

# Policy networks, stakeholder interactions and climate adaptation in the region of South East Queensland, Australia

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**Abstract** The strategic use of science in regional policy-making forums often assumes collaborative interactions between stakeholders. However, other types of stakeholder interactions are possible. This paper uses the ecology of games to frame an investigation into stakeholder participation in the policy networks for regional climate change planning for South East Queensland, Australia. We tracked organisational participation in policy forums between 2008 and 2012. We then used a novel bipartite network theoretical approach to identify participation by different types of organisations across shared multiple forums, which we argue prefaces: cooperation, collaboration, support or advocacy. Network analysis was then combined with semi-structured interviews to access how scientific information was utilised across the regional network. Our results suggest that stakeholder interactions were predominately used to advocate for organisational agendas. Advocacy artificially narrows the scope of possible policy options and represents a biased, selective use of information. While advocacy is an important part of policy process, as a counter balance, explicit efforts are needed to recurrently expand the scope of policy options.

**Keywords** Social network analysis · Exponential random graph model · Governance · Science and technology policy · Science technology and society · Political science

## Introduction

This paper combines quantitative network analysis with qualitative interviews to explore the nature of stakeholder engagement within the regional climate change planning networks of South East Queensland (SEQ), Australia. As in other policy domains featuring high levels of uncertainty, patterns of stakeholder engagement, where stakeholders identify and clarify different policy solutions, play a key role in policy learning. Yet, there is an inherent tension in policy learning between impartiality and stakeholders who strategically advocate for solutions that best serve their interests. This tension occurs because each policy solution distributes benefits and costs in different ways and is heightened by the reality that most policy domains feature multiple decision-making and planning venues in which scientific information may be used.

To analyse the potential for strategic policy learning, Pielke (2007) outlines four modes scientists may adopt when engaging with policy. The ‘pure scientist’ rarely engages with stakeholders and works on problems that are interesting for sciences’ sake, rather than for practical purpose. The ‘arbiter’ engages with key policy stakeholders to help define policy relevant problems, but maintains a linear view of science impact where scientific information is generated independently from policy (Beck 2011). The ‘issue advocate’ strategically uses science to advocate for particular policy solutions, often in cooperation with a smaller coalition of stakeholders with similar policy preferences and values. The fourth

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type is the ‘honest broker’, who plays a more collaborative role amongst a broad set of stakeholders in the hope of clarifying the scope of policy alternatives and quite possibly increasing the number of alternatives for discussion and associated sense of uncertainty.

Key features distinguishing Pielke’s (2007) different modes of engagement in policy networks are the degree to which stakeholders cooperate with their organisational peers, collaborate across organisations and their level of engagement. Such features define the nature of all stakeholder interactions and not just for those involving scientists. Our hypothesis is that stakeholders predominantly engage in policy networks subjectively as advocates, rather than to support policy instruments or to impartially guide open debates on policy options. Exploring the observed mix of the engagement modes in our case study, of which advocacy is one, provides for a constructive analysis on how to manage policy networks with the objective of supporting impartial use of scientific information, thus contributing to debates about the science–policy interface within regional climate adaptation (Hanger et al. 2013).

To frame our data collection, we use the recently revived ‘ecology of games’ which describes patterns of conflict and cooperation that occur in policy domains featuring multiple venues for policy debates (Lubell et al. 2010a). The ecology of games can be operationalised as a policy network, where actors participate in different policy venues. Structural patterns associated with the various types of participating organisations preface the nature of how they interact in the policy network and speak to the ways in which the networks distil scientific information.

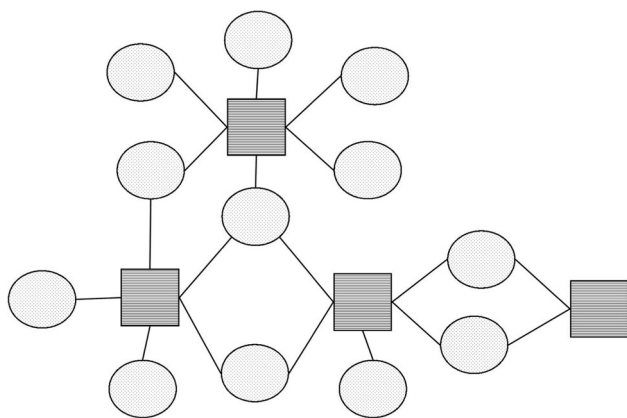
In SEQ, the contentious and highly uncertain problem of regional climate adaptation is underpinned by divergent stakeholder preferences (Bohensky and Leitch this edition; Shearer et al. 2013; Taylor et al. in press) and capacities (Keys et al. this edition). How stakeholders engage within the emerging networks determines how science is brought to bear in such policy debates and holds lesson not just in SEQ, but for other regions around the world. During our study period (2008–2012), the state of Queensland was governed by a party which made adaptation and planning for climate change a priority and also supported related scientific research programs (Matthews 2012; Burton and Mustelin in press). While the political landscape changed considerably after elections in March 2012 (Matthews 2012), essentially pausing regional climate change planning, our dataset reflects a period where policy networks developed and operated to mobilise policy, industry and research actors to attempt to understand and resolve regional climate change planning problems.

## Policy networks and network configurations

Network approaches to analysing policy systems have focused on what structural conditions matter for different policy and political outcomes, connecting structural characteristics to theoretical concepts. Various case studies have explored how the structure of networks affects governance. For example, based on the case of water management in Western Australia, Robins et al. (2011) linked effective governance to high degrees of network closure. Network closure is the propensity for a group of actors to operate within a tightly bound part, or clique, within a network and is expected to facilitate trust, reputation and cooperation. Sandstrom and Carlsson (2008) likewise suggest that network closure predisposes efficiency. They additionally link heterophily, or a high diversity in actor types, to higher levels of innovation. Based on the case of Swiss Gotthard tourism, Luthe et al. (2012) linked low levels of network density with an inability to collaborate and network centralisation to the capacity to coordinate but an inability to solve unforeseen, complex problems.

What such studies have in common, and what differs from ours, is that they tend (thought not exclusively) to focus on social processes that characterise the entire network. Instead, we are interested in how types of actors participate within networks, exploring various modes of stakeholder interactions in our policy network, and how certain types of organisations are associated with different structural patterns. Other studies have included a sub-network scale focus. Crona and Parker (2011) used network theory to study the utilisation of science in policy using an Arizonan research organisation as its case study. They show that policy makers with more links to a research organisation, and/or to other organisations that utilise science, are themselves more likely to utilise science. Berardo and Scholz’s (2010) network-based ‘risk hypothesis’ discerns between modes of stakeholder interaction, holding that actors who perceive low risks will seek bridging links, which provide access to new information. When the risks are higher, actors will seek more collaborative bonding links, leading to network closure around trusted others. Our study aligns more closely with studies based on how types of actors interact within a network.

Methodologically, our approach focuses on the distribution of the various sub-networks within a policy network (called configurations or motifs). Other authors have also focused on the distribution of configurations (e.g. Lubell et al. 2010b; Robins et al. 2011), and Robins et al. (2012) review the growing body of approaches for robustly examining the prevalence of certain configurations relative to other configurations. As shown by Bodin and Tengo (2012), configurations can be mapped to theory, considerably enhancing the theoretical rigour of network analysis.



**Fig. 1** Stylised policy network with actors (*circle*) linked to forums (*squares*) through participation

We build on such studies in a novel way by exploring how selected configurations can then be aligned with modes of stakeholder engagement in policy networks.

Defining and interpreting policy networks

Leading from the ecology of games perspective (Lubell et al. 2010b), we define a policy network as a collection of organisational actors and the forums across which the actors participate in policy debates (i.e. our networks are bipartite). Hence, the actors are not directly linked to other actors, but to the forums within which they choose to participate (Fig. 1). Each organisational actor has attributes—we focus on the type of organisation (local, state,







federal government, etc.; see ‘Data and Methods’ section below).

Table 1 pulls together a nomenclature of the configurations of organisation–forum interactions, which foster different types of stakeholder interactions. The first is a basic configuration (rA) which indicates an organisation’s level of activity (Robins et al. 2011). A given actor can have one link or many. The number of links associated with an actor does not imply anything about the strength of those links. What this speaks to is the breadth (or selectivity) of an organisation’s engagement across the various forums (Lubell et al. 2010b).

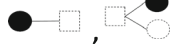



We treat ‘bridging’ configurations (TsoA1, TsoA2 and TsoA) as fostering learning, given these connect actors to others in more distant parts of the network, where information is more likely to be new to them (Granovetter 1973). In these stakeholder interactions, multiple actors are associated with each other via a single, mutually attended forum and can be associated with other actors of the same type (bridging within-type, Table 1, TsA2) or just generically with actors of no particular type (bridging across-type, TsoA1). Where such interactions span organisational types (TsoA1), learning is additionally fostered by ‘heterophily’ or the diversity of actor types (Sandstrom and Carlsson 2008). ‘Bridging’ configurations can also be based on a single organisation that uniquely spans two forums (TsoA).

In contrast, more tightly bonded, ‘closed’ configurations relate to fostering collaborative/cooperative stakeholder interactions, either within-type (Table 1, C4A2) or across-type (C4A1). Within these closed configurations,

**Table 1** Network configurations and types of stakeholder interactions, where bold indicates that organisational actors (circles) must be of a given type (e.g. local, state and federal government) (dashed actors can be of any type, squares indicate forums)

Configuration	Types of stakeholder interactions
rA	 Activity: higher number of links per actor of a specified type of organisation (i.e. fewer links per actor show a organisational type with more limited, more selective engagement)
TsoA1	 Bridging across-type: where one type of organisation disproportionately links to forums attended by different organisational types (given prevalence is relative to TsoA2 in particular). This represents heterophily (interactions between different actor types)
TsoA2	 Bridging within-type: where one type of organisation disproportionately links to forums attended by like organisations (given prevalence is relative to TsoA1 in particular). This represents homophily
TsoA	 Forum bridging: where one type of organisation disproportionately forms ‘unique’ links between forums. Note that this configuration relates to a single organisational type, so this does not speak to heterophily or homophily of actors interactions
C4A1	 Closed across-type: where one type of organisation disproportionately forms cliques that include actors with different attributes (given prevalence is relative to C4A2 in particular)
C4A2	 Closed within-type: where one type of organisation disproportionately forms cliques that include like organisations (given prevalence is relative to C4A1 in particular)

**Table 2** Interaction modes facilitated by level and type of organisational engagement (↑/↓ refer to greater/lesser representation of configurations than expected by chance)

		Type of engagement	
		Across-type	Within-type
Level of engagement	Low	<p><i>Advocate</i></p>  <p>rA↓, TsoA1↑</p>	<p><i>Supportive</i></p>  <p>rA↓, TsoA2↑</p>
	High	<p><i>Collaborative</i></p>  <p>rA↑, C4A1↑</p>	<p><i>Cooperative</i></p>  <p>rA↑, C4A2↑</p>

interactions are more likely to be to others with shared views and knowledge. This fosters shared understandings and expectations, but limits access to new information. Sandstrom and Carlsson (2008) link closure, particularly involving like actors (homophily), with high levels of cooperation and efficiency in delivering process-based tasks (C4A2). Closure involving different types of organisations prefaces collaboration across organisational types (C4A1).

#### Exploratory framework and advocacy

A key part of Pielke's (2007) thesis is that advocacy biases learning and obstructs the efficient use of science for contested problems with uncertain outcomes. The balance of advocacy amongst other modes of stakeholder interactions is a key yardstick in understanding the nature of strategic learning in a policy network. Part of the novelty in our approach is in seeking to identify the balance of advocacy by linking the representation of selected configurations to modes of stakeholder interactions that preface, not just advocacy, but supportive, cooperative, and collaborative interactions as well. A key advantage of such an approach is the potential for greatly improved theoretical power from network theory by mapping to ideas from domains not traditionally adopted by network analysis (Bodin and Tengo 2012). Such a novel approach will require further development, but this research presents its framework as a first step in linking stakeholder interactions with structures found in policy networks.

To develop an exploratory framework based on interpreting network configurations, we start by asking, for any given type of organisation participating in the policy network, which configurations might we expect to see over and/or under represented if they tended to engage as advocates. We build the framework up from Table 1 and present a typology of interaction modes in Table 2, which we suggest preface various types of stakeholder

interactions (advocative, collaborative, supportive and cooperative).

Advocates will seek to persuade other types of organisations and hence tend to interact more across-type than within-type. Additionally we argue that in seeking to persuade others, they will exhibit bridging relationships as they more frequently interact with stakeholders unlikely to already share the same views and knowledge (bridging across-types, TsoA1↑). We also argue that advocates will have lower, more selective levels of engagement (rA↓). Non-advocates in policy networks for contested problems will need relatively higher levels of engagement in order adequately sift through the broad range of policy solutions. In contrast, advocates come with a pre-defined policy solution and so engage less given their more simplified rationale for participation.

To complement our exploration of advocacy, we further define pairs of configurations as stakeholder interactions preface supportive, cooperative and collaborative modes of engagement.

Stakeholders taking a 'supportive' role we define as likewise engaging with a small, targeted set of stakeholders (rA↓) but they disproportionately interact within-type in supporting their organisational peers (TsoA2↑). We define 'cooperative' and 'collaborative' stakeholder interactions as organisations which engage with a broader set of stakeholders (rA↑). 'Cooperative' organisations are tightly bonded in closed configurations with the same types of organisations (C2A2↑). In contrast, 'collaborative' organisations operate in closed configurations across various types of organisations.

There may also be other modes of stakeholder interactions. However, this research presents its framework as a first step and builds on previous research by linking stakeholder interactions with *constellations* of network configurations. By exploring whether such patterns of configurations are more or less frequent in a policy network than expected by chance and combining this with information from stakeholder interviews, statements can be

made as to which organisational types engage in different modes of stakeholder interaction. This builds toward more concrete thinking about what we mean when we relate structure to network function, which is somewhat missing in the literature.

## Data and methods

### Network data

Network data were collected iteratively. First, attendance records for key, known forums were obtained. To be in scope, a forum had to have a focus on climate change planning or adaptation and with a strong (though not exclusive) focus on the region of SEQ (Table 3). It must also have sponsored debate and negotiation, rather than one-way communication, so as to facilitate stakeholder interactions. Our sample period covers 2008 to mid-2012. Network data and our list of forums were checked with participants as part of our semi-structured interviews. Participants were also asked to suggest additional forums with potential significance to climate planning in SEQ.<sup>1</sup>

Three of the 16 forums' attributes were coded as having a clear defined role in terms of supporting a specific 'policy' instrument (Table 3). Other forums frequently had fairly broad agendas and generally aimed at some form of consensus rather than providing either data or decisions. Organisational attributes were coded by type, as either local, state or federal government, or consulting, research, industry or non-government organisation (Table 4).

The attendance records showed individuals, while our interest was in organisational representation. Hence, we coded attendance as the organisation which the individual represented at the time of forum sitting. To account for Queensland Government departmental restructuring in 2009, our organisational coding was based on functional areas, based largely on 2009 departmental titles. This allowed us to code consistently across restructures. For example, the 'Environmental Protection Agency' (EPA) was abolished in 2009 and their activities moved to the new the 'Department of Environment and Resource Management' (DERM). EPA activities were coded as 'DERM—Environment'. Post-2009, DERM participants focusing on environmental management were also coded as 'DERM—Environment' and most of these functions had in fact previously been housed within the EPA.

<sup>1</sup> The lead author had extensive prior knowledge, having represented the research organisation 'CSIRO' in six of the studied 16 forums in various capacities, and no new forums were identified as part of this cross-checking and snow-balling process.

Figure 1 depicts a stylised network, while Fig. 2 depicts the actual network (raw data available in electronic supplement 1). Our network formulation follows Lubell et al. (2010b). Organisations are linked to any forum which had participation by an individual while representing that organisation. The network links are not weighted, meaning that a link based on an actor attending a selected forum once was treated equally to where an actor attended a forum many times. Returning to our typology for identifying modes of stakeholder interactions (see Table 2), if an organisation demonstrates a greater number of rA configurations, than by chance this allows interpretation about the breadth of stakeholder engagement, but not the strength/depth. Similarly, all forums are treated equally, regardless of whether a forum sat once or several times. Hence, the power of network theory is in rather clinical explanations of structure alone. We complement such analyses with qualitative data, which allows us to unpack the processes underpinning the structural aspects of the data (below).

### Network configurations

Exponential Random Graph Modelling (ERGM) is used to describe the relative prevalence of particular configurations (e.g. Table 1) within networks (see Robins and Morris 2007; Robins et al. 2007a, b). ERGMs are essentially logistic regressions where the dependant variables are the instances where a link exists between two nodes, and the configurations in the network are the explanatory data (i.e. predicting whether an organisation attended a forum based on their position in the network). ERGMs assume network links are part of a stochastic process. This means they assume an observed network is just one expression of some underlying process, allowing statistical tests without the need for comparative networks. By estimating what might be expected by chance specifically given the distribution of other configurations minimises the potential for mis-interpretation (Robins et al. 2012). Other approaches, such as stochastic-actor models (Snijders 2001) and relational events models (Butts 2008), explore longitudinal datasets. While our forums occur over time, there is considerable overlap in timing and uneven longevity of the forums (and organisational participation). Hence, we analyse our network as a single dataset. We used the computer package pNet (bpNet for bipartite networks, Wang et al. 2009).

### Semi-structured interviews

We used semi-structured interviews to complement our network analysis. We sourced participants who had been more active in the policy network. Preliminary network analysis showed that state and local governments had both high levels of participation in forums and were both

**Table 3** Forums relating to climate change planning and adaptation in South East Queensland (SEQ)

	Time frame/ acronym	Meeting dates	Representation (attendance)
(1) Climate Change Management Plan—Working Group 1—Regional Climate Projections and Impact Modelling	2008 WG1	28 May 2008; 16 June 2008; 30 June 2008	Attendance records
(2) Climate Change Management Plan—Working Group 2—Regional Vulnerability Assessment and Adaptation Planning,	2008 WG2	28 May 2008; 16 June 2008	Meeting notes/attended by lead author
(3) Climate Change Management Plan—Working Group 3—Regional Greenhouse Gas Investigations and Mitigation Planning	2008 WG3	28 May 2008; 16 June 2008; 30 June 2008	Attendance records
(4) Climate Change Management Plan—Steering committee—oversee working groups	2008 SC	26 March 2008; 30 April 2008; 25 June 2008; 30 July 2008; 03 September 2008; 29 October 2008; 17 December 2008	Meeting notes/attendance records/attended by lead author
(5) Climate Change Management Plan—Terms of Reference Committee	2008 TOR	07 April 2008	Meeting notes
(6) Climate Change Management Plan—Regional Planning Information Inventory Gap Analysis	2008 WS1	27 February 2008	Meeting notes
(7) Climate Change Management Plan—Priorities for Adaptation Workshop	2008 WS2	14 April 2008	Meeting notes
(8) SEQ Urban Water Security Research Alliance—Climate and Water Project Reference Group Meeting	2008–2012 UWSRASC	8 March 2008; 3 November 2009; 13 April 2010; 7 September 2010; 9 August 2011; 24 February 2012	Meeting notes/attended by lead author
(9) SEQ Climate Adaptation Research Initiative—Steering Committee	2009–2012 CARISC	20 November 2009; 21 May 2010; 22 June 2010; 2 March 2011; 5 September 2011	Meeting notes/attended by lead author
(10) Climate Q—Helping Primary producers adapt to Climate change—Steering committee	2010–2011	24 August 2010; 18 October 2010; 15 July 2011; 28 October 2011	Meeting notes
(11) SEQ Climate Adaptation Research Initiative—Human Settlements Project Reference Group	2010–2012 PRG	10 June 2012; 8 November 2012; 5 September 2011	Meeting notes/attended by lead author
(12) SEQ Climate Adaptation Research Initiative—Human Settlements Project Workshop	2011 PRGWS	17 November 2011	Meeting
(13) SEQ Adaptation Research Liaison Group	2009 LI	9 April 2009; 28 July 2009; 29 September 2009	Attendance records
(14) Inland Flooding Scientific Advisory Group meeting <sup>a</sup>	2010 INFSC	4 March 2010; 12 July 2010; 23 August 2010	Attended by lead author
(15) Greencross Hardenup—Project Reference Committee <sup>a</sup>	2011 GCHU	16 May 2011; 15 July 2011; 8 August 2011	Attendance records
(16) Greencross King Tides—Steering Committee <sup>a</sup>	2011–2012 GCSC	10 January 2012; 28 February 2012	Meeting Notes

<sup>a</sup> Coded as directly supporting an existing policy instrument

associated with significant explanatory power (i.e. significant configurations in the ERGM, see below). Hence, we interviewed key state departments, and local government and their representatives, who we knew to be key information users. Five interview participants came from state government, eight from local government (representing six different regional councils), and two from local government representative bodies. Interviews lasted between 40 and 60 min. Questions centred on why and how organisations participated and how they used scientific information, including

- What would a good outcome for your organisation look like as a result of participating in these forums?
- How does your organisation's perspective compare with others at these forums?
- Within these forums, what scientific information did you find most useful? When, where and in what formats? How were they useful?
- What types of scientific information did you find least useful (and in what types of formats?)
- What scientific information is missing that would be useful?



**Table 4** Organisational actors who participated in Table 3's forums relating to climate change planning and adaptation in South East Queensland (SEQ). Subheadings indicate the type of organisation

Policy actor (organisational level)	Acronym
<b>Non-government sector</b>	
Queensland Council of Social Service	QCOSS
Non-government Individual	NGII
Greencross	GC
<b>Consultancies</b>	
Climate Risk Pty Ltd	CR
Mercury Project Solutions	MPS
Maunsell AECOM	Maunsell
DHI Consultants	DHI
<b>Australian government sector</b>	
Department of Climate Change and Energy Efficiency	DCCEE
Bureau of Meteorology	BOM
<b>Industry and representative groups</b>	
DERM—Queensland Water Commission	DERM-QWC
Queensland Farmers Federation	QFF
Energex	Energex
SEQ Catchments	SEQC
<b>Local councils (government) and representative groups</b>	
Western Suburbs Regional Organisation of Councils	WESROC
Toowoomba Regional Council	TRC
Sunshine Coast Regional Council	SCRC
Redland City Council	RCC
Queensland Coastal Council Group	QCCG
Moreton Bay Regional Council	MBRC
Lockyer Valley Regional Council	LVRC
Local Government Association of Queensland	LGAQ
Logan City Council	LCC
Ipswich City Council	ICC
Gold Coast City Council	GCCC
Council of Mayors (SEQ)	COM-SEQ
Brisbane City Council	BCC
<b>Research</b>	
Emergency Management Aust. Institute Centre for Excellence	AEMI
Walker Institute for Climate System Research	WICSR
Urban Water Security Research Alliance	UWSRA
University of Queensland	UQ
SEQ Healthy Waterways Partnership	SEQHWP
Queensland University of Technology	QUT
National Climate Change Adaptation Research Facility	NCCARF
Griffith University	GU
Commonwealth Scientific and Industrial Research Organisation	CSIRO

**Table 4** continued

Policy actor (organisational level)	Acronym
<b>State Government and affiliated</b>	
Urban Development Institute of Australia	UDIA
Queensland Health	QH
NSW Environment—Climate Change and Water	NSW-ECCW
Department of Transport and Main Roads—Transport	DTM-T
Department of Transport and Main Roads—Main Roads	DTM-MR
Department of the Premier and Cabinet	DPC
Department of Communities	DOC
Department of Local Government and Planning	DLGP
DERM—Water and Water Policy	DERM-W
DERM—Queensland Climate Change Centre for Excellence	DERM-QCCCE
DERM—Office of Climate Change	DERM-OCC
DERM—Mines and Energy	DERM-EM
DERM—Environment	DERM-E
DEEDI Primary industries and fisheries	DEEDI-PI
DEEDI—Economic Development (tourism, regional)	DEEDI-ED
EMQ—Emergency Management Queensland	DCS-EMQ
DCS—Department of Community Safety	DCS

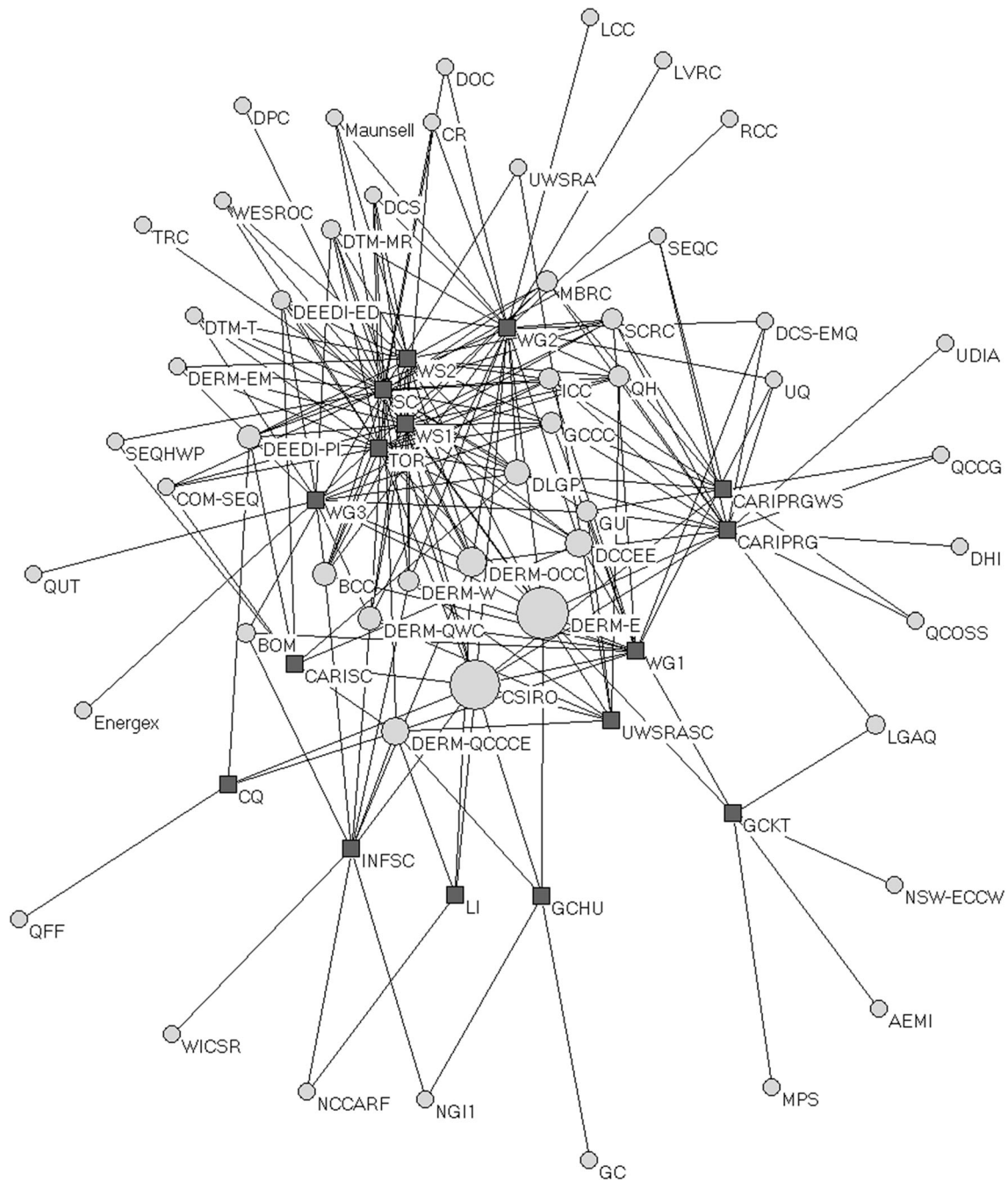
- How have you used scientific information in achieving your organisational objectives?
- How did other organisations use science information at these forums?

These interviews were recorded, transcribed, de-identified and coded. The text data were coded using NVivo into broad categories relating to the above questions. Common themes within each broad category emerged and selected text was then coded into sub-categories, which often related to organizational types. This provided qualitative data on organizational motivations, agendas, uses of science information, opportunities and challenges, as well as formal and informal interactions inside and outside the policy network.

## Quantitative results

### Exponential Random Graph Model (ERGM)

Our ERGM includes 15 configurations, which collectively explain the network's overall structure (Table 5, and also see Supplementary material 2 for further modelling detail). Ten of these are versions of configurations described above (Table 1), which relate to specific types of organisations. Five more are more general configurations (Fig. 3.), which



**Fig. 2** Graphical representation of network data. Forums are depicted as *squares* (Table 3)—organisations as *circles* (Table 4). Organisations have sizes scaled by betweenness centrality (see Figure A1, Supplementary material 2)

are included to control for the influence of the overall structure of the network.

The model shows that 11 configurations are observed more frequently than expected by chance, given the distribution of other network patterns. Having significantly fewer stars (K-Sa) suggests a low propensity to cluster around key organisations. L3 configurations are over represented. These are essentially loose threads on the

periphery of the network. To have more of these, given the abundance of configurations like K-Cp and K-Ca, implies that the network also contains regions of relative density and clustering (i.e. where the L3s are not). Both K-Ca and K-Cp relate to closure, but the first is significantly positive and the second negative: there is closure in the network, but only focused around key forums, not key organisations.



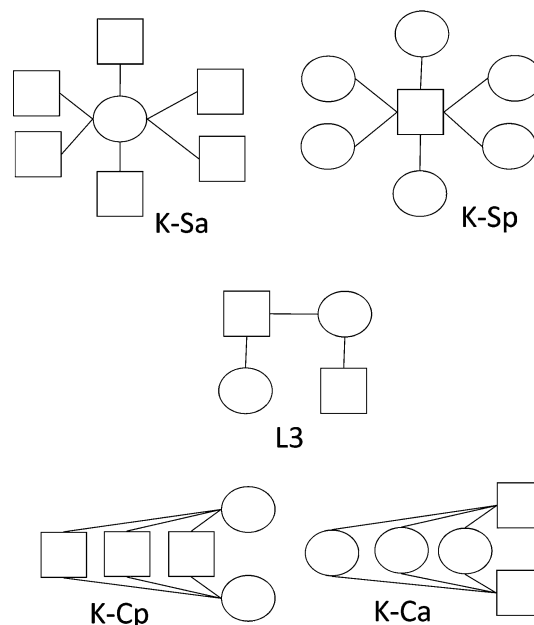
While our model controls for these broader aspects of network function, our main interest relates to how different types of organisations interact within the network. Hence, key to our discussion is the results that relate to the over and/or under representation of configurations for the various types of organisations:

- **Consulting** organisations tended to have significantly more cross-type bridging configurations (TsoA1) and less activity (rA) than what could be expected given its representation in the policy network. According to our typology, these collectively imply an issues ‘advocacy’ role (Table 2).
- **Local** governments had significantly greater representations of closed within-type configurations (C4A2) and across-type bridging (TsoA1) configurations, but significantly low numbers of rA which pointed to lower level of, and selective, engagement. The significance (and signs) of TsoA1 and rA implies local governments take on an ‘advocacy’ role, but in addition to significant closed within-type configurations (C4A2).
- **State** government demonstrated a statistical propensity to have more within-type bridging stakeholder interactions (TsoA2). The activity parameter (rA) was positive, but while deemed important enough to retain in the model (see Supplementary material) was not significant.

**Table 5** ERGM model: estimated parameters and observed configuration counts for an Exponential Random Graph Model with a fixed density = 0.25481: \*/\*\*/\* showing 90/95/99 % significance for the parameters

Configurations	Parameter estimates (t stat)	Observed counts (t stat <sup>a</sup> )
L3	0.0091 (4.5465)***	18612 (-0.02)
K-Sa	-1.3709 (-3.2562)***	259 (-0.02)
K-Sp	-2.9396 (-0.9606)	361 (0.02)
K-Ca	0.3049 (1.6480)*	192 (0.01)
K-Cp	-0.1387 (-4.0797)***	1039 (-0.01)
rA (State Gvt)	-0.3901 (-1.2747)	86 (0.04)
rA (Local Gvt)	-1.3507 (-2.9883)***	45 (0.00)
rA (Consultancy)	-2.2856 (-2.1163)**	6 (0.01)
TsoA (Research)	0.0467 (1.3341)	99 (-0.04)
TsoA1 (Local Gvt)	0.1841 (2.7899)***	387 (-0.03)
TsoA1 (Consultancy)	0.1170 (2.3398)**	161 (0.00)
TsoA2 (State Gvt)	0.1308 (3.1902)***	357 (0.03)
TsoA2 (Local Gvt)	-0.2791 (-1.5336)	115 (-0.02)
c4A2 (Local Gvt)	0.0641 (1.8861)*	167 (0.03)
TsoP1(Instrum. forum)	-0.0968 (-1.6975)*	93 (-0.01)

<sup>a</sup> T tests compare observed configuration counts against simulation means



**Fig. 3** Generic configurations included used in Exponential Random Graph Model. Circles indicate organisations of no particular type; squares forums. See Wang et al. (2009) for more information

- No significance was found for **federal** government, **research**, **NGO** or **industry** configurations. This may reflect their limited number of participating organisations.

### Qualitative data

The qualitative data are useful for exploring the different uses of science information by stakeholders and how this interacts with different modes of stakeholder interaction. As mentioned in the methods in ‘Data and methods’ section, two predominant types of stakeholders were followed up with qualitative interviews: local and state government stakeholders.

The local government officers generally sought science information to understand the complexity of climate change, especially any implications for small spatial areas, to facilitate planning in their local government areas.

Like it wasn’t brought down to the local government level or even to SEQ [region] level, a lot of the information. So it was when you’re talking to engineers or to planners they want more detailed information. (Local Gvt, officer 73)

This desire of local government officers to understand the implications of climate change for their local areas was balanced by a need to communicate climate change implications simply and clearly to their councillors to gain

local political support for adaptation plans. This suggests local government officers are also issue advocates outside the regional policy network.

We had to bring them along on the journey and get their understanding quite clear about climate change. Because obviously some were climate change sceptics and we had to sort of answer their questions, so it was about getting really clear messages and clear slides.... So, it's not like they've got a huge background in it at all. (Local Gvt, officer 73)

State government organisations faced a similar situation where different state organisations worked with different levels of climate change complexity. For example, state government research organisations produce detailed climate change information, while state government policy organisations often preferred less detailed climate change information.

So the government just sticking to an AIFI policy as opposed to looking at a range of emission scenarios... It happens, so the trick as a scientist is to know it's going to happen and to try and incorporate it in a way that's digestible, which is what we try to do with our advice. We try to couch it in such a way that we can still get that risk profile in there somehow. (State Gvt – scientist)

c.f.

Policy Officer 17: ... it will get hotter and warmer, dryer, wetter, whatever. For a policy person they're useful words that you can start feeding up. I personally don't need to go into the detail of the data... You're also very mindful that you've got a very credible source of information. (State Gvt, policy officer 17).

Thus, science information was used in a variety of ways by stakeholders in perusing their own agendas, often adopting advocative modes of interaction when engaging across organisational types.

Within-type cooperative interactions were more evident between environmental officers in local government organisations.

Well we just run into each other at different adaptation meetings, well relating to adaptation and always discuss how our councils are going and how we're implementing it and what challenges are we having. So that's an informal network. (Local Gvt, officer 73)

This provides some qualitative support for the risk hypothesis (see Berardo and Scholz 2010) where local government cooperates more because of their increased vulnerability to climate change impacts. As well as

participating in these forums, this group of local government environmental officers also met regularly outside of these forums, though less formally, to discuss similar issues. So the forums capitalised upon and further facilitated common understandings, knowledge and cooperation at the local government level.

Collaborative interactions across types of organisations were complicated by different levels of prior knowledge about climate change which suggests that forums may be better managed to facilitate collaboration and learning.

I was frustrated because ... the same questions were being asked through lack of knowledge, lack of understanding, which had been going on for twenty years. I just got the feeling we hadn't advanced. (Local Gvt, officer 73)

Actors had different levels of understanding about climate change issues and different needs for different levels of understanding. For example, the need was for more complex understandings for state government research organisations and local government planning, and more simplified understandings (with credible sources) for policy and political purposes. In another example, cross-type collaboration between local government and other levels of government was complicated by needs for different geographic levels of information (e.g. small area vs. regional information).

Across-type collaboration between local government and other levels of government was also complicated by existing power relationships which meant that local governments were primarily feeding up information to state government bodies for their draft regional plans as a way of advocating for their own needs in the process.

Probably with some of them it was more like the state dragging information out of - or taking information from local governments and then nothing coming back. But I mean, if you didn't give that information then you wouldn't have any say. (Local Gvt, officer 73)

Similarly, collaboration can be complicated by power relations between state government organisations and ministers such that regional plans do not necessarily get approved without support at the highest levels of government.

... it comes down to basically internal government processes and whose minister has got more clout than someone's minister. So the planning minister generally has more clout than the environment minister. So there were serious loggerhead discussions about that plan and what it could and couldn't do ... Ultimately that's why, I think, it went nowhere. (State Gvt, policy officer 288)

Clearly, collaboration across organisational types cannot be assumed in policy networks. Given the different agendas, needs and power relations between different types of stakeholders, advocacy is a more likely mode of interaction across stakeholder types. Any attempts to facilitate collaboration need to be carefully managed.

In a similar vein, just participating in forums did not mean that organisations necessarily engaged in meaningful stakeholder interactions. Some participants felt that forum activities focused primarily on getting people together as the actual outcome, as opposed to any subsequent decision making.

... I go along to some of these sessions and an achievement will seem to be that all the important people are involved [but that] doesn't mean that they've agreed or signed up or are strong champions or promoters.... I know good efforts were made to try and make sure that stakeholders were informed and engaged, but I'm not sure that actually that was achieved. (State Gvt, policy officer 16)

Our qualitative data suggest the most common modes of stakeholder interaction were within-type cooperation and across-type advocacy. It seems as if within-type cooperation can displace within-type support and across-type advocacy can displace across-type collaboration.

Different actors and organisations within the network have different roles, levels of understanding and different information needs to perform their roles within the network. Thus, the efficient use of science information in the network needs to involve various modes of stakeholder interaction using science information pitched at the needs and roles of the different actors.

## Discussion and conclusions

### Identifying modes of stakeholder interactions in networks

Local government showed three significant network configurations, which when combined with qualitative data allow us to tell a rich narrative around both cooperation and issues advocacy. The qualitative data suggested that local governments cooperate to share important information and to discuss agendas. Our quantitative results also suggested within-type cooperation (C4A2, Table 5). On the other hand, local governments also demonstrate characteristics of advocacy in the qualitative and quantitative data, with fewer links to other network stakeholders (rA-local govt) and positive across-type stakeholder interactions (TsoA1). Overall, our analysis suggests local governments cooperate as a

closed group to form a shared agenda and then lobby other organisational types in an advocacy role.

In contrast to local government actors, the state government showed more within-type supportive stakeholder interactions (TsoA2) according to the quantitative data. The qualitative data, however, strongly questions the degree to which various state organisations share values and agendas and hence the degree to which they may be considered within-type (e.g. departments responsible for the environment had different agendas to departments responsible for infrastructure, and departments responsible for climate change research had different information needs to those responsible for policy). Thus, within-type stakeholder interactions may misrepresent interactions for state organisations, and care should be taken not to code within-type interactions too broadly. It seems that for state organisations, within-type stakeholder interactions were more like across-type stakeholder interactions. Noting too that the activity parameter was negative, but insignificant (see rA-local, Table 5). We would argue therefore that on the balance of qualitative and quantitative evidence, state organisations seem most engaged in advocacy stakeholder interactions.

Consultant organisations demonstrated fewer links to other network actors than expected by chance (see rA-consultant, Table 5) and more across-type stakeholder interactions (TsoA1). This accords with advocative stakeholder interactions, where such organisations engage with a particular agenda.

Overall, our data suggest that organisations within our SEQ policy network were most engaged as 'advocates'. Consultants and local government both engaged in stakeholder interactions that we define as prefacing 'advocacy', and there is an argument that state organisations did the same. Our analysis also points to the multifaceted aspect of participants, with local governments both advocating and cooperating where appropriate. However, there was little evidence of collaborative stakeholder interactions across both qualitative and quantitative data.

### Managing policy networks for effective learning

Formal governance structures of checks and balances can be designed and implemented. Policy networks on the other hand can only be managed (Klijn et al. 1995; Klijn and Koppenjan 2000, 2006; van Bueren et al. 2003). The objective of managing policy networks is not in achieving a stated outcome necessarily but rather in promoting the effectiveness of the network to facilitate the various embedded policy 'games'. Given advocative stakeholder interactions seem to dominate the policy network, and thinking specifically about learning and using scientific information (regardless of the policy outcome), we may

ask, what would be different if our network were better managed to ensure efficient use of science? And how can we achieve this?

Beck (2011) argued that the linear model of science has prematurely narrowed the scope of policy debates on adaptation. And Hanger et al. (2013) likewise identify a need for richer stakeholder engagement in climate debates in order to improve the science–policy interface. Pielke’s (2007) ‘honest broker’ mode of how scientists could engage in policy also talks to these issues. Where the outcomes from various policy actions are highly uncertain, ‘honest brokers’ are critical because they, by seeking to expand problem scope, work to offset the narrowing role of ‘issue advocates’. Advocacy and lobbying are critical ingredients for achieving policy decisions in contested spaces. However, the biased learning associated with advocacy does not yield efficient use of science for contested problems with uncertain outcomes.

In our more general typology, the honest broker role accords most closely with collaborative interaction modes involving research organisations. Research organisations and federal government are perhaps most likely to play an enhanced role in broadening the scope of policy alternatives in collaborative engagement with other stakeholders. In practice, however, this would involve increasing and broadening engagement with stakeholders, which will require new, targeted funding, initiatives or incentives.

In contrast, collaboration is perhaps not a role that can be expected of state or local government because they do and should have strong local agendas, and as such advocacy is a legitimate role. Neither is it the role of NGOs, industry or consultants. However, the balance between various stakeholder interaction modes can be managed by better structuring engagement so that advocacy can be channelled so that it becomes more functional, for example, by sharing power between levels of government, encouraging collaborative interactions and involving unaligned stakeholders such as research organisations.

Wagenaar (2011) reviews collaborative policy making, where empowered stakeholders contest in open-minded, reciprocal debates. In such debates, knowledge’s worth is judged in relationship to its practical solutions. Our qualitative data point to the diversity in expectations and requirements of various stakeholders. The ‘practical solution’ for an advocate may simply be an achieved political agenda, whereas for a local government policy officer, it may be on-ground action. The style and complexity of information requirements are equally diverse. Our discussions with stakeholders also pointed to the frustrations where those seeking learning were mixed in the one forum with those seeking decisions, for example. There needs to be greater clarity within discrete forums such that stakeholders can be meaningfully empowered to deliver. In

tightening the roles/agenda of forums, additional forums will likely be needed to accommodate the existing diversity of objectives.

Efforts to improve policy network efficiency need to reflect not just how to intervene, but when. Berardo and Scholz’s (2010) risk hypothesis holds that new policy networks, where the risk of stakeholder ‘defection’ is low, stakeholders will favour bridging links, which we interpret more broadly to include across-type stakeholder interactions. As policy networks mature, stakeholders refine the problems that they are seeking to resolve. Correspondingly, as attention turns toward action, the risks associated with making more binding decisions increase, and now, stakeholders will prefer bonding links, i.e., within-type cooperative stakeholder interactions. For example, a study of regional flooding adaptation in the Netherlands argued that the related networks had collaborative linkages between stakeholders during master planning and more isolated interactions during implementation (van Buuren et al. in press). In Australia, local government is at the ‘coal-face’ of action on climate adaptation and for them the potential costs of poor outcomes are highest (Barnett et al. 2013; Fletcher et al. 2013). Correspondingly, local government was also the only organisational type with a significant representation of within-type cooperative stakeholder interactions (Table 5, C4A2). While our data do not allow us to explore Berardo and Scholz’s (2010) risk hypothesis temporally, our results suggest it may hold across space. The implication is that given cooperation already exists in the parts of the network facing the greatest risks, then the need for intervention and more structured engagement will be in the parts of the networks where the risks are actually lowest.

Data on climate change planning in SEQ suggest policy networks are not simply a means for fostering collaboration. Instead, they are an emergent structure through which contestation, vested interests, factions and cooperatives are partitioned through selective participation in various debates and sub-issues. Our results suggest that within these policy networks for uncertain, contested problems, advocacy is the dominate mode of stakeholder interaction, and collaboration cannot be assumed. In order to counter balance advocacy, rather than trying to simplify stakeholder engagement, we need to facilitate more diversity in engagement with greater clarity in purpose.

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