareness re preparation, common terminology/language, mis-messaging/social media technology	Public communication that provides timely information on preparing for disasters, using clear terminology and messages, is highly valued.
5.3 Expectation management (community)	Expectation management (community)	Communities that understand what they can and cannot expect from disaster response organisations are highly valued.
6. Longitudinal Issues		
6.1 Recovery and reconstruction	Recovery: resupply, reconstruction, insurance claims processing concerns	Recovery activities (such as resupply, construction, and insurance settlements) that proceed smoothly and quickly are highly valued.
6.2 Adapting to future conditions	Changed future conditions: climate change/demography (aged)/disaster expectations/political and government (re-structure)	A high value is placed on incorporating changing future conditions (e.g. climatic, demographic, governmental) into disaster management.
6.3 Pre-planning and preparedness	Planning and preparedness; training; scenario-building	The existence of disaster plans that are known and preparedness activities with many participants are highly valued.
6.4 Staff continuity/ succession planning	Continuity (of staff)/succession planning	Network members who have established staff and good succession planning are highly valued.

5.6.1 Brisbane

For the Brisbane location, across all types of organisations, the most frequently expressed values were those relating to shared information systems, shared resources, communication and shared language (which includes terminology), and collaboration and flexibility (Figure 14). A notable feature of the cultural themes results is that structure/roles and responsibilities is strongly valued by all government groups – including where this is set by legislation (such as the *Disaster Management Act*). Conversely, local industry and community groups do not express this value at all: instead, these organisations strongly value trust and personal networks, inclusivity, and pre-planning and preparedness.

Culturally, the federal government participants in Brisbane appear to place high value in three predominant areas: communication/shared language; collaboration and flexibility; and a strong structure with clearly defined roles and responsibilities. None thought the network should be ‘non-bureaucratic’. Notably, respondents only weakly valued shared information systems, with none mentioning other resources, timely and accurate data, or enabling technology (from category 1). Meanwhile, the state government organisations share some values with the federal government organisations, for example, in the areas of collaboration and flexibility, and a strong structure. They also favoured shared information systems (to a greater extent than other organisational types), and attention to human resource management (fatigue, workforce availability). By contrast, local government’s highest values clustered under personal dimensions, competence and communication, with smaller values in shared resource, timely and accurate data, local expertise and knowledge, management of community expectations, and pre-planning and preparedness.

The water utilities place a high value on collaboration for shared resources. Outside this fairly strong value, the utilities tended to register something for almost all of the value sets except community wellbeing and longitudinal Issues. This suggests that if collaborative relationships are to run smoothly with the water utilities, then acknowledgement of this broad set of values may be important from the perspective of collaborating partners, particularly if they themselves have a relatively narrow set of cultural values. Finally, culturally, community and industry seem quite different to other types of organisations – placing high value on trust, collaboration, inclusivity, shared resources, timely and accurate data, and pre-planning, with much less emphasis on structures. Similarly to the water grouping, the C&I group seem to want a range of different values to be covered all at the same time; however, their values were more strongly expressed, indicating more homogeneity within the group.

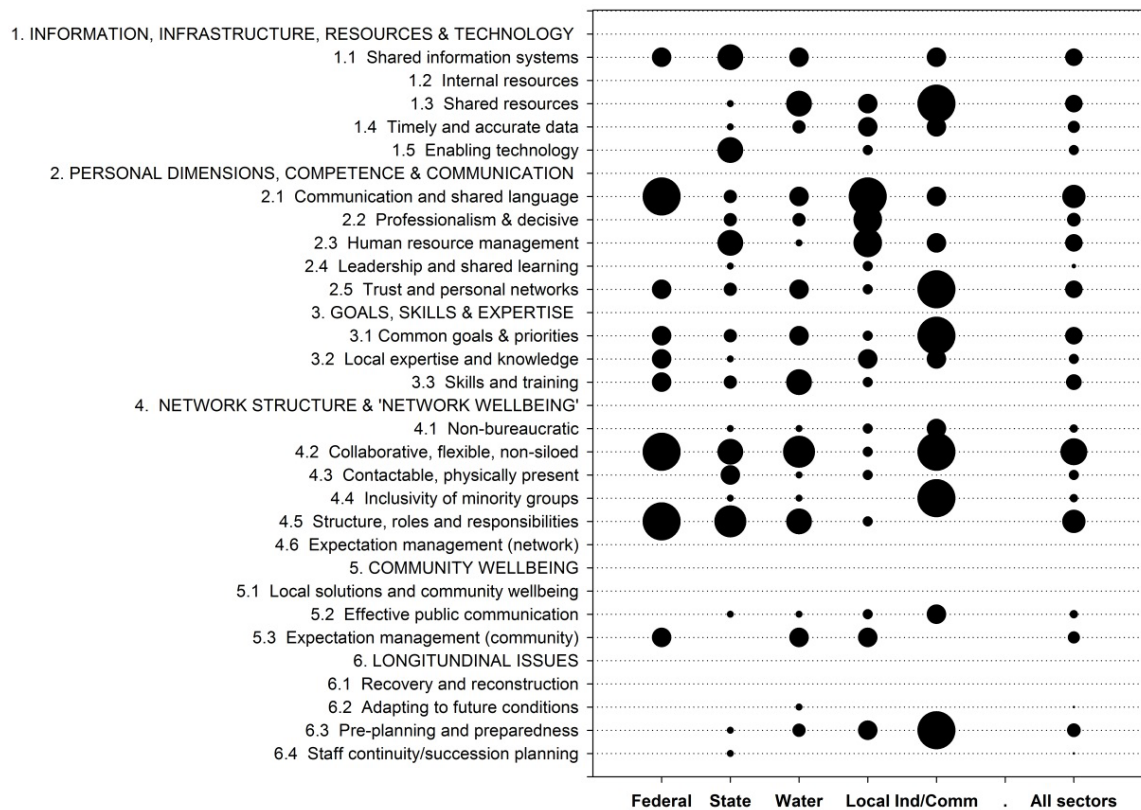


Figure 14 Bubble plot summary of cultural themes distilled from different categories of organisations involved in the Brisbane flood response

Ind/Comm = industry and community. A large circle indicates that found many or all of the participants in a cohort provided survey responses that mapped to a given cultural value, whereas a small circle (or absence of one) indicates that few or none of them did.

5.6.2 Central Queensland

In CQ, the culture of federal government departments seems quite different to that of any of the other sectors, based on the responses provided by the participants (Figure 15). The highest value was placed on structure and expectation management, both at the network as well as the community level. By contrast, there was very little or no value placed on the themes grouped under information, infrastructure, resources and technology, and personal dimensions. The state government respondents' values showed a generally even spread across most value sets, with the most important ones being shared information, as well as structures, roles and responsibilities. These values were also shared by local government in many cases. Industry participants in CQ were most vocal about the need to have collaborative and flexible partners during the disaster response, and were far less concerned with bureaucracy and structural roles and responsibilities. Community groups in CQ also strongly emphasized the need for good communication, professionalism, and common goals and priorities. They also appeared to favour local solutions, inclusivity and adapting to future conditions more than the other sectors. Overall, CQ showed a high 'diversity' of cultural values; as each of the macro-themes were of similar importance.

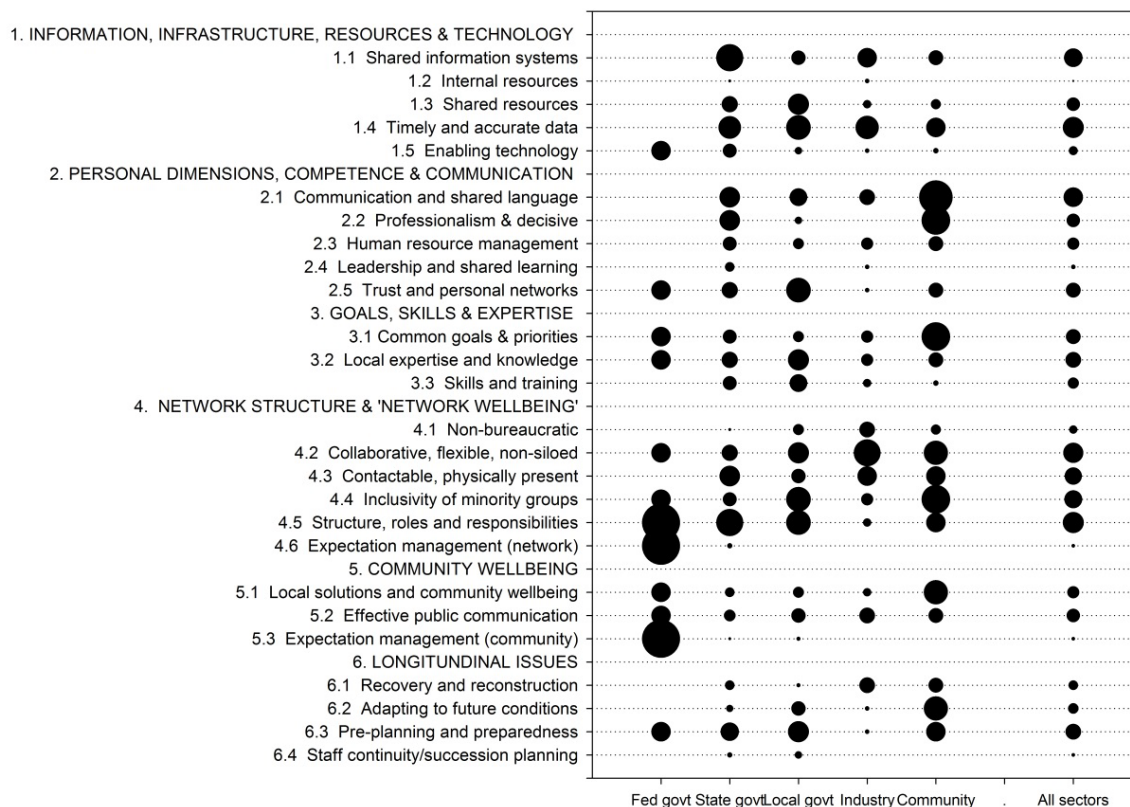


Figure 15 Bubble plot summary of cultural themes distilled from different categories of organisations involved in flood response for Central Queensland (Emerald and Rockhampton).

A large circle indicates that found many or all of the participants in a cohort provided survey responses that mapped to a given cultural value, whereas a small circle (or absence of one) indicates that few or none of them did.

5.6.3 Cross-regional and cross-sectoral comparison

In a comparison of the metropolitan (Brisbane) and regional (Central Queensland) participants, the key differences were the emphasis that the regional groups (especially the more rural Emerald) placed on community wellbeing and longitudinal issues; whereas the metropolitan respondents often focussed on collaboration and the need to break down 'silos' (Figure 16). Linked with the latter was a strong need for communication, shared language, and a clear structure for operating during the disaster response. That is, in Brisbane, effective mass communication and having a shared information system and single point of control for flood visibility were identified as being of central importance. The use of liaison officers and social media in facilitating communication were also considered important. Given the size and population of Brisbane and the fact that Brisbane City Council is the largest in the southern hemisphere, these results are not surprising. In contrast to Brisbane, Central Queensland respondents' key issues were based around local issues, for example, the well-being of the local community and having local knowledge.

A comparison of Emerald with Rockhampton also showed that both study locations were interested in aspects of network structure and network 'wellbeing'; but there were no substantive differences across those regions in terms of macrothemes. Overall, across the Central Queensland and Brisbane sites, participants' responses were similar in terms of their values around the importance of established relationships and trust, inclusive LDMG membership and holding regular meetings. Other shared

attitudes across the three sites were the importance placed on having a shared language and timely information, and addressing fatigue management issues. For the whole-of-study dataset, those top-10 themes of highest value included (in order):

- collaboration, flexibility and the lack of silos;
- having a clear structure for the network; with well-identified roles and responsibilities for each organisation;
- good communication based in a shared and accessible language;
- sharing information systems;
- the need for timely and accurate data;
- having trust, and using personal networks to establish good working relationships;
- that organisations involved in the disaster response should be easily contactable, and be physically present before and during collaboration;
- that there needs to be greater inclusivity of minority groups (largely meaning the community sector, and business and industry);
- that disaster pre-planning and preparedness is critically important; and
- that local expertise and knowledge is highly valued.

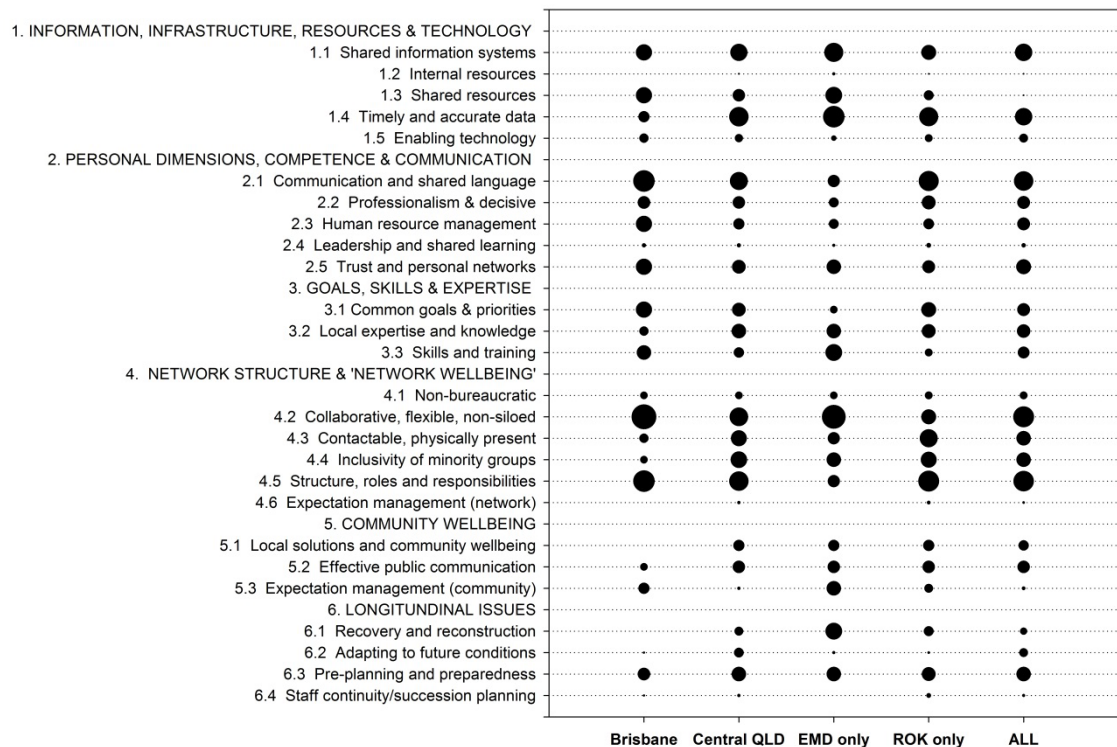


Figure 16 Bubble plot showing a cross-regional comparison of the cultural themes distilled from different categories of organisations involved in the Queensland flood response.

QLD=Queensland, EMD=Emerald, ROK=Rockhampton. A large circle indicates that found many or all of the participants in a cohort provided survey responses that mapped to a given cultural value, whereas a small circle (or absence of one) indicates that few or none of them did.

5.7 Other qualitative results

5.7.1 Perceptions of gaps in information or collaboration

When asked to identify any gaps in information or collaboration that were a problem for their organisation and the network of collaboration during previous flood events, participants across the three case study sites generally reported that there was a lack of early and timely information and alerting, and a need for better shared information systems. For example:

“... sometimes you would give out information and then that information would change. Sometimes the information was conflicting...” (community organisation).

Respondents also identified not knowing the key people to talk to as a hindrance to effective communication and collaboration. A lack of a clear and consistent terminology to describe flood levels for flood warnings was also identified as a significant barrier. For example, according to one Brisbane respondent, there are currently up to five different terms used to describe the height of the water.

5.7.2 Characteristics of good and poor collaborators

Participants responded enthusiastically when asked to articulate those characteristics that made a collaborating organisation either effective or difficult to work with during the flood event. There was generally good agreement across the three study sites with respect to the traits of effective collaborating organisations. Being contactable and having effective shared information systems, common goals, trust and knowledge were characteristics that were cited by many respondents for effective collaborators. Having established networks, resources, and experience, as well as being available, prepared and professional were also listed. In addition, good leadership and being flexible, cooperative, organised, accountable, respectful, transparent, innovative, were cited as effective characteristics. On the other hand, characteristics of difficult collaborators were described as being bureaucratic and having poor communication, as well as having different priorities, limited local knowledge, and lack of proximity and availability. Other difficult characteristics cited were isolated decision making, lacking training, and being unprepared, uncommitted, and under- resourced. Being overconfident, territorial, blaming, and having siloed, insular and self-interested attitudes were also listed as characteristics of difficult collaborators. The reflections on being ‘siloed and insular’ were particularly notable given the context of this study.

Following a thematic analysis of the raw data, a model was built to generate word clouds that were broadly representative of these responses, for the ‘effective’ and ‘difficult’ categories (Figure 17 and Figure 18, respectively).

Typically, respondents favoured collaborators who shared common goals with their peers, and who used effective systems, protocols and/or processes for handling enquiries and tasks. There was also a high value placed on collaborators who were experienced, flexible, trustworthy, and those who had good knowledge and understanding of local contexts:

“... they [good collaborators] understand our local communities, the way it operates and what it needs; they’re willing to listen and be flexible in their response...” (local government).

Overall, however, one of the strongest indicators of an effective collaborator was that their people were easily and consistently contactable, and that they were good

Table 19 Summary results for preferred type of participation in the LDMG

	Core member	Advisory member	Not a member	Unsure
"Federal Government"	1	1	2	--
"State Government - water"	4	1	--	--
"State Government"	16	--	3	1
"Local Government"	9	2	--	--
"Commerce and Industry"	5	4	2	--
"Community Organisations"	4	6	1	--

5.7.4 Perceptions of future collaboration needs

Respondents were asked to indicate how they expected their organisation to collaborate with others in to the future, using a Likert scale followed by an open-ended response. The question was specifically framed around the influence of climate change:

"... we'd now like you to think about activities and challenges for the future. In particular, the Intergovernmental Panel on Climate Change has stated that there is 'medium confidence that heavy rainfall will contribute to increases in local flooding in some regions'. Keeping this in mind, how do you think [organisation] will collaborate with others in the future?"

Over half of the respondents (52.4%) indicated that 'much more collaboration' was likely. When grouped by region, organisations from the Brisbane cohort were collectively the most likely to tend towards more collaboration in the future, compared with the other locations (Figure 19). When grouped by sector, the state government (water) entities and community organisations were the most likely to tend towards more collaboration in the future, whilst the federal government agencies were the least likely.

Some respondents also offered useful insights into ways in which organisational collaboration could be improved, for the benefit of disaster management and climate change adaptation overall. For example:

"...perhaps we could make sure that the processes that currently rely on personality get adopted 'beyond personalities'... It would also be good to have regular meetings when not in times of disaster so people get to know each other and know how things work..." (state government).

Some participants also indicated that they were thinking outside of the box in terms of future collaboration needs, in responding to the question of who their future collaborators might be:

"...the local snake catchers - we would be making an individual request each time we received a request for help regarding snakes particularly during recovery..." (state government).

In terms of other ways in which future collaborations could be improved, many participants cited the need to maintain solid relationships at all times and not just in emergency events. The need for more training and attention to fatigue management was emphasised. Better defined roles and a directory of key contacts were also listed as essential to improving future collaborations. A number of respondents listed the need for a common and shared information system and single point of control. More emphasis on the use of social media, better messaging and looking more broadly into

the LDMG membership were also suggested as ways of improving future collaborations.

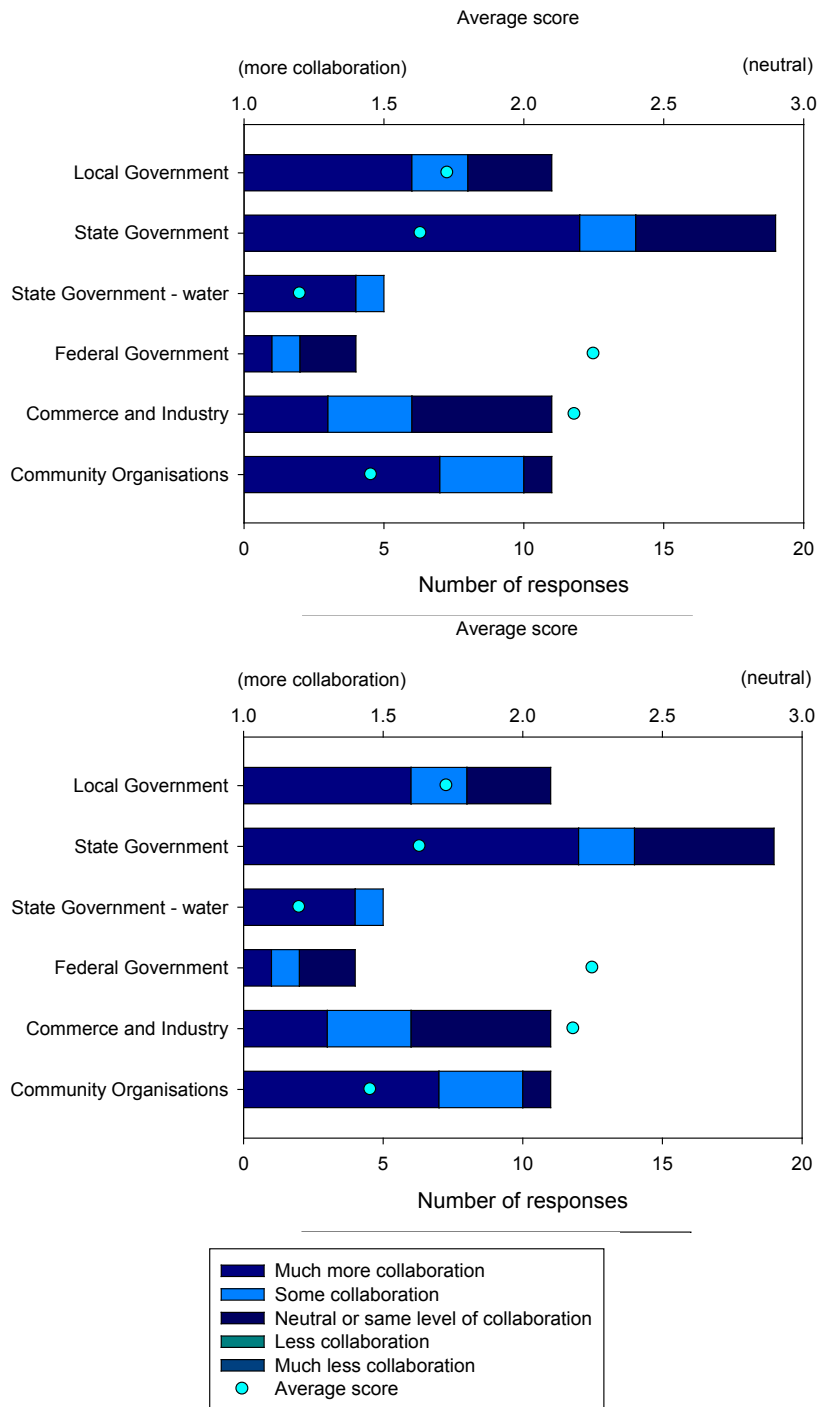


Figure 19 Summary data for respondent's views on the need for organisational collaboration in the future: comparison by location (top) and organisation type (bottom)

5.7.5 Other issues

A number of participants highlighted the need to be careful with messaging and media communications with the public – in particular, to check facts and avoid mistakes. It was also noted that the resources needed to properly manage social media were often underestimated. Respondents suggested that emergency action plans should be available to the public, and that more transparency was needed.

In Brisbane, the point was raised that the 2011 floods highlighted the need for communication about the risks of building and living in areas that are considered flood plains:

“...you would never find flood engineers living beside the river on a flood plain – they tend to all choose to live on hills because they understand the risks...”
(Brisbane respondent).

One respondent said that the public should be made more aware of the areas at risk of flooding, and that similar communications had worked successfully in New South Wales. The issue of how to distinguish between “response” and “recovery” was also raised. It was suggested that a lot of work needs to be done on when the response phase finishes and the recovery phase begins, and who should take ownership for recovery. Finally, participants also provided comment on other areas of climate change adaptation and disaster management during the survey, often with respect to contingency planning for supply chains, the importance of having well-managed insurance response, and the expectation for future needs:

“...there was no evidence of a coordinated approach to the range of financial services available to land holders following the flood event for the cleanup and restoration of damaged infrastructure...no clear process for people affected by flooding to raise concerns with government or reconstruction authorities...”
(community group);

“...about fresh commodities...they loaded Hercules with groceries and flew them over the top of us to Mackay, there was no communication between them and us at the regional level... there was no need to do it; we knew nothing about it...” (local government);

“...even though there might be an increased frequency of these events [floods], that simply means that what we’re doing what we already do more often... there may not be a steep change in what we have to do...” (water utility); and

“...the Rocky region [Rockhampton] has a history of flooding to various degrees, which has resulted in a fair bit of apathy to the risk of flooding. On the issue of climate change there’s still a fair bit of scepticism about the whole issue... One relationship that needs to improve would be the collaboration and cooperation between local governments - you can then look at disaster management as a regional issue on a whole...” (local government).

5.8 Stakeholder workshop outcomes

In both workshops, there was a high level of engagement and lively discussion from the stakeholders, both in the room environment as well as within table groups. However, care must be taken in interpreting this material, and drawing conclusions from it, because of (a) the small sample sizes involved and (b) the format of the workshops, with group situations sometimes failing to provide an environment where all participants can contribute easily and equally.

5.8.1 Activity 1: identifying the LMDG membership

Stakeholders participated willingly in the first activity at both workshop locations. The number of comments and ‘wild card’ entries presented below reflect this high level of engagement.

In Brisbane, the initial discussion emphasized two points: that the legislation mandated only a few organisations; and that the Chair had the authority to add anyone s/he chose, given the particular situation and needs of the area covered by the LDMG. Most participants seemed to have very definite ideas about membership.

In the Central Queensland workshop, participants reported that decision-making during the task was relatively easy, although some participants needed additional time to complete the activity. This would suggest familiarity with the organisations listed, and at least a reasonable sense of the type of criteria by which an organisation should, or should not, merit inclusion.

The average number of nominations given for LDMG membership was similar for both Brisbane and Central Queensland (Table 20). In the Brisbane cohort, only two participants indicated a preferred chairing organisation, and both nominated the local government (Brisbane City Council). In terms of membership, Brisbane City Council received the greatest number of nominations, followed closely by Queensland Fire and Rescue and Emergency Management Queensland (Figure 20). Only eight of the 14 participating organisations in the Brisbane workshop actually nominated themselves as ‘definite’ members.

Table 20 Summary results for nominations to the LDMG membership in the Brisbane and Central Queensland regions

‘DEFINITES’	Brisbane	Central Queensland
Average	13.5	12.2
Minimum	4	4
Maximum	29	28
‘POSSIBLES’	Brisbane	Central Queensland
Average	13.1	6
Minimum	0	0
Maximum	23	14

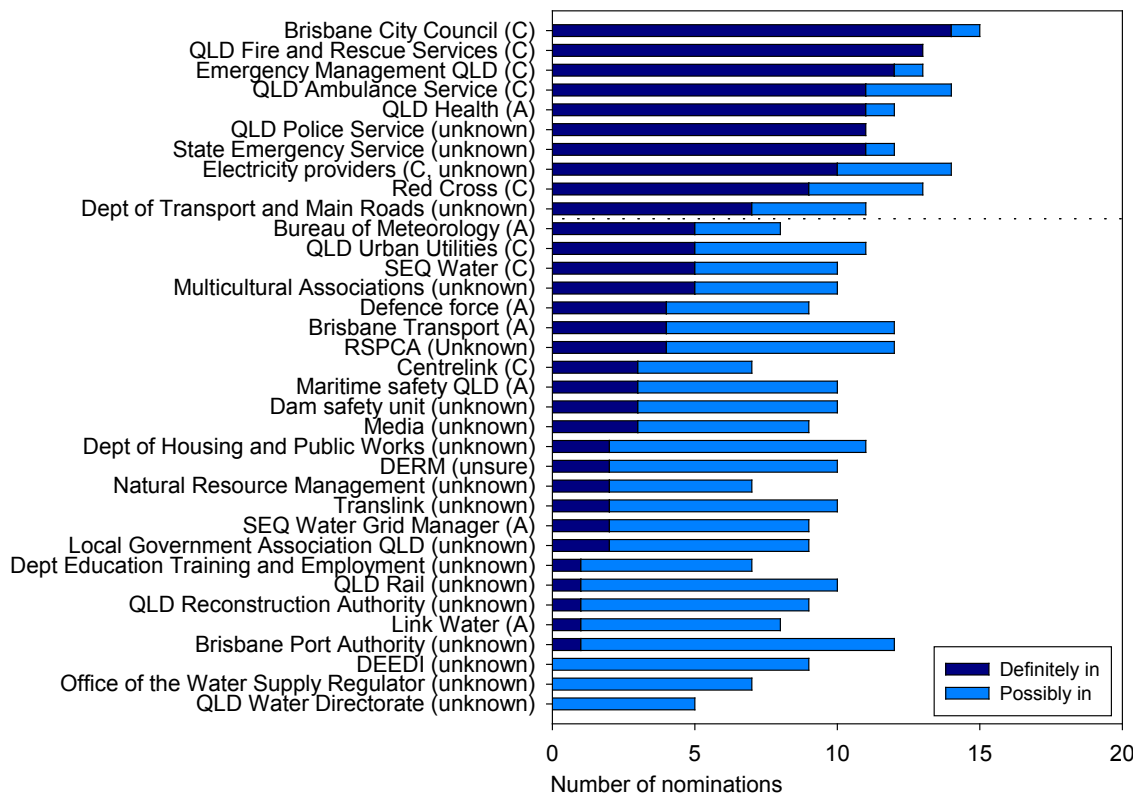


Figure 20 Number of LDMG nominations for listed organisations in Brisbane (wild cards excluded)

The reference line indicates the top ten for ‘definitely in’ nominations. Brackets indicate organisational status with respect to membership of the LDMG (at time of data collection and as self-reported by the respondent), with C=core; A=advisory; N= not a member and ‘unknown’ indicating a non-respondent organisation.

In Central Queensland, local Councils received 15 nominations to chair the LDMG (either Rockhampton, Central Highlands, or Banana⁶), with the Queensland Police Service receiving five nominations, SES two nominations, and one for EMQ (Figure 21). Like Brisbane, the top-ranking organisation for ‘definite’ nomination was the local government, although in this case, it represented the pooled nominations for both the Rockhampton and Central Highlands councils. Other key organisations included the Queensland Police Service, followed by Queensland Fire and Rescue. A total of 19 of the 23 participants self-nominated their group for a ‘definite’ role on the LDMG.

⁶ A regional council that neighbours Central Highlands and Rockhampton Regional Councils.

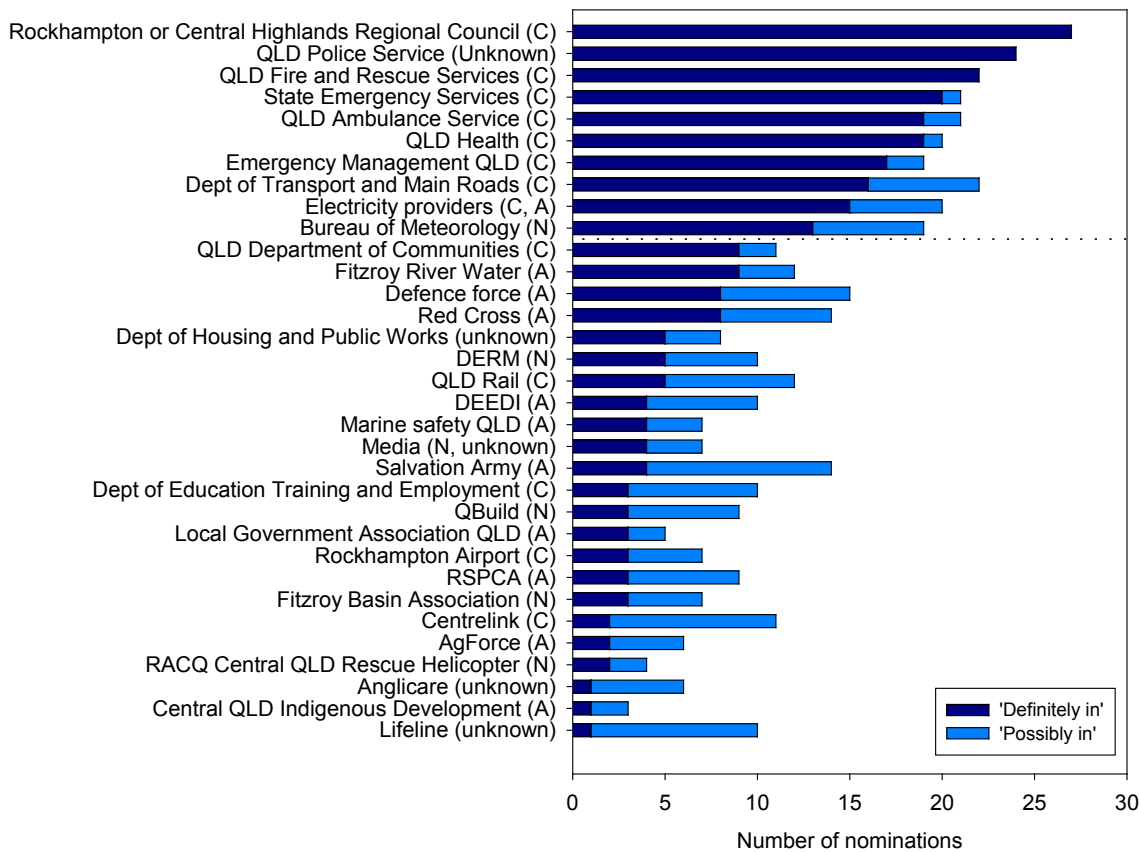


Figure 21 Number of LDMG nominations for listed organisations in Central Queensland (wild cards excluded)

The reference line indicates the top ten for 'definitely in' nominations. Brackets indicate organisational status with respect to membership of the LDMG (at time of data collection and as self-reported by the respondent), with C=core and A=advisory.

The “top ten” lists for the two locations were remarkably similar. Also, the upper half of both lists appeared to closely reflect the current membership of the existing LDMGs, indicating some level of satisfaction with the current structure and membership. However, there were also many existing LDMG member organisations that appeared outside of the preferred top-ten listing, with 3 core and 5 advisory members in Brisbane, and 4 core and 10 advisory members in Central Queensland. In contrast, the Bureau of Meteorology was striking in being nominated at position 10 and 11 in the lists, despite being a non-member of one LDMG and only an advisory member of the other (Figure 20 and Figure 21).

Wild cards were used by four participants in Brisbane and eight participants in CQ. The entries typically included a range of community development or diversity type organisations, as well as other volunteer and nongovernmental organisations, health-related organisations, and businesses (Table 21). This indicates that participants placed a high value on the involvement of these kinds of groups; however, it also creates an interesting anomaly in the data. For example, participants were able to select the names of specific community groups from the organisation lists provided to them during the workshop activity, but it was uncommon for these to receive many nominations. For example, only two of the 35 entities in the Brisbane nominations listing were community groups – these being Red Cross (at rank 9) and the RSPCA (at rank 17)(Figure 20). Similarly, only six of the 33 entities in the Central Queensland

listing were community groups; again Red Cross (at rank position 14) and the Salvation Army (at rank 21). One explanation for this apparent difference could be that whilst stakeholders do place a value on community group participation in general, they prefer quite specific organisations to take on any LDMG membership role. In considering this, it is important to note that the organisation lists that were generated for use in the workshop activity were in fact derived from the collected network data, and based on those organisations with the highest numbers of network nominations. The fact that these named community organisations didn't receive a high ranking with respect to nominations for the LDMG; while the names appearing on the 'wild cards' were frequently those of community groups, suggests that the existing ties between actors in the network are either not known, or not perceived as having value in the current situation.

Some respondents annotated their cards with caveats such as 'only for Brisbane [LDMG]' or 'NGOs must be engaged [but] may be members only where there is local capacity'. One wrote on their submission bag:

"...the individual agencies are not necessarily generic – a community may be better represented when [membership is] tailored to the risk, local capacity and capability...e.g. individuals with local knowledge..."

Another named agencies, but also indicated the specific role which should attend, for example 'mayor and CEO'; 'Council's community services department'; 'chair of the local chamber of commerce'; and 'education providers at all levels' or 'DETE⁷ as the holders of the cyclone shelter'. In Central Queensland, one person suggested 'have a representative from community groups/organisations... or have them in a separate group that reports to the LMDG'.

One federal government participant indicated that 'utilities' might have been a useful grouping, including both power and water entities. A local government participant noted the importance of supply chains, calling to 'include Queensland Health and all suppliers'. Respondents also indicated that some of the organisations that had been allocated to the 'possibles' pile may in fact be more suited to a role on an alternate group, such as the district and/or state disaster management groups. Finally, one of the issues that arose during this activity was the differentiation between 'core' and 'advisory' or 'observer' membership. Here, some participants noted that there were some organisations that should definitely be included, but which should have membership only as an advising (as opposed to decision-making) entity.

⁷ Department of Education, Training and Employment (new title, as of 2012 state elections).

Table 21 Organisations included by participants as ‘wild card’ entries.

Brisbane	Central Queensland
<i>Definite members</i>	<i>Definite members</i>
Community leaders	CQ multicultural society
Critical infrastructure representatives	Rural Fire Brigade
Risk and hazard identification and management agencies	CHHRUP
Chamber of commerce (2)	St Vincent de Paul
Save the Children	CHDC
AVA	Banana Shire Council
Key business leaders	Telstra
Local knowledge holders	Sunwater
Sunwater (dam operator)	Local community stakeholders
Ozcare	Business stakeholders (mining, agriculture)
Bluecare	A representative from community groups
Spiritus	
HACC	
Aged care facilities	
Volunteering Queensland	
Special needs sector groups	
Faith-based organisations	
Community service providers (2)	
<i>Possible members</i>	<i>Possible members</i>
Private sector (capacity and local resources)	CCC (Capricorn Conservation Council)
Other NGOs	Telstra
	St John's Ambulance
	Uniting Care
	Anglo American Dawson Mine
	BMA
	CHDC
	Rio Tinto
	Correctional centre
	Neighbourhood Centre
	Capricorn Enterprise
	Chamber of Commerce
	St Vincent de Paul
	Hasting Deering
	CHHRUP

5.8.2 Activity 2: defining an effective disaster response

In this activity, workshop participants were asked to complete statements about how to measure the effectiveness of disaster response (conducted at both Brisbane and Central Queensland workshops) and the effectiveness of the LDMG (Brisbane only, due to time constraints at the Central Queensland workshop). In both workshops, the activity/ies sparked immediate and serious discussion of the issues involved in completing the statements; with respondents working as one group (in Brisbane) or based on their table (in Central Queensland).

The statements that were recorded during the activities spanned a broad range of areas, from an emphasis on network preparedness to specific crisis operations to

community and other outcomes. In the responses and in subsequent discussions, both process and outcome criteria were important. However, both are difficult to define and measure. Almost all completion statements raise significant measurement issues.

In Brisbane, workshop participants responded to both questions (Table 22). Issues of whole-of-LDMG goals throughout the phases of planning, response and recovery also took on black-humour tinges in two comments about the potential for responders to be blamed for a less-than-ideal implementation (Table 22, responses 6 and 7). In the responses listed in Table 22 (effective flood response), good planning, preparation, communication, shared goals, and role/responsibility delineation account for two thirds of the responses – matters that reflect how well the network handles the situation, somewhat in contrast to the more marked Central Queensland attention to the community end-states. However, the Brisbane responses in Table 23 (effective working of the LDMG) focussed very particularly on the community end-state, termed “normalcy” but with no measurable definition of that term. Brisbane participants discussed the difficulty of determining “normal” conditions that could be the end point of flood response and recovery. Two criteria proposed were businesses being “back up” and schools functioning again. Several people pointed out that there were citizens who still had not recovered to anything like a pre-flood situation – and may never recover. How can a “return to normal” be measured?

Table 22 Summary of responses by Brisbane participants to: “We will know that a flood has been responded to effectively when ...?”

1	the risk is minimized.
2	there is a common, shared goal and vision.
3	lines of authority and communication are clear.
4	egos are left at the door.
5	the community has the capacity and capability to respond.
6	we're all still here after the inquiry.
7	the [Italian] geologists are out of jail.
8	the planning function embeds implementation of all phases across the service delivery areas of LDMG members.
9	in activating the response plan/action plan, everyone understands the common goals.
10	we are poised to adapt and respond to the next event.
11	communication works both internally and externally to the network.
12	we are able to keep the community informed.
13	community expectations are well managed.
14	the networks and contact information are known in the preparatory phase.
15	roles and responsibilities are clear.

Another topic particularly discussed at the Brisbane workshop was that, no matter how well response plans and their implementation were being carried out, the politics of a disaster cannot be predicted. A mayor, for instance, may decide to call in the Defence force (perhaps because of media pressure or to demonstrate the seriousness of the situation). Such an action has repercussions on responder morale and future community resilience; if the Defence force is going to be called in, why should the community plan to take care of itself?

Table 23 Summary of responses by Brisbane participants to: “the LDMG will be working effectively when ...?”

1	... It is tracking flood responses as the crisis is going on – what is being achieved in each phase and looking/planning forward for the next phases/disasters.
2	... the community returns to normalcy or better than “normal,” considering --how fast the return is --how to rebuild in advance of the next floods (which will increase in frequency and intensity) --how isolates are reconnected and insurance issues are resolved --how to reassess, e.g. zoning --that “normal” is different in different places.

In the Central Queensland workshop, more than a third of the completion statements to the question, “We will know that a flood has been responded to effectively when...?” held up the end states of “meeting community expectations,” accelerated economic recovery, no major loss of life or injury, minimal impacts, good community feedback, and enabled resilience (Table 24). About a third of the completion statements focused on the existence and implementation of good plans and training. Other responses demonstrated concerns for the environment and the animal population, as well as the wellbeing of responders and the most vulnerable.

In subsequent discussion, participants suggested the need to prepare for crises by thinking through scenarios and coordination mechanisms and by building mutual understandings among network members. These elements must be repeated periodically because the people involved in the network change over time.

Table 24 Grouped responses by Central Queensland participants to: “We will know that a flood has been responded to effectively when ...?”

1	organisations have contributed to planning, management, response and recovery in collaboration and meeting community expectations.
2	organisations have had previous planning and training.
3	appropriate people and resources were ready to deploy.
4	the capability was equal to the demand.
5	people’s availability and wellbeing (e.g. fatigue, stress) were well managed.
6	there were very few animal welfare issues.
7	there were good supply chains in and out.
8	economic recovery was accelerated (back to normal).
9	there was the least possible social impact to the most vulnerable groups.
10	communities were informed and messages were consistent (no panic).
11	there was no major loss of life or injury, no looting.
12	there was minimal time back to normalcy.
13	the disaster plan was implemented effectively.
14	the impact on the community was minimal.
15	communities were well informed and knew what to expect.
16	the LDMG stands down.
17	the community approves of the response (feedback from the community).
18	information is shared to LDMG and to the public.
19	there was effective environmental/natural resource management.
20	isolation is avoided.
21	resources arrive in a timely manner.
22	community resilience is enabled (no expectation that ‘the Army will save you’).

6 DISCUSSION: IMPLICATIONS FOR POLICY AND PRACTICE

6.1 Assessing social networks

Network governance systems, such as watershed agreements, can display social properties that are conducive to cooperative relationships that are not necessarily seen under centralised governance systems. Lubell and Fulton (2008) describe three social processes that contribute to the effectiveness of governance systems to deal with environmental issues and management: the diffusion of innovation through the network, such as the spread of information and behaviour among stakeholders; the accumulation of social capital, such as trust; and avenues for cultural exchange, such as the transmission of stakeholder attitudes to innovation. Conversely, the possible attributes of ineffective networks can include the presence of conflicted or negative ties; lack of reciprocity; and/or indication of poor information flows and bottlenecks.

This case study of the Queensland floods showed that the existing social networks in Brisbane and CQ were characterised by a greater number of ties in periods of floods compared with routine operations; with a mix of importance between information and resource flows; and with high levels of trust a generally low number of difficult ties. In particular, the densities of trust and collaboration were much higher than those of difficult ties: this compares favourably with a study on network governance of a large river resource, where there was more evidence of conflict and contestation between crucial organisations/entities than cooperation (Robins *et al.* 2011).

Moderate increases in the density of ties were observed for the flood networks in both locations, but there was no evidence of 'bottlenecks' arising during the disaster response period (at least in the network sense). In fact, the slight increases in centrality (indegree) and betweenness of key organisations during the flood period may in fact lead to shorter paths through the network, thus helping to streamline the response by organisations within the network. Taken together, these features suggest resilience in the networks overall, although this would depend on the distribution of ties overall. Many of the respondents gave positive reports about the success of regional-level activities, particularly given the avoidance of any loss of life in Rockhampton and Emerald.

However, both the quantitative and qualitative data collected indicated possible issues within the studied networks. For example, some relatively isolated nodes were observed in both locations, and some of these represented organisations that were potentially quite important, based on their attributes (e.g., LDMG membership) and function (e.g. electricity supply). This may indicate the need to consider ways to effectively integrate important actors in the network; however, it also introduces the issue of which actors are 'key' to the network, in both the perceived and/or actual sense. For example, one organisation did not wish to participate in this research because the approached representative believed that the study was not relevant to the organisation, yet that non-participant was regarded by not one, but many other organisations as a 'key partner'. Here, providing the network visualisations and other information about the network governance structure would allow stakeholders to discern what may need to be changed within the current system, or for a new system to be designed, so that the network functions most effectively (i.e. one of the key objectives of the workshop activity). This characteristic of being self-organising to deal with complexity is one of the key advantages of a network governance arrangement, compared with (for example) a centralised government approach.

Notwithstanding the above, neither the existing literature nor the current project has defined the measurement or assessment frameworks that would be necessary to

determine whether the networks at each location are effectively responding to issues of water management, disaster management and/or climate change adaptation. The workshop responses indicate that networked organisations have a wide span of ideas about how to measure effectiveness. Given the often unexpected nature of climate events, the existing literature points to the need for organisational systems (i.e. networks) to be agile, flexible and creative (Harrald 2006). However, importantly, there is no such thing as the 'right' network structure: rather, the effectiveness and appropriateness of different structures vary with the end application. Each network is likely to be different from the next (e.g. Bodin *et al.* 2006); and whilst certain structural features can indicate positive network properties, these may be highly contextual. For example, if ties are expected to occur between particular organisations due to policy or regulatory settings, but they are absent, this may be interpreted in one of two ways: one, a breakdown in communication leading to a difficult (or absent) tie; or alternatively, that the organisations in question have in fact found another pathway that is more effective or efficient, and it is in fact the operational framework that is lagging.

There are also complexities introduced by the fact that networks have different reasons-for-being: examples of these include routine activities compared with flood responses; spatial and temporal differences; and mandated compared with organic 'bottom-up' ties. Thus, very different network architectures may be appropriate in different settings.

Nonetheless, network analysis can both reveal effective features and point to potential improvements in the ties studied, always leaving decisions about interventions to the network and/or its designers (as already mentioned above). In the example given above, a difficult or absent tie may become problematic if network personnel change and the workaround fails, so it is important for analysts to know how the network deals with issues in practice. Thus, for those organisations interested in strengthening their own effectiveness, the key themes of the research may be insightful in directing efforts towards creating new ties, the possible choices of collaborative partners, and how relationships with these might best be approached and maintained. Some of these are described in Section 6.2 below.

6.2 Application of SNA to climate change adaptation

How adaptive capacity manifests in a social network is a complex issue, and the state of science within network theory is not currently such that the question can be answered credibly – nor is the definition or theoretical basis for adaptive capacity well established. When broadly defined, *adaptive capacity* refers to the ability to take action that either avoids or reduces the adverse impacts of climate change, and/or help to realise any benefit from climate change (Barnett *et al* 2011, after Parry *et al* 2007). This includes the nature and extent of characteristics in a system that confers the ability to cope with change; the concept is context-specific and much literature has been devoted to understanding the various subtleties of the different applications (e.g. that reviewed by Smit and Wandel 2006).

Yohe and Tol (2002) noted that the determinants of adaptive capacity includes a range of (often interdependent) elements such as technological options; resource availability and distribution; institutional structure; human and social capital; information management and risk-spreading. Network governance studies, such as the one presented in this report, are able to contribute to an understanding of – though not any quantitative measurement of – many of these components. For example, through a SNA approach, this project provides insight into the connectedness of stakeholders, especially the importance of existing frameworks in relation to the information flows for climate adaptation. As one example, the regulatory framework which controls the

membership of the LDMG appears to be a powerful tool in not only influencing the composition of the LDMG, but also, the broader social networks involved in disaster response in both Brisbane and CQ. Figure 22 below summarises the key findings of this study (both from the network analysis as well as from the qualitative interpretations), and maps these against the core elements of adaptation as described by Apan *et al* (2010), including the enablers to adaptation, barriers to adaptation, and translating capacity into action.

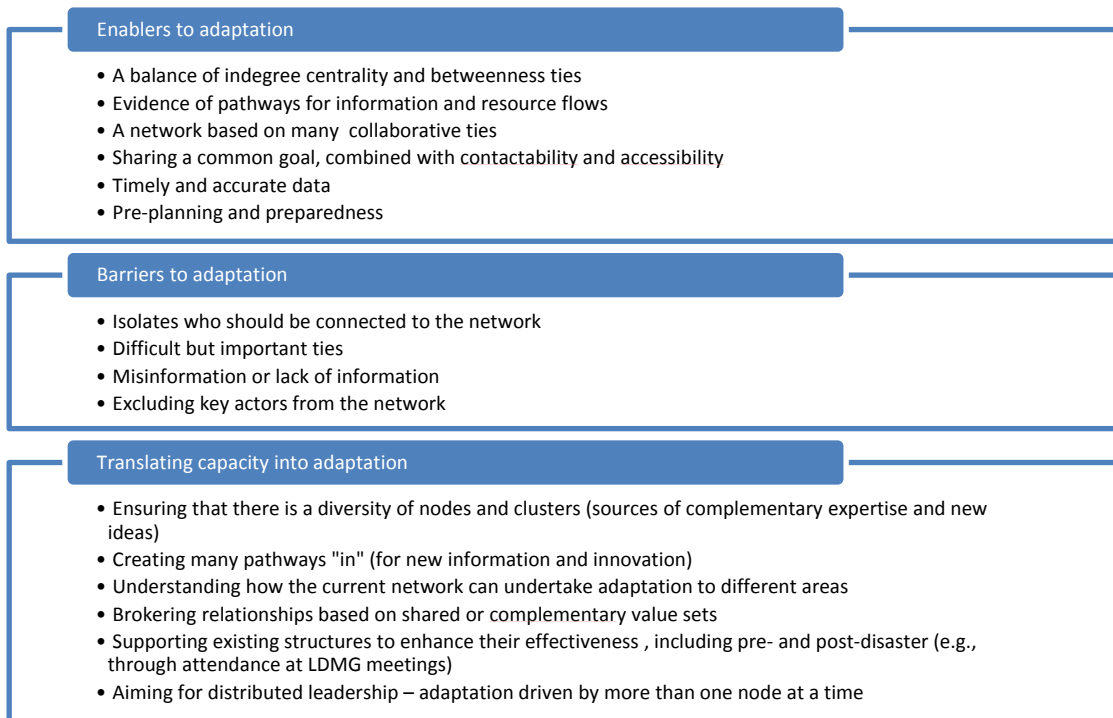


Figure 22 The key elements for climate adaptation from a network governance perspective

Under “enablers to adaptation,” the project findings strongly support the LDMG structure and values, with links that provide ways for organizations to share information, resources, and plans. The network itself can be an enabler of adaptation, since the collaboration fosters not only response operations but also preparedness, including long-range planning for increasing impacts of climate change. Collaborative efforts within the network and facilitated by this project prompt members to engage in such long-range adaptation planning.

Under “barriers to adaptation,” the project has identified both structural and management issues that need to be addressed. The network contains several “isolates,” organizations that should be connected but are not. With this information, the LDMG can work to establish ties with these isolates, to share information, collaborate, and/or plan for disaster management. Even though not completely isolated, organizations that target ethnic and other diverse groups are not as well connected in the network as they could be; new approaches to inclusion of these organizations should be explored. Fatigue and “reachability” of network members’ staff are expressed concerns highlighted in the project findings; resolution of these issues will improve disaster response and adaptive capacity. A final barrier, the lack of effective measurement definitions and criteria, has been discussed but not resolved; without good metrics, it will be difficult to know whether actions to build adaptive capacity and deploy it have succeeded.

Under “translating capacity to adaptation,” the project results point to an emerging resolution in the network to expand its scope to an “all hazards” approach, which will encompass a broad range of climate change impacts. Yet both the networks analysed in the project have adapted their structures and collaborative ties to the characteristics and needs of their specific areas. Moreover, the diversity evident in the clusters of organizations is and will be a source of new ideas, expertise, and leadership to address the increased scope. The brokering relationships add to the potential for shared and complementary values to be the basis for translating capacity to adaptation. Finally, the expressed value of participants in the project for a common goal and language points to the potential for evolving in the direction of broad-based goals and language related to adaptation.

6.3 Comparing the social networks

As expected, the two networks in this study exhibited many of the same features, yet there were also differences among the sites (Brisbane and Central Queensland). This was reflected in different network configurations, despite each having similar mandated structures with respect to the membership of the LDMG (i.e. the Disaster Management Act). For example, in both networks:

- the routine and flood operations were similar;
- all five sectors and clusters were represented (i.e. there was a range of expertise and functions within the networks);
- the types of organisations that exhibited high indegree centrality and betweenness were largely the same; and
- some difficult ties were present in both networks.

By contrast, some key differences between the study sites were the “reach” and number of organisations in each area, the participation of community-based, non-governmental organisations, as well as in the nature of the network values expressed. The implications of these findings, in terms of both policy-making and practice, are examined further below.

6.4 Recommendations

This report has been framed around identifying practical ways in which organisations (and communities more generally) might improve their adaptive capacity, through a better understanding of the role and importance of collaboration via a network governance perspective. Given the existing legislative arrangements regarding disaster management, this largely includes identifying the way the networks currently function in each location, and the way(s) in which they might be improved; compared with identifying other, entirely novel models for operating. Below, a number of suggestions are made regarding the ways in which the research findings might be applied.

6.4.1 Stakeholders need to drive adaptation to climate change through collaboration and communication

Collaboration is already acknowledged as being a critical element of effective disaster response (Waugh and Strieb 2006). The organisations participating in this study indicated that sharing information and expertise is often the greatest motivation for working with another organisation (Section 5.1.2). For example:

“... we’re a big region in geography, but were a small region in population. We can’t fix things on our own and we can’t respond to things on our own. We need the support of all government and all people in the community to help us respond ... whether that’s people being more resilient and being able to prepare

their own homes and have their own evacuation plans in place before floods, to the federal and state government having resources available. It requires cooperation from everybody..." (local government).

To facilitate collaboration, there is a need to provide detailed information to stakeholders regarding the role of the organisation within the social network: this allows for pragmatic and informed decision-making with respect to how (and where) efforts in building stronger collaborative partnerships might be directed.

What are the 'good' ties for stakeholders to make, and how should they go about making them? Overall, the research findings indicate that effective collaboration is likely to coincide with groups of organisations that share common goals and communicate effectively. However, this must be planned strategically: as a disaster unfolds, the network may change with ties becoming more numerous and/or stronger, and the potential for subgroups to form. This can be problematic if multiple subgroups respond to the same task and none respond to others: effective coordination is thus very important to minimise the potential for disorganisation (Gillespie and Colignon 1993; Hossain and Kuti 2010).

The 2012 Floods Commission of Inquiry report acknowledged that there is 'a good deal of room for improvement in planning for emergency response' (QFCoI 2012, p. 30). Many of the recommendations contained within the final report of the Commission describe very specific actions around dam operations, floodplain development, building controls and local planning instruments. However, several of the recommendations in the emergency response area highlighted the potential areas of greater collaboration that have also been examined in this study, for example:

- between councils and business owners (recommendation 15.1, p. 24);
- between Emergency Management Queensland and Councils (recommendations 15.6, 15.8 and others, p. 24-25); and
- specific mention of Central Highlands Regional Council in the context of clarifying issues of ownership and responsibility with the state-owned SunWater (recommendation 10.12).

With respect to CHRC and Sunwater, the data collected in this project suggests that a mutual, strong and positive relationship already exists between these two parties.

Communication was recognised as a key enabler of effective partnerships:

"It's important right from the start of a disaster for organisations ... to think through and settle on what they are going to communicate to the public, and then stick to it...we should have communicated to the public that we don't need the donation of goods or clothes, we need the donation of money so we can issue funds to victims who can buy goods and clothes from the existing stores in the town..." (community group)

In addition, the risk of fatigue was also a recurring theme in the responses from both networks, and the importance of this issue should not be underestimated. Existing research suggests that some of the key triggers for fatigue and stress amongst disaster management personnel include the complex and unpredictable nature of disaster management, lack of communication, dealing with the media, and operating in team environments (Paton 2003, Paton and Flin 1999). As a result of the increasing number of global disasters, many guidelines have been developed for managing and mitigating worker fatigue (e.g. NRT 2009). However, these appear to be focussed on reducing physical and operational hazards (e.g. injury from debris; lack of sleep), rather than

facilitating a better network environment (e.g. familiarity with collaborating organisations). Increased levels of effective collaboration, good leadership and strong communication pathways may help to alleviate the fatigue that may be experienced during flooding and other disaster events.

6.4.2 Stakeholders need to share a common goal and language

Effective climate adaptation relies on a complex set of parameters that include not only access to, and quality of, information, but also the method in which it is delivered, and by whom; and a range of different and competing incentives and barriers for adaptation. The national plan for socioeconomic and institutional dimensions in Australian climate change adaptation research identified that understanding how ‘shared symbols, beliefs and practices’ was a critical issue in understanding the enablers and barriers to collective adaptation (Barnett *et al.* 2011, p. 6). This sentiment was echoed by participants in this research:

“...you need a common frame of reference to communicate with; it’s [with] communication and awareness that there are differences...” (local government)

There is a need for a broad cross-section of the community to come to a consensus about a ‘common goal’ in responding to the impacts of extreme weather events. The *Disaster Management Act* suggests that a common goal would be that of a ‘prepared, resilient community’, but this is a somewhat abstract concept with no obvious metrics for success. If organisations feel that they are working toward the same goals and using terminology in the same way, they will tend to be more efficient as well as effective, thus increasing the odds of success and future expanded collaboration. Thus, devoting time and resources to collaboratively articulating goals will be important for network effectiveness. Seeking out organisations with complementary skill sets (or resources) is likely to be a useful strategy for those organisations wishing to increase their adaptive capacity through collaboration. However, care should be taken to establish the links of common goals and mutually understood ways of communicating (see Section 6.4.2). It is not enough to establish such links via mandate or other impersonal process (Brummel *et al.* 2012). For example, “effectiveness” involves matching network nodes with ties that people consider effective: for some (organisations and situations) that might mean full, free, and accurate information flows; for others, it might mean the development of trust ties.

The workshop discussions highlighted concerns amongst participants about achieving a community outcome of minimal impact/rapid recovery (Section 5.8.2). This may reflect the accountabilities of different organisations, with governmental organisations accountable for the former and community organisations more accountable (by mission statement) for the latter. These are complementary objectives, so one focus of developing network ties could be to build that complementarity. For instance, governmental draft disaster management plans, and by extension draft climate adaptation plans, could be the starting point for scenario exercises in which community organisations critique the plans based on real-world knowledge of people, animals, and natural resources likely to be affected.

The need for shared language, and a well-functioning communication and information system was also highlighted throughout the project, particularly by stakeholders in the Brisbane network (Section 5.6.1). For example, an accurate and consistent terminology to describe flood levels is particularly essential in Brisbane, where water releases from Wivenhoe Dam can potentially have far reaching impacts on stakeholders and infrastructure further along the Brisbane River. There is a need to develop strategies to translate technical engineering language into an easily understood and well accepted

terminology, and to develop and improve communication platforms to support incident coordination at operational, tactical and strategic levels. Curating and sharing information for disaster management, particularly through the use of information technology systems, is already a field of study in its own right (NRC 2007). Developing a centralized database to enable a shared, consistent view of the unfolding incident would be a useful pathway to coordinated adaptation.

6.4.3 There is a need for better engagement with community, diversity and Indigenous organisations

It is already known that climate change has a disproportionate impact on vulnerable sectors of society, such as the poor, the very old, the very young, and the sick (NCCARF 2012b). So, too, it has been recognized that the socially vulnerable are amongst the most likely to be affected by disaster events (Flanagan *et al.* 2011). In many cases, these population cohorts are serviced by the community sector as well as by government; so it is important that climate change adaptation initiatives make provisions for community groups to be fully involved in the response. Within the disaster management setting, this research has highlighted a clear need to identify and implement appropriate forms of engagement such that NGOs can participate effectively in disaster response activities (and climate change adaptation more generally). This was clearly highlighted by a comment from an Emerald participant:

“...marginalised people are affected very differently...we had a strange scenario whereby we got a call from an Elder in Emerald about some elders in Blackwater who said they had no food... it still comes down to the individual and local knowledge. We just assumed that the elders would have been taken care of but we don't know how organisations were checking them...”

Emergent response groups who are not formally associated with disaster management may comprise relief organisations, private sector organisations and/or members of the public, such as volunteers with little or no training in emergency response. These actors may join together to provide necessary resources and may fill voids that are not otherwise covered by formal operations (Majchrzak *et al.* 2007). If so, such non-governmental groups might contribute significantly to the capacity of communities to deal with disasters (Waugh and Streib 2006), but their involvement may also create communication problems due to the increased number of information paths created within the network (Hossain and Kuti 2010). For example, where multiple groups try to address the same issue, problems can arise when different groups receive different information at different times and respond accordingly without coordinating their actions. This situation was identified in the aftermath of Hurricane Katrina when communication infrastructure failed and multiple groups were responding independently to the same crisis (Comfort 2007).

According to NCCARF (2012c), an organisation's ability to anticipate, prepare, respond and recover from climate-induced disasters is dependent on a range of factors, including access to information, socio-economic status, capacity to mobilise financial and other resources, and participation in social networks. This research suggests that the formal membership of LDMGs is a powerful influence on the overall social network for disaster response. The results also suggest that current LMDG membership in the case study locations reflects both the requirements as set out by relevant legislation, and the 'health' of stakeholder relationships in particular locations. Introducing a more flexible and inclusive LDMG membership may be useful in introducing new sectors of the community into climate change adaptation. An important caveat here is that this is likely to be meaningful only where (a) existing members recognize the need for, and value of, any new partners and (b) where new entrants can provide for a network

response, or resources, that are not already being fulfilled by existing members. Issues of information sensitivities must also be considered (e.g. media representation).

For example, currently, the Disaster Management Act only allows for participation in the LDMG by 'local industry and community representatives, or others, as deemed applicable'. Section 48A of the Act makes provisions for the LDMG Chair to invite 'essential providers' to attend meetings and/or receive reports and recommendations; but this is included in the context of hard infrastructure providers (gas, electricity, telecommunications, water, sewage) (DCS 2011, pp. 31-32) rather than providers of community services. It may be appropriate for this to be revisited to include a more explicit focus on participation of community services organisations. This finding is supported by earlier work following the large-scale flooding that affected Queensland in 2008, where Apan *et al.* (2010) reported the views of residents and business owners in the townships of Charleville and Mackay about how well-prepared they believed different types of organisations were for future flood events. Here, the Bureau of Meteorology, state government organisations and social welfare organisations were considered to be amongst the best-prepared entities; compared with utilities providers, commonwealth government and local government organisations. These data may be useful in considering the outcomes of the workshop activity on LDMG membership, as here, it was the Bureau of Meteorology, local and state government who were most likely to receive nominations to lead the community response via the LDMG (see Section 5.7.1). There was also acknowledgement that community groups should be involved, although the specific nature of this involvement, and which particular entities it would embrace, remained less clear.

An important note was a sentiment captured from the CQ stakeholder workshop, which was that it is not desirable to establish a single officer to represent all community groups on the LDMG because these groups cover many different tasks and it would be difficult for one person to have authority to act on behalf of all the groups. Rather, a community welfare sub-committee might be more appropriate. Another possible pathway may be to have leading network organisations 'reach out' to specific community organisations in order to build informal trust ties – for example, through site visits, or attendance at their planning meetings.

6.4.4 There is a need to establish the foundations of collaboration outside of disaster events

Stakeholders repeatedly mentioned the value of building relationships outside of peak crisis periods, for example, through desktop or simulation exercises. For example:

"...building relationships in advance with key people rather than trying to build relationships while everything's falling down..." (community group).

As emergency ties are likely to grow out of pre-existing routine ties, pre-established relationships are very important as they then become drawn on in difficult situations (Norris *et al.* 2008). Hence, culturing strong collaborative ties within a region can help to form a foundation on which adaptive responses can be built.

Network governance also provides both a degree of centralized control and also flexibility in adding nodes during crisis situations. Because each disaster is unique in some ways, planning can only accomplish part of the actual response activities needed. Here the foundations (shared goals, training, building of network ties) will be particularly important. The network's prior ties to communities will help them become better able to provide for their own needs and manage their expectations of outside assistance

For example, formal collaborative partnerships between core members of the LDMG could be established with those organisations that are currently ‘on the fringe’, such as the community groups that interact with diversity and minority groups during a disaster event. A possible starting point may be to include these actors in relationship-building exercises outside of peak disaster response periods: this would provide an opportunity to build the values of familiarity, trust, local resourcing and inclusivity that were expressed by many of the research participants (Section 5.6), without the pressures of time-sensitivity that accompany the acute response period. In time, this may help to remove the ‘invisibility’ of these groups and a better acknowledgement of the role that they may play in disaster management.

6.4.5 Network governance systems should play an important role in facilitating climate change adaptation

Effective climate change adaptation should result in changes in how institutional and governance frameworks operate. The strength of the network governance approach is in the system features of flexibility and adaptiveness and distributed/localised leadership. For example, understanding how network structure affects inter-organisational coordination and disaster outcomes may help to identify specific resourcing for relief or recovery activities (Moore *et al.* 2003).

The use of a partnerships (=network governance) approach may offer the ability to establish greater flexibility and inclusivity around climate-induced disaster events, particularly where this is complementary to what formal government can do. For example, this could be achieved in two ways: adapting the current membership, or by establishing a complementary network. The latter is quite a different approach to simply suggesting a policy change that would see new actors join the LMDG: this could result in interference and the formation of difficult ties (actual or perceived), particularly given that it was uncommon for the existing members to indicate that these groups should become members (see Section 5.8.1).

The development of adaptive response to climate change must also account for the interconnectedness of different sectors, and the value in working across them. Effective adaptation will not be achieved unless organisations work collaboratively:

“...we’ll collaborate much more in the future because it increases and widens communication channels for key stakeholders exponentially...” (Brisbane participant).

“...we need ongoing relationships with all organisations [so] they understand our local communities, the way it operates and what it needs, and they’re willing to listen and be flexible in their response...” (Emerald participant).

In this context, building collaborative government and governance frameworks is an important strategy to help achieve water security (that is, manage supply/demand issues) as well as reduce the risks of extreme events (that is, manage extreme floods in terms of planning, response and recover efforts). Within in, it is important that the financial and human resource commitment required to sustain strong collaboration over time is also considered.

Finally, an inclusive network governance approach is also important in building adaptive capacity from the perspective of helping to overcome the ‘churn’ of staff members or others who participate in the network. The nature of disaster response work, and or regional communities in particular, suggests that high staff turnover rates

are common (Furbee *et al.* 2006). Without proper management and succession planning, this can lead to loss of key corporate (or network) knowledge: evidence of this in the current study was repeated concerns over the ability to easily identify and/or provide contact details for key network players (see Section 5.7.2).

6.4.6 Ongoing research is needed into the social dimensions of climate change adaptation

The work undertaken during this project highlighted several new areas of research enquiry for SNA, including the following topics:

- What is adaptive capacity and how does it manifest within a social network?
- What are the appropriate methodological techniques to study climate adaptive behaviours using SNA? In particular, this includes novel methods of collecting data, including network sampling so that the actors from the periphery of the network are represented.
- Distinguishing between the ‘macro-level’ (network structure) and ‘egocentric level’ (the position of an individual actor in the network) with respect the most advantageous structure for adaptation and learning.
- Developing ways to measure the effectiveness of networks for environmental governance.
- A study of ‘exogenous learning’ – that is, how does information travel and become shared *between* regions, and what impact might this have on increasing (or accelerating) climate change adaptation?

Due to time and resource limitations, this study has only examined ‘snapshots’ of the social networks operating in Brisbane and Central Queensland. For disaster management – and indeed, climate change adaptation more broadly – longitudinal studies would be very helpful in understanding changes to the network. A related work could be that of including measures of network adaptability, such as the extent of flexibility, innovation and/or the rate at which network positions are changed in response to internal and external stimuli. This may be insightful in understanding the potential for climate change adaptation from a much more ‘embedded’ perspective: that is, whether particular regions or communities are better suited for adaptation due to the nature of their networks.

Other potential research topics, not necessarily related to SNA, also include:

- How can communities and stakeholders be encouraged and resourced to come to a shared goal with respect to climate change adaptation, given the mixture of different drivers at play?
- What are the most effective way(s) to communicate disaster information to the general public; for example, through studies of shared language, meaningful terminology and the use of social media)?
- How can community diversity groups (e.g. Indigenous or other cultural groups, special medical-needs groups, aged care, fly-in and fly-out residents) be better considered with respect to climate change adaptation? For example, this includes managing these groups both as liabilities and as resources.
- How might the changing nature of regional cities and towns be impacting on adaptive capacity, in the network sense? For example, growth of the resources sector may bring entirely new businesses and organisations into a centre: these are essentially new actors which must be articulated into the existing network. Is there an erosion of adaptive capacity if the network is fundamentally changed by new entrants, too often?
- Climate events as an opportunity to drive innovation in regional communities.

6.5 Constraints to the study

The key constraints to this study include:

- the collected data reflect only two ‘snapshots’ of the social networks at each location, for routine and flood operations;
- data collection occurred approximately 14 months after the 2010-11 major flood event, so it is possible that respondent’s perceptions and recollection of interactions with stakeholders have been influenced by this passage of time;
- there is also a the possibility that some answers provided by respondents were coloured by the media coverage associated with the Floods Commission of Inquiry; and
- it was not possible to secure an interview with all of the organisations that received nominations by others in the network; and some organisations were only comfortable with partial completion of the survey.

6.6 Conclusion

The results of this study show that the networks are structured to provide many ties to central points as well as dispersed pathways to less connected nodes. The networks contain a relatively small number of difficult ties that are also important. These results were complemented by qualitative analyses of open-ended survey questions and data collected at the workshops, which showed that values within the network ranged from reliance on structured roles, responsibilities, and information flows; to community wellbeing and inclusiveness. Both the quantitative network diagrams and analyses, and the qualitative results, show networks that are functioning well in some major respects but also raise issues that suggest potential improvements tailored to the study areas. The strengths of the current networks indicate that they are positioned to incorporate the dynamic conditions of climate change into their prevention, preparation, response, and recovery activities. Overall, this research has demonstrated that the use of a network approach, based in both qualitative and quantitative methods, is useful in providing an increased understanding of how social networks can contribute to the governance of water resources in both routine and flood conditions. The work also provides insight into how network governance systems may assist with changing routine and sudden-onset conditions, in response to climate change.

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APPENDICES

Appendix A: Research survey instrument

The following sheets were provided to participants prior to participation in the study.

RESEARCH PROJECT - INFORMATION SHEET

How can your organisation collaborate better on climate change adaptation?

A social networks analysis study being led by CQUniversity Australia

What is this project about?

This study has been funded by the National Climate Change Adaptation Research Facility (NCCARF) and will investigate the use of 'social networks analysis' (SNA) to understand how regional organisations and groups communicate and share information about water resources and flooding disasters. The project commenced November 2011 and will run to December 2012. For communities to be able to respond to climate change, finding ways to effectively communicate information will be critically important. SNA has successfully been already used to help manage complex problems, such as in natural resource management as well as disaster management. However, this research project is the first time SNA will be used to assist water resource management and responses to flooding. Specifically, the research will focus on the three case study areas of Central Queensland (Rockhampton and Emerald) and South-East Queensland (Brisbane). We have a project team that includes Australian and American research experts, and we intend to engage closely with the key stakeholders from the three case study areas. The project outputs will include preparing research reports, articles and fact sheets, as well as staging stakeholder workshops. The key outcomes will be to help local organisations work more effectively, and to help develop policy at the regional, state and national levels.

How you can be involved

Our research team is interested in interviewing representatives from organisations involved in management of water resources and infrastructure; and/or in disaster management and the recovery effort during periods of flooding.

If you are over 18 years of age, you can participate in this research by agreeing to spend approximately 30-45 minutes doing a survey with us, in the form of either a telephone or face-to-face interview. We will email you a copy of the survey questions 15 minutes ahead of the agreed interview time, so that you can familiarise yourself with the document. During the interview, you will be asked questions about how your organisation operates, and in particular, the ways in which it communicates and collaborates with other organisations. There will also be some questions regarding how you might expect your organisation to operate in the future. There are no right or wrong answers, and the responses should be given on behalf of your organisation, not in a personal capacity. Interviews will be conducted by a researcher from CQUniversity or Griffith University, at a time convenient to you.

Rights and confidentiality

The answers from the survey will be used by our team to identify the ways in which organisations in your community interact with each other, and how this influences

decision-making on water resources management and/or the overall response to flooding. The anonymity of individual participants will be maintained at all times – we will record your answers by your organisation, not by your name. If you feel uncomfortable at any point, you are free to withdraw from the research. You can also withdraw your permission for us to use your unprocessed information, even after the interview has taken place. The data gained from this research project will be stored for 5 years in accordance with the CQUniversity Code of Conduct for Research. All information is treated confidentially, and access to the data is limited to the needs of the research team only. This research has been approved by the CQUniversity Human Research Ethics Committee. The Approval Number is H12/02-021. If you have any complaints or reservations about the ethical conduct of this research, you may contact the Office of Research on (07) 4923 2603 or ethics@cqu.edu.au. Any issues you raise will be treated in confidence and investigated fully, and you will be informed of the outcome.

Who do I contact for more information?

This research project is being managed by:

Dr Susan Kinnear

Sustainable Regional Development Programme Leader, Centre for Environmental Management

Building 7/1.03 | Bruce Highway, North Rockhampton, Queensland 4702

PH +61 (0) 7 4930 9336 | s.kinnear@cqu.edu.au

Dr Kinnear will be happy to answer any questions you may have regarding this research.

What do I do now?

Thank you for your willingness to participate in this research – we appreciate your involvement. The next step is to contact our research team to determine a convenient time for us to interview you.

However, please first note this **important information**: we would like to collect **data about your organisation, not yourself as an individual**. There may be important legal or employment issues that need to be considered by you, or your organisation, before participating in this research. *We suggest that you send this information sheet to an appropriately authorised person within your organisation to discuss and approve your participation, before you schedule an interview time with us.* If any questions arise during this process, or you would like a project representative to talk with, please contact Dr Susan Kinnear using the information above. Thank you again for supporting our research project.

**SOCIAL NETWORKS ANALYSIS FOR CLIMATE CHANGE ADAPTATION
(NCCARF PROJECT SD11 10)
Survey questions to collect primary data from target organisations**

Part A: ORGANISATIONAL PROFILING

Qualifying Question

1. Can you please confirm that you are over 18 years of age, that you are prepared to answer this survey on behalf of [organisation], and, where necessary, you have sought advice on participation with your management?
 - Yes or
 - No (would you like arrange another interview time after speaking with your managers?) or
 - No (sorry, but we can only accept response from adults in this research. Would you be able to direct us to another person within your organisation?)

Organisation details

2. Can I please confirm your organisation name as
3. In one or two sentences, could you briefly describe the key role of [organisation]?
4. How many full time equivalent employees does [organisation] have?
5. Do [organisation] have any volunteers? If yes, how many?
6. What is the geographic area that [organisation] services (e.g. town or region)
7. How long has [organisation] been operating in [town]?
8. Is [organisation] involved in [Town]'s Local Disaster Management Group?

Yes (member)	Yes (allied member/observer)	No	Not sure
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Roles and responsibilities:

I'd like to ask you some questions about what [organisation] does.

9. Can you please tell me how [your organisation] is involved with the routine (day-to-day) management of water resources and infrastructure in [location]? Please tick all that apply.

	Physical infrastructure management - water catchment and storage (dams or weirs)
	Physical infrastructure management - water treatment facilities
	Physical infrastructure management - water transport/distribution networks and/or sewerage management
	Distribution- retail (sale and delivery)
	Stream flow gauging - data collection and analysis
	Stream flow management including dams and weirs
	Water quality monitoring
	Rainfall monitoring
	Climate data and modelling (e.g. seasonal, annual or daily forecasting)
	Municipal supply/demand modelling
	Community education and information dissemination
	Policy development / Regulatory compliance
	Other (please describe)

OR:

	Not involved in the management of water resources and/or infrastructure
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10. Can you please tell me how [your organisation] is involved with planning and/or management of disaster response and/or recovery in [location]? Please tick all that apply.

	Management and coordination – emergency response (including evacuations)
	Operation of community recovery centres
	Deployment of personnel – monitoring
	Deployment of personnel – recovery and rescue
	Resources support (e.g. tools, materials and supplies, but not human resources)
	Planning, assessment and/or delivery of essential services – power
	Planning, assessment and/or delivery of essential services – road/rail/air transport
	Planning, assessment and/or delivery of essential services – food and water
	Planning, assessment and/or delivery of essential services – health and medicinal
	Planning, assessment and/or delivery of temporary shelter/housing
	Planning, assessment and/or delivery of other services – (please describe)
	Risk reduction through land-use planning
	Risk reduction through social and community planning
	Risk reduction through water resources/water infrastructure planning
	Communications/information dissemination (including media liaison, flood alerts)
	Other (please describe)

OR:

	Not involved in planning, management or implementation of disaster response/ recovery
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11. And again, thinking about routine operations, does [organisation] use any formal policies or frameworks for communication and/or collaboration with other organisations?

Yes - please describe	No	I don't know
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12. I'd like you to think about [organisation]'s reasons for working with another organisation, and indicate what these are for each of routine and flood operations. Please answer with a yes, no or not sure in each column/row.

Organisation works with others	During routine operations	During flood operations
To satisfy regulatory/policy compliance		
To obtain or share information		
To access or share specialised expertise		
To access or share resources (personnel – general labour)		
To access or share resources (physical assets)		
To access or share resources (funding)		
To coordinate response/recovery efforts		
To reach more stakeholders		
Something else (please describe)		

I'd now like you to think about how [organisation] operates when major flood event occurs.

13. Would you say that collaboration becomes more or less important for [organisation] during a flooding disaster?

1 – much more important	2 – more important	3 –neutral or same	4 – less important	5 – much less important	Don't know
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14. Thinking back to previous flood events, and considering the network of communication and cooperation that [organisation] relies on, can you list any ways in which collaborative relationships between organisations could be improved? If yes, what are these?

Nature of the organisation

15. This set of questions is focussed on the *nature* of [your organisation]. Could you please indicate how much your organisation

	1 - very little	2 - only a little	3 - neutral	4 – some what	5 - very much	Don't know
.. relies on pre-existing, proven policies and procedures						
... experiments with new communication technologies						
....continually makes policy and process changes						
....is flexible in how it communicates, and who with						

Part B: Identifying your collaborating organisations

This research project is focussed on collecting information relevant to the water sector – that is, the management of municipal supplies, as well as examine disaster management, in the context of extreme flooding. In this section, we'd like to know what other entities [organisation] collaborates with, and a little about the nature of those relationships.

16. I'd like you to think about {organisation's} routine operations - for example, on a weekly to monthly basis. To what degree does [organisation] collaborate with one or more organisations on water and/or disaster management?

1 – Always collaborates; a great deal of collaboration	2 – Often, collaborates a lot	3 – Some collaboration	4 – rarely, collaborates little	5 – never collaborates at all	Don't know
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17. And thinking about your **routine operations**, could you please name those organisations that are **essential** for [organisation] to collaborate with? Please note, we are interested in the key organisations with whom you collaborate, not **all** organisations.

18. And thinking about your operations **specifically during flood events**, could you please name those organisations are **essential** for [organisation] to collaborate with? Please note, we are interested in the key organisations with whom you collaborate, not **all** organisations.
19. Thinking about [organisation] overall, which is your most important collaborator with **overall**? Why?
20. I'd now like you to comment on the relationship between [organisation], and each of the entities you've just listed. Please think about [collaborating organisation #]

	5 - Strongly agree	4 - Agree	3 - Neutral	2 - Disagree	1 - Strongly disagree	Don't know
a) #1 provides {organisation} with data, knowledge or information						
b) #1 provides {organisation} with resources (e.g, funding, human resources)						
c) [Organisation] provides #1 with data, knowledge or information						
d) [Organisation] provides #1 with resources (e.g. funding, human resources)						
e) #1 is easy for {organisation} to collaborate with						
f) {Organisation} can trust #1						

21. Thinking about organisations working in your sector, what **characteristics** make them effective for [organisation] to collaborate with during a flood event?
22. And again thinking about organisations working your sector, what **characteristics** make them difficult for [organisation] to collaborate with during a flood event?
23. Thinking back to previous major flood events (for example, in 2010/11), and the network of collaboration that [organisation] was involved with, were there any gaps in information or collaboration that were a problem for [organisation]? Could you please describe these?

Part C: Communication and collaboration in the future

This is the last section of the survey, and we'd now like you to think about activities and challenges for the future. In particular, the Intergovernmental Panel on Climate Change has stated that there is 'medium confidence that heavy rainfall will contribute to increases in local flooding in some regions⁸'. Keeping this in mind,

24. How do you think [organisation] will collaborate with others in the future?

1 – much more collaboration	2 – some collaboration	3 – neutral or same	4 – less collaboration	5 – much less collaboration	Don't know
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Can you please explain why?

25. Again, reflecting on the future are there any organisations that you **haven't worked with before**, that you think [organisation] will need to collaborate with in the future? Who and why?

26. Thinking about the Local Disaster Management Group, and flood events in the future, would { organisation} prefer to

Remain a member or allied member/observer	Become be a member/ allied member/observer	Prefer not to be involved	Not sure
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Can you please explain why?

27. Finally, would you be able to suggest ways that the network of collaboration in [location] could be improved to better manage flooding events in the future?

Part D: Close

28. Is there anything else **of importance** you would like to add before we close?

29. Thank you for your participation in the survey. We will be preparing a short summary of our research findings for people and organisations who participated in this research.

- a) Would [organisation] like a copy? If yes, please provide contact details.
- b) Would you [individual] like your own separate copy? If yes, please provide contact details. Please note, we will protect your anonymity – this information will not be stored together with your response.

⁸ SREX 2012 – Managing the risks of extreme events and disasters to advance climate change adaptation, Summary for Policymakers , p. 11

Appendix B: Characteristics of respondent organisations

Organisation name	Number of responses^	Region^^	Sector	Cluster
AgForce	1	CQ	Commerce and Industry	Policy and Information Providers
Aurecon	1	Rockhampton	Commerce and Industry	Policy and Information Providers
Brisbane City Council	2	Brisbane	Local Government	Planning and delivery of emergency response
Brisbane Transport	1	Brisbane	Local Government	Support for emergency operations
Bureau of Meteorology (Brisbane)	1	Brisbane	Federal Government	Policy and Information Providers
Bureau of Meteorology (CQ)	1	CQ	Federal Government	Policy and Information Providers
Capricorn Enterprise	1	Rockhampton	Commerce and Industry	Support for emergency operations
Capricornia Correctional Centre	1	Rockhampton	State Government	Support for emergency operations
Centacare	1	Rockhampton	Community Organisations	Planning and delivery of emergency response
Central Highlands Development Corporation	1	Emerald	Commerce and Industry	Support for emergency operations
Central Highlands LDMG	1	Emerald	Local Government	Water and Disaster Management Generalists
Central Highlands Regional Council	4	Emerald	Local Government	Water and Disaster Management Generalists
CQ Indigenous Development	1	Emerald	Community Organisations	Planning and delivery of emergency response
CQ Multicultural Society	1	Rockhampton	Community Organisations	Support for emergency operations
CQ News	1	Emerald	Commerce and Industry	Policy and Information Providers
Centrelink	1	Brisbane	Federal Government	Support for emergency operations
Dam safety unit	1	Brisbane	State Government - water	Policy and Information Providers
Defence force	1	Rockhampton	Federal Government	Planning and delivery of emergency response
Department of Community Safety	1	Brisbane	State Government	Support for emergency operations
Department of Education Training and Employment	1	Rockhampton	State Government	Planning and delivery of emergency response
DEEDI	2	Rockhampton	State Government	Planning and delivery of emergency response
DERM (Brisbane)	1	Brisbane	State Government	Policy and Information Providers
DERM (CQ)	1	Rockhampton	State Government	Natural resource management
Department of Transport and	1	Emerald	State Government	Support for emergency operations

Organisation name	Number of responses^	Region^^	Sector	Cluster
Main Roads (Emerald)				
Department of Transport and Main Roads (Rockhampton)	1	Rockhampton	State Government	Planning and delivery of emergency response
Emerald Chamber of Commerce	1	Emerald	Commerce and Industry	Support for emergency operations
Emergency Management QLD (Brisbane)	1	Brisbane	State Government	Support for emergency operations
Emergency Management QLD (CQ)	1	Rockhampton	State Government	Support for emergency operations
Ergon	1	Emerald	Commerce and Industry	Support for emergency operations
Fitzroy Basin Association	1	Rockhampton	Community Organisations	Policy and Information Providers
Fitzroy River and Coastal Catchments	1	Rockhampton	Community Organisations	Policy and Information Providers
Fitzroy River Water	1	Rockhampton	Local Government	Natural resource management
Hastings Deering	1	Rockhampton	Commerce and Industry	Support for emergency operations
Link Water	2	Brisbane	State Government - water	Natural resource management
Local Government Association QLD	1	Brisbane	Local Government	Planning and delivery of emergency response
Maritime Safety QLD	1	Rockhampton	State Government	Support for emergency operations
Origin Energy	1	Brisbane	Commerce and Industry	Support for emergency operations
QBuild	1	Rockhampton	State Government	Planning and delivery of emergency response
QLD Ambulance Service	1	Emerald	State Government	Planning and delivery of emergency response
QLD Department of Communities (Emerald)	1	Emerald	State Government	Support for emergency operations
QLD Department of Communities (Rockhampton)	1	Rockhampton	State Government	Support for emergency operations
QLD Fire and Rescue Services (Brisbane)	1	Brisbane	State Government	Planning and delivery of emergency response
QLD Fire and Rescue Services (CQ)	1	Rockhampton	State Government	Planning and delivery of emergency response
QLD Health (Brisbane)	2	Brisbane	State Government	Water and Disaster Management Generalists
QLD Health (CQ)	1	Emerald	State Government	Planning and delivery of emergency response
QLD Rail	1	Emerald	State Government	Planning and delivery of emergency

Organisation name	Number of responses [^]	Region ^{^^}	Sector	Cluster
QLD Urban Utilities	2	Brisbane	State Government - water	response Natural resource management
RACQ CQ Rescue Helicopter	1	CQ	Community Organisations	Support for emergency operations
Red Cross (Brisbane)	1	Brisbane	Community Organisations	Planning and delivery of emergency response
Red Cross (CQ)	1	Rockhampton	Community Organisations	Planning and delivery of emergency response
Rockhampton Airport Operations	1	Rockhampton	Local Government	Planning and delivery of emergency response
Rockhampton LDMG	1	Rockhampton	Local Government	Water and Disaster Management Generalists
Rockhampton Regional Council	1	Rockhampton	Local Government	Water and Disaster Management Generalists
RSPCA	1	Rockhampton	Community Organisations	Support for emergency operations
Salvation Army	1	Rockhampton	Community Organisations	Planning and delivery of emergency response
SEQ Water	1	Brisbane	State Government - water	Natural resource management
SEQ Water Grid Manager	1	Brisbane	State Government - water	Policy and Information Providers
Stanwell Power Station	1	Rockhampton	Commerce and Industry	Natural resource management
State Emergency Service (Emerald)	1	Emerald	Local Government	Water and Disaster Management Generalists
State Emergency Service (Rockhampton)	1	Rockhampton	Local Government	Planning and delivery of emergency response
SunWater	1	Emerald	Commerce and Industry	Natural resource management
The Morning Bulletin	1	Rockhampton	Commerce and Industry	Support for emergency operations
Yeppoon Coastguard	1	Rockhampton	Community Organisations	Planning and delivery of emergency response

[^] This number indicates how many respondents participated in the survey, for a given organisation. Where necessary, these responses were collapsed to one representative value per organisation, for use in the network analysis

^{^^} Organisations listed as 'CQ' indicated that they had operations in both the Rockhampton and Emerald study locations

Appendix C: Abbreviations used to identify respondent and non-respondent organisations in network diagrams

Organisation name	Abbreviated name	Network
AgForce	AgForce	CQ
Air traffic control	Air traffic control	CQ
Airline handling agency	Airline handling agency	CQ
Allconnex	Allconnex	Brisbane
Anglicare	Anglicare	CQ
Anglo coal	Anglo coal	CQ
Australian Maritime Safety Authority	MSA	CQ
Aviation fire fighting services	Aviation fire fighting services	CQ
Aviation ground handling	Aviation ground handling	CQ
Banana Shire Council	Banana Shire Council	CQ
Banana Shire LDMG	Banana Shire LDMG	CQ
Barcaldine Regional Council	Barcaldine Regional Council	CQ
Blackall Local Council	Blackall Local Council	CQ
BMA	BMA	CQ
Boating and Fisheries Patrol	Boating and Fisheries Patrol	CQ
Bottle water suppliers	Bottle water suppliers	Brisbane
Boyne-Calliope Sub Region	Boyne-Calliope Sub Region	CQ
BP	BP	Brisbane
Brisbane City Council	BCC	Brisbane
Brisbane District Disaster Management Group	Brisbane DDMG	Brisbane
Brisbane LDMG	Brisbane LDMG	Brisbane
Brisbane Port Authority	Brisbane Port Authority	Brisbane
Brisbane Transport	BCCT	Brisbane
Bundaberg Council	Bundaberg Council	CQ
Bureau of Meteorology	BoM	Brisbane/CQ
Caltex	Caltex	Brisbane
Capricorn conservation council	CCC	CQ
Capricorn Enterprise	Cap Enterprise	CQ
Capricornia Correctional Centre	Prison	CQ
CD Adams Real Estate	CD Adams Real Estate	CQ
Centacare	Centacare	CQ
Central Highlands Automotive	Central Highlands Auto	CQ
Central Highlands Development Corporation	CHDC	CQ
Central Highlands LDMG	CH LDMG	CQ
Central Highlands Regional Council	CHRC	CQ
Central Highlands Regional Resources Use Planning Cooperative	CHRRUP	CQ
CQ Indigenous Development	CQID	CQ
CQ Multicultural Society	CQ Multicultural Society	CQ

Organisation name	Abbreviated name	Network
CQ News	CQ News	CQ
Centrelink	Centrelink	Brisbane/CQ
Courts	Courts	CQ
CQUniversity	CQUniversity	CQ
Dam owners	Dam owners	Brisbane
Dam safety unit	Dam safety unit	Brisbane
Dawson Catchment Coordinating Association	DCCA	CQ
DEEDI	DEEDI	Brisbane/CQ
Defence force	Defence	Brisbane/CQ
Department of Community Safety	DCS	Brisbane
Department of Education Employment and Workplace Relations	DEEWR	CQ
Department of Education Training and Employment	DETE	CQ
Department of Housing and Public Works	Department of Housing and Public Works	CQ
Department of local government and planning	Department of local government and planning	CQ
Department Transport and Main Roads	EMD/ROK/DTMR	Brisbane/CQ
DERM	DERM	Brisbane/CQ
Emerald Chamber of Commerce	EMD Chamber of Commerce	CQ
Emerald Chamber of Commerce Members and Associates	Emerald Chamber of Commerce Members and Associates	CQ
Emerald Neighbourhood Centre	Emerald Neighbourhood Centre	CQ
Emergency Management QLD	EMQ	Brisbane/CQ
Energex	Energex	Brisbane
Ensham	Ensham	CQ
Ergon	Ergon	CQ
Federal government	Federal government	Brisbane/CQ
Fitzroy Basin Association	FBA	CQ
Fitzroy River and Coastal Catchments	FRCC	CQ
Fitzroy River Water	FRW	CQ
Gladstone Area Promotion and Development Limited	GAPDL	CQ
Gladstone DDMG	Gladstone DDMG	CQ
Gladstone LDMG	Gladstone LDMG	CQ
Gladstone Ports Corporation	Gladstone Ports Corporation	CQ
Gladstone Regional Council	Gladstone Regional Council	CQ
Gold Coast Council	Gold Coast Council	Brisbane
Government Employee Housing	Government Employee Housing	CQ
Hastings Deering	Hastings Deering	CQ
Hydrologists	Hydrologists	CQ
Indigenous community works group	Indigenous community works group	CQ

Organisation name	Abbreviated name	Network
Internal civil operators	Internal civil operators	CQ
Ipswich City Council	Ipswich City Council	Brisbane
Isaac LDMG	Isaac LDMG	CQ
Isaac Regional Council	Isaac Regional Council	CQ
ISS security	ISS security	CQ
Ken O'Dowd MP	Ken O'Dowd MP	CQ
Kestrel	Kestrel	CQ
Lifeline	Lifeline	CQ
Link Water	Link Water	Brisbane
Local communities	Local communities	CQ
Local Government Association QLD	LGAQ	Brisbane/CQ
Lockyer Valley Regional Council	Lockyer Valley Regional Council	Brisbane
Longreach Regional Council	Longreach Regional Council	CQ
Mackay Regional Council	Mackay Regional Council	CQ
Maritime Safety QLD	Maritime Safety QLD	CQ
Moreton City Council	Moreton City Council	Brisbane
Multicultural Affairs QLD	Multicultural Affairs QLD	CQ
Multicultural Development Association	Multicultural Development Association	CQ
National Farmers Federation	NFF	CQ
Office of the Water Supply Regulator	OWSR	Brisbane
Origin Energy	Origin	Brisbane
Police Citizens Youth Club	PCYC	CQ
Qantas	Qantas	CQ
QBuild	QBuild	CQ
QLD Ambulance Service	QAS	Brisbane/CQ
QLD Department of Communities	EMD/ROK Department of Communities	CQ
QLD Farmers Federation	QFF	CQ
QLD Fire and Rescue Services	QFRS	Brisbane/CQ
QLD Health	QLD Health	Brisbane/CQ
QLD Police Service	QPS	Brisbane/CQ
QLD Rail	QR	Brisbane/CQ
QLD Rail Holidays	QR Holidays	CQ
QLD Reconstruction Authority	QRA	Brisbane
QLD Rural Adjustment Authority	QRAA	CQ
QLD Tourism industry council	QTIC	CQ
QLD Urban Utilities	QUU	Brisbane
QLD Water Directorate	QLD Water Directorate	Brisbane
QLD Water Police	QLD Water Police	CQ
RACQ	RACQ	CQ
RACQ CQ Rescue Helicopter	RACQ Rescue Helicopter	CQ
Red Cross	Red Cross	Brisbane/CQ
Redlands City Council	Redlands City Council	Brisbane

Organisation name	Abbreviated name	Network
Regional Development Australia	RDA	CQ
Rio Tinto	Rio Tinto	CQ
Rockhampton Airport Operations	ROK Airport	CQ
Rockhampton DDMG	ROK DDMG	CQ
Rockhampton LDMG	ROK LDMG	CQ
Rockhampton LDMG evacuation sub-committee	ROK LDMG evacuation sub-committee	CQ
Rockhampton Region Recovery Committee	ROK Region Recovery Committee	CQ
Rockhampton Regional Council	RRC	CQ
Rotary Club of Rockhampton	Rotary	CQ
RSPCA	RSPCA	CQ
Salvation Army	Salvation Army	CQ
Scenic Rim Regional Council	Scenic Rim Regional Council	Brisbane
Security contractor	Security contractor	CQ
SEQ Water	SEQ Water	Brisbane/CQ
SEQ Water Grid Manager	SEQ WGM	Brisbane
SES	EMD/ROK/SES	Brisbane/CQ
Seven news	Seven	CQ
Somerset Regional Council	Somerset Regional Council	Brisbane
St Vincent de Paul	St Vincent de Paul	CQ
Stanwell Power Station	Stanwell	CQ
State government	State government	Brisbane/CQ
SunWater	SunWater	CQ
SunWater customers	SunWater customers	CQ
The Morning Bulletin	The Morning Bulletin	CQ
Three Rivers District Council	Three Rivers District Council	CQ
Three Rivers Sub Region	Three Rivers Sub Region	CQ
Tourism QLD	Tourism QLD	CQ
Translink	Translink	Brisbane
Uniting Care Community	Uniting Care	CQ
Unity Water	Unity Water	Brisbane
Vaughn Johnson MP	Vaughn Johnson MP	CQ
Virgin	Virgin	CQ
Waterways and Infrastructure Planning	Waterways and Infrastructure Planning	CQ
Whitsunday Regional Council	Whitsunday Regional Council	CQ
Win network	Win	CQ
Winton Local Council	Winton Local Council	CQ
Xstrata	Xstrata	CQ
Yeppoon Coastguard	Yeppoon Coastguard	CQ
Yeppoon Multicultural Group	Yeppoon Multicultural Group	CQ

