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# Understanding the pre-conditions of commons governance: The role of network management

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## ABSTRACT

The institutional analysis and development framework helps analyze and understand the common property governance arrangements and dynamics. In setting out the IAD model Ostrom advocates a ‘polycentric’ approach to commons management involving oversight ‘at multiple times’. As Ostrom’s work notes, however, self-organization is only possible if there are means of building trust through communication and the creation of a setting in which individuals or groups are able to extend reciprocity to others. In fact, she argued, the ‘capacity of CPR users to govern themselves is often a necessary condition for overcoming the temptations involved in a CPR dilemma’ (Ostrom et al., 1994, 328). However, the IAD framework itself does not explain how such a pre-condition emerges or under which conditions capacity is built. The article argues that understanding the dynamics of the origins of ‘governance of the commons’ requires going well beyond the self-organizing cooperative structure suggested by Ostrom. Specifically, it points to the merits of framing the issue of commons governance in network terms and examining in detail the key role played by “network managers” in applying, maintaining and enforcing Ostrom’s eight principles of commons governance. Examples from the Australian climate change network are used to illustrate this point.

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## 1. Introduction

In her discussion of commons management, Ostrom highlights several crucial problems communities have when dealing with issues involving the local, national or global commons. This can be illustrated by the case of climate change, which has become a global issue through international treaties and meetings, such as the ones in Kyoto or Copenhagen,<sup>1</sup> but is also in need of localized solutions within

those global benchmarks. This creates a nested system of local, regional, national and global units that interact to create outcomes (Ostrom, 2009b; IRIN, 2012). Responses to these environmental developments have taken the form of treaties and agreements between governments at different levels and from different understandings and actions undertaken by local communities (Ostrom, 2001, 2005; Pahl-Wostl, 2009). In the search for lessons concerning the appropriate institutional arrangements to address such a multi-level issue, many works in the IAD tradition argue these

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<sup>1</sup> In Kyoto (Japan), the Kyoto Protocol was adopted on 11 December 1997 and entered into force on 16 February 2005. It is a binding international agreement linked to the United Nations Framework Convention on Climate Change. The so-called Copenhagen accord recognizes the scientific case for keeping temperature rises to no more than 2 °C, but document is not legally binding and does not contain any legally binding commitments for reducing CO<sub>2</sub> emissions.

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can emerge more or less spontaneously from community-level organizations and focus on the nature of favourable rules for cooperation to occur across levels while applying Ostrom's eight principles of commons governance to the design of their structure (Ostrom, 1990; Goldsmith and Eggers, 2004).<sup>2</sup> *On the contrary, we argue that in order to create trust and reciprocity within a community, there needs to be a network leader, who operates within the system and complements it through directed management activities aimed at its membership.* Such a leader enables communication among heterogeneous actors for building social capital and exchanging knowledge. A manager of this kind can also mobilize new and valuable participants as well as attract funding opportunities. Overall, this type of leadership can be governmental- or community-based, but in either case builds trust and long-term cooperative structures in a way which is not self-forming or auto-poetic.

The paper addresses this issue of the 'pre-conditions of commons governance' by looking at it from a network theory perspective, utilizing a case study of Australian efforts to deal with climate change adaptation and mitigation. The example will show that network leadership is different from direct government involvement or networking on the ground. Instead, it is an additional layer in the middle of a polycentric system, balancing hierarchical and horizontal dynamics. A network manager is able to minimize the costs for potential network members and create collaborative structured based on trust. The paper begins by establishing a conceptual framework on the role of networks and network management in commons governance, pointing towards the characteristics of network settings and the importance of leadership for effective institutional designs. Australia's Flagship initiative then serves as a case study to highlight the role of a network structure and cluster managers in creating such capital.

## 2. The governance of the commons as the creation of social, intellectual and political capital

Partners build trust by sharing information and knowledge, demonstrating competency, good intentions, and follow through; conversely, failure to follow through and unilateral action undermines trust (Folke et al., 2005; Arino and de la Torre, 1998; Merrill-Sands and Sheridan, 1996). Trust and reciprocity are core determinants of collective action according to Ostrom (for an overview of Ostrom's work, see Araral, 2013). Thus, improving communication in commons governance helps to foster trust-building practices.

<sup>2</sup> The eight principles of governing the commons by Ostrom (1990) are: (I) Define clear group boundaries. (II) Match rules governing use of common goods to local needs and conditions. (III) Ensure that those affected by the rules can participate in modifying the rules. (IV) Make sure the rule-making rights of community members are respected by outside authorities. (V) Develop a system, carried out by community members, for monitoring members' behaviour. (VI) Use graduated sanctions for rule violators. (VII) Provide accessible, low-cost means for dispute resolution. (VIII) Build responsibility for governing the common resource in nested tiers from the lowest level up to the entire interconnected system.

In the IAD framework, the creation of trust is continuously emphasized as an important feature or pre-condition of commons government. Once different stakeholders arrive at the table, communication and continued interaction build trust (Ostrom et al., 1994; Araral, 2013). The setting needs to generate 'sufficient information about the likely behaviour of others to be trustworthy reciprocators who will bear their share of the costs' (Ostrom, 2009a, 432). Trust in the actions of others is one pre-condition but in order to create knowledge-building exercises, stakeholders must also have trust in information. Many sustainability issues are connected to conflicts over scientific information. 'This information must be obtained and processed by an actor to formulate strategies for action, and so trust or mistrust in this information is also an important driver of conflict and consensus in commons governance arenas' (Henry and Dietz, 2011, 194; see also Sabatier and Jenkins-Smith, 1993). According to Goldsmith and Eggers (2004) a way must be found to establish dependability, fairness and goodwill among the organizations.

Overall, trust in actions and information can be said to be the basis of sustainable commons governance. Once trust is established, the risks of networking, such as free-rider problems or the 'weakness of loose ties' (Orton, 1990), which are caused by a missing hierarchical governance elements in such arrangement, can be compensated for by community-level coordination (Urbaniec and Gerstlberger, 2011).

Building trust is closely related to investments in social capital. Several authors have regarded social capital as the 'glue for adaptive capacity and collaboration' (Folke et al., 2005, 111). And while social capital creates the potential for fruitful discussions to take place among otherwise conflicting stakeholders, the trust in actions or 'intellectual capital' provides a common basis for problem definition and agreements. Intellectual capital can be defined as the relationships, innovation efforts, infrastructure, knowledge and skills of network members – basically any intangible resource that can generate value in the future without having a physical or financial form (Hormiga et al., 2011; Sullivan, 1999; Lev, 2001). In other words, intellectual capital combines human, structural and relational capital, which define the available knowledge through network members, the strategic vision for a network and the set-up for knowledge exchange.

On top of these first two, according to Innes et al. (1994), there is a third type: political capital. This kind of capital takes the form of 'alliances and agreements or proposals that provide mutual gain creat[ing] the possibility that proposals will be adopted' (ix). This implies that consensus-building has a positive effect throughout the whole policy cycle. If larger networks have agreed upon a problem and how it is defined, seeking a solution becomes easier and faster in the formulation and decision-making phase. It also makes it easier to monitor results in the evaluation phase as the realization of the policy is framed on the ground (Howlett et al., 2009). This is supported by research that suggests the readiness to accept new ideas largely depends on the stability of existing dominant coalitions of actors (Benz and Fuerst, 2002). Further, the incentive to participate in common solution-finding and knowledge-sharing becomes even stronger in some cases after a critical mass of committed and important players was achieved, along with some first-stage agreements (Innes et al., 1994).

In sum, the expectation of commons governance arrangements is that network dynamics created between different institutions in commons governance arrangements build trust and lead to a productivity loop: as experience at collaborating grows, the network widens. When network diversity grows, it becomes more visible, which in turn leads to more members that contribute. These arrangements in general improve innovative capabilities, because they expose their members to novel sources of ideas, enabling fast access to resources and enhancing the transfer of knowledge. Face-to-face contacts for example make it easier to exchange tacit knowledge and co-create innovative ideas (Powell and Grodal, 2005).

But how do the networks required to build trust emerge and operate

### 3. Network dynamics in the governance of the commons

Networks can be described as ‘a set of relatively stable relationships which are non-hierarchical and interdependent, linking a variety of actors who share common interests with regard to a policy and who exchange resources to pursue these shared interests acknowledging that cooperation is the best way to achieve common goals’ (Boerzel, 1998, 254). The role of networks involves ‘disseminating information and ideas, providing access to resources, capabilities and markets, and allowing the combination of different pieces of knowledge’ (Cassi et al., 2008, 1).

Networks emerge due to positive or negative incentives and agreed-upon collaborations. Stakeholders can and do often find common ground to collaborate. This happens in cases when a severe problem is present or when – specifically businesses – see an advantage in building ties with different groups to acquire necessary resources for growth or knowledge development (Provan and Kenis, 2007). ‘Firms strategically adapt and align their networks to gain the resources they need to ensure successful emergence and early growth’ (Hite and Hesterly, 2001, 278). However this often results in uncoordinated efforts by those who have a stake in the success of the network, and does not guarantee a long-term network or reaching common goals.

Significantly, positive incentives often come from a higher entity, for example government, and can include funding opportunities under the condition of collaboration in order to create an environment favourable for innovation. Offering access to significant funds by government may act as ‘an important inducement for interested actors to collaborate on regional boards and through this mechanism advance their natural resource management initiative’ (Holley et al., 2012, 40). Negative incentives, on the other hand, force collaboration by increasing the transaction costs for not cooperating. Such measures could be community pressure to bring industry to the table through legal objectives, shaming companies in the media or challenging their ‘social licence’ (Gunningham et al., 2003).

Thus, contra Ostrom and much IAD literature, networks provide access to information and knowledge as well as control over fast-moving developments (Powell et al., 1996) but often require effective management if their potential is to be realized.

Network leaders manage collaboration in a way that there is a low risk in joining for potential members, the creation of trust for stakeholders and ultimately the establishment of social and intellectual capital.

In what follows below, the emergence of network relationships in commons governance is examined through analysis of a case of the emergence of climate change governance in Australia (O’Riordan and Jaeger, 1996).

### 4. The Australian case

‘Environmental problems are (1) complex, involving complex dense networks of physical, biological and social causation; (2) technical: understanding often demands a high degree of scientific and/or social sophistication, and (3) surrounded by uncertainty: we do not know enough (and in many cases it may be impossible in principle) to predict outcomes reliably’ (Lafferty and Meadowcroft, 1996, 4). Governance arrangements in the field of climate change attempt to address these challenges. These arrangements are, however, uncertain, often change quickly and, therefore, need a flexible set-up. Also, cooperation and know-how exchange are crucial for governance arrangements to lead to the innovations required to address these issues. A network structure offers ways to deal with these challenges in different ways.

There are several key motivations why governments like the one in Australia have attempted to address climate change issues. Those include, extreme weather events, economic costs connected to those events, global treaties, research, private sector interests, and examples of other countries or the activities undertaken by local governments. Australia’s post-2009 national climate change strategy addresses these issues based on global and national assessments, but also acknowledges the need for a networked and innovative environment (on the development of climate change policy in Australia see Harrison and Sandberg). The strategy states that ‘climate change science is entering a new phase of complexity as decision-makers and the public demand greater insight into likely impacts and the effort required for mitigation and adaptation’ (Department of Climate Change, 2009, 3). To fill the knowledge gaps and connect different actors, the report states that Australia ‘cannot rely on others to produce all the science’ (5) and needs ‘efficient and effective mechanisms for access to climate change information’ (11).

In pursuit of this strategy, the responsible government agencies at the Commonwealth and State/Territory levels underwent a restructuring process, which led to an improvement of arrangements for environmental governance (OECD, 2007). Australia evolved from ad-hoc cooperation structures to a networked approach with strong inter-jurisdictional and inter-agency cooperation as well as leadership functions at every level.

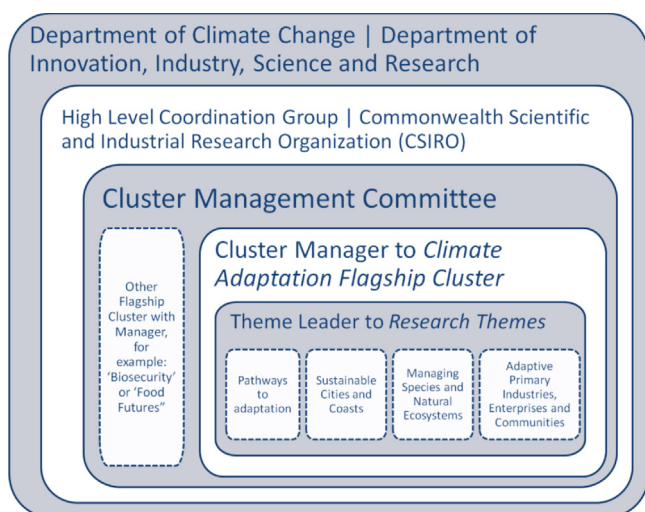
The key bodies for intergovernmental environmental policy coordination and integration are the Commonwealth/State/Territorial Ministerial Councils (Ross and Dovers, 2008). And it was the Commonwealth Scientific and Industrial Research Organization (CSIRO), which launched the National Research Flagship initiative in 2003. Today, the Flagship encompasses ten large multi-disciplinary research

partnerships with other research institutions, industry and governmental agencies, addressing a range of major human, environmental and economic challenges. After a government-mandated review of the Flagships in 2006, which found the Flagships to be ‘promising’, three more Flagships were developed – one of them ‘Climate Adaptation’.

The overall concept for the initiative was developed through extensive consultation with government, partners in science, industry and opinion leaders in the community. ‘The intent was to reinforce the collaborative research partnerships addressing issues of national importance’ (CSIRO, 2012b, 3). On top of that, the initiative is under regular independent review to secure its use for research, industry and environmental policy.

The key feature of the Flagships is the idea of a networked approach, bringing together multi-disciplinary research teams from CSIRO and other research institutions under a partnership arrangement, which also engages industry and government (Australia National Audit Office, 2009). To realize a networked structure for different sub-themes, such as climate adaptation, a cultural and organizational transformation within CSIRO had to happen. The Commonwealth Scientific and Industrial Research Organization moved from atomized units to a coordinated matrix leadership and management structure. The idea of the matrix model is that it is built on a system that has interdependent parts, which collaborate and cooperate. The goal is seamless support from top to bottom and along different horizontal stages of for example research. Applying or switching over to this type of management involves reorganization vertically and horizontally, which is exactly what happened inside CSIRO.

With a focus on the horizontal dimension, CSIRO extended lower-level units by creating multi-stakeholder Flagships, which are connected through Cluster Leaders. In fact, this approach extended beyond CSIRO. As Fig. 1 indicates, the developments leading up to the National Research Flagships created a nested, polycentric system, which includes leaders at every level – from theme leaders to the Minister of Innovation, Industry, Science and Research. For example,



**Fig. 1 – Nested and polycentric Australian climate change coordination structure.**

the Department of Climate Change established a mechanism to liaise with States and Territories and other stakeholders on climate change science, with a particular emphasis on ensuring the national programme delivers useful information about likely future climate change (Department of Climate Change, 2009). The high level coordination group comprises ‘major funding bodies, key research organizations and senior scientists and chaired by the Chief Scientist’ (Department of Climate Change, 2009, 3). The coordination group also develops and oversees the execution of climate change plans.

The Climate Adaptation Flagship in particular addresses the challenges Australia is facing in terms of droughts, fires, storms and flooding rains. ‘Australian ecosystems, water resources, agriculture, built infrastructure, regional and remote communities, and health all have vulnerabilities to climate change’ (CSIRO, 2009, 1). The Climate Adaptation Flagship encompasses adaptation to both climate variability and climate change. It further contains different research themes, which are led by theme leaders. Those are:

- ‘Pathways to adaptation’, providing knowledge on climate projection and predictions, national scale social and economic vulnerabilities, international impacts and stakeholder values;
- ‘Sustainable cities and coasts’, looking at urban and coastal population exposed to climate change;
- ‘Managing species and natural ecosystems’, focusing on their ability to adapt to projected changes;
- ‘Adaptive primary industries, enterprises and communities’, developing adaptation options.

Defining these themes was possible based on a ‘shared understanding of the policy problem’ (Bulkeley, 2000, 734). This means there was extensive consultation with scientists, industry and opinion leaders before an agreement on climate adaptation and more specifically on energy efficiency and renewable energy as one of the focal points. This can be attributed to the involvement and backing of a climate change plan at higher levels and a clear climate adaptation theme, which research can pursue under the ‘Flagship roof’.

Significantly, the Climate Adaptation Flagship itself is organized by a ‘Cluster Manager’, Dr. Andrew Ash, who brings together experts from across CSIRO and builds partnerships with research and industry groups around Australia. ‘As Flagship Director, Dr Andrew Ash is responsible for deciding research priorities, overseeing a large portfolio of research projects and managing many partnerships and collaborations’ (CSIRO, 2012a). These research projects include the four research themes and each theme also has its own theme leaders: Dr. Bryson Bates, Mr. Allen Kearns, Dr. Trevor Booth and Dr. Mark Howden.

The Cluster manager also poses a direct link to the Cluster Management Committee when reporting on progress in the Flagship and new projects. Those projects and other more general cluster applications in all clusters are evaluated and approved by CSIRO. This is part of a comprehensive performance monitoring. These processes of exchanging deliverables and ideas on climate change then inform the Department of Climate Change and the Department of Innovation, Industry and Science for policy decisions.



Ultimately, the project leader or theme leader is accountable for the delivery of project outputs, while the Cluster Leader is responsible for the management of the Climate Adaptation Cluster and its projects including research leadership, reporting and administrative functions.

## 5. The Flagship programme as an example of commons management

The process of establishing the Flagships and reorganizing CSIRO and government relationships has, in turn, created new alliances as energy companies, local governments, and green groups redefine their interests with respect to climate change. This coalition includes actors 'operating at different scales of governance (the local, state, federal, and global)' (Bulkeley, 2000, 745). Each Flagship involves collaboration between leading Australian and international scientists, research institutions, commercial companies and the CSIRO. A funding pool was set-up to further strengthen collaboration between Flagships, universities and other publicly funded research institutions that incorporate an Australian-based cluster leader.

In the Australian example, a network coordination mechanism was used for each environmental sub-field, such as 'Minerals Down Under' or 'Water for a healthy country' while linking them through a Cluster Management Committee, which serves as a focal point for collaboration beyond thematic groups. The cluster leader is responsible for the management of one Flagship cluster and its projects including research, reporting and administrative functions (CSIRO, 2012b). However, there are also monitoring mechanisms in place. Flagship projects agree upon milestones, deliverables and have to account for the funding they receive. This means, the responsibility for failing to achieve some of those goals can be passed on to single actors in the network by creating group pressure. At the same time, monitoring gives the network and its manager a form of legitimization and creates trust in the progress of the alliance.

The Australian Flagship programme embodies all eight of Ostrom's principles of government of the commons. First, the issue at hand defines the group boundaries. In other words, instead of drawing a line between users and non-users, the network manager defines – together with participants – the problem and then creates a community of valuable contributors. The network and its knowledge is open to anyone, but a firm or institution gaining profit from the generated information or the funding without giving back would be excluded from the networking activities by other members. Also, the Australian government clearly defines resource boundaries. Funding is limited to research institutions that work in the defined problem area of climate adaptation and is contributing to the agreed-upon deliverables (CSIRO, 2012b).

For the second principle of matching rules to local conditions: the whole idea of establishing the Flagship cluster on climate adaptation by government is to receive local recommendations for policies and legal decisions. One example is the carbon tax policy, which was passed in June 2012. The Climate Adaptation Flagship gave advice on the decision based on local experience with emissions. This input

made it easier to communicate those changes to the public by pointing towards local benefits and at the same time develop solutions for firms that were negatively impacted by those changes. In the long-run, innovative products developed by the Flagship can also pose as investment opportunities.

The third principle states that those affected by the rules should be able to participate in modifying the rules. CSIRO acknowledged exactly that when establishing the Flagships and monitoring them later on. First, there was extensive consultation with research organizations, industry and opinion leaders in the community. This is when the agreement on climate adaptation as the main theme around which the cluster and the smaller projects would evolve, was reached (CSIRO, 2010; Bulkeley, 2000). Now, each project group that applies for funding from government within the Flagship framework has to show that it can deliver outputs relevant to the research area and present a timeline. Based on this, the government monitors the progress of the funded project. Thus, the rules for being funded and the monitoring afterwards are partly defined by the network.

The same mechanism works for the fourth principle of rule-making being respected by outside authorities. Again, the cluster defines the goals and timeline, while government monitors its progress accordingly. Within the community, the system for monitoring other members is given by the competitive application process and the commitment to the network. Project funding applications are competitive and include (1) a document in which the cluster or project specifies its capabilities, research area; (2) achievable goals in a certain timeframe; (3) quality and relevance of the science; (4) quality and track record of investigators, and (5) quality of (industry) partners (CSIRO, 2012b). Such an application comes close to a contract between cluster members in which they outline their contribution to the project. If these promises are broken, the cluster manager or project leader can resolve conflict through mediating. In a next step, if the manager is unable to resolve the issue, government would intervene by cutting funding to the whole project – creating group pressure within the network – or for a certain member. Throughout this process there is also the option of negotiating changes to the original document, if everyone agrees. These steps cover the fifth, sixth and seventh principles of Ostrom's list of how to govern the commons.

The last and eighth principle is building responsibility to govern the commons in nested tiers. As Fig. 1 indicated, the Australian design is mostly voluntary and multi-stakeholder. At the bottom, there are multiple project hubs, in addition to the climate adaptation cluster. This doubles the networking effect by having several smaller networks that can come together under the Flagship for funding and knowledge exchange. It also reduces the risk of duplicating research.

However, each project manager is well-connected to the director of the Climate Flagship. And the Director is also the direct connection to the Cluster Management Committee for possible links to other interdisciplinary clusters. CSIRO (2012a,b) states that project leaders are responsible for the delivery of project outputs, while the Flagship leader is in charge of the management of the cluster including research leadership, reporting and administrative functions. The Cluster Management Committee is again connected to the High-level

Coordination Group and the CSIRO. This leadership structure is a significant factor in the formation and operation of the cluster and is a phenomenon which is not captured in Ostrom's eight points.

## 6. Analysis: the pre-conditions of commons governance in the Australian Flagship case

The form of network management found in the Australian Flagship programme on climate change challenges the principles of commons governance emergence and polycentricity found in IAD theory. The cluster manager for the Climate Adaptation Flagship is responsible for the ongoing interdisciplinary collaboration in order to create meaningful research and possible solutions for climate change goals in Australia. Practically, this means – on a project basis – reaching out and connecting to partners in research institutes, commercial companies, CSIRO itself, leading scientists and a selection of international partners.

This activity led, for example, to the research theme 'Primary Industries, enterprises and communities adapting to climate change', which develops adaptation options for primary industries (agriculture, fisheries, forestry and mining). In this theme, the collaborators include State and Federal government agencies, rural industry research and development corporations, (private) industry and farmer groups, cooperative research universities and international science collaborators. Such collaboration, organized and led by the cluster manager, resulted in detailed reports and publications – for example, 'Adapting agriculture to climate change' (2010), which was created by 30 authors to help the industry harness their opportunities. The cluster manager also helps to navigate the current management structure, as the ANAO report points out: the division of responsibilities is sometimes not as clear and the leadership structure needs simplification. Having the cluster manager as an access point to the system makes it easier to create trust in the Flagships and communicate with other projects.

Rather than a definitive assessment of the success and failure of particular policies, the concept of policy learning emphasizes the educational dynamic among policy makers and others not directly involved in the policy issues at hand (Howlett et al., 2009). For learning in commons governance arrangements, cluster managers play a key role, because they bring together people and create an environment conducive to knowledge exchange (Lee and van de Meene, 2012). The creation of networks by such leaders encourages learning through offering new opportunities, better access to information and members profit from reduced transaction costs when seeking new solutions to climate change challenges. Generally speaking, the ability of a network to learn comes down to the ability to generate and diffuse new information as well as solve conflicts coming from policy or environmental changes (Benz and Fuerst, 2002). This environment was actively created and supported in this case by a system containing a network manager backed by policy.

The Australian case shows how network managers have contributed to the three forms of network capital – social, intellectual and political – which are critical for commons

governance in several ways. In terms of social capital, the cluster manager attracts different stakeholders for a variety of projects under the Climate Adaptation Flagship roof. As projects evolve and are able to build a track-record through publications and political impact, trust in the network and its manager grows. These connections reach beyond one Flagship and span different disciplines, departments and industries. Intellectual capital, which is a broader term for human, structural and relational capital is gathered through:

- Finding and attracting knowledgeable people for the Flagship/specific projects (human capital)
- Establishing internal processes of exchanging information and communicating, i.e. in regular meetings (structural capital)
- Interaction of stakeholders in the same field/with the same goal framed by a certain project and facilitated by the cluster manager (relational capital)
- Being open to participation (relational capital)

Also, the Flagship under a cluster manager leadership contributes to political capital through communicating with and writing reports for policy-makers.<sup>3</sup>

## 7. Discussion: the need for network management in the governance of the commons

This discussion shows that the solution for creating social capital and overcoming obstacles in the creation of commons governance is a type of network leadership or management. This leadership is a middle way between self-organization and government regulation. It does not replace the accountability of existing hierarchical bureaucracies, but operates within and complements it. This is similar to what Lee et al. (2013) define as 'boundary organization'<sup>4</sup> in an international arena to facilitate climate change governance in less developed countries (LDCs). They emphasize the role of a neutral leader in overcoming networking obstacles. In their refinement of the boundary agent concept, Lee et al. (2013) point towards the knowledge of the organization in a specific area, the proximity to stakeholders and responsive neutrality as

<sup>3</sup> A leader in such a setting also takes on another crucial problem, that of accountability. When self-organization, authority and responsibility are parcelled out across the network, the manager has to balance between accountability and flexibility. In the Australian example, this was solved by having a tight-knit structure at higher levels and a looser network accessible for stakeholders. Also, regular monitoring makes the cluster believable while giving space in between deliverables. This said, there is always the danger of suffocating flexibility in a false dare for accountability. Everything should be dynamic with opportunities for learning and change (Goldsmith and Eggers, 2004).

<sup>4</sup> Boundary organizations are characterized as (1) providing the opportunity and sometimes the incentives for the creation and use of boundary objects, such as patents; (2) involving the participation of actors from both sides of the boundary, as well as professionals who serve a mediating role, and (3) they exist at the frontier of the two relatively different social worlds of politics and science, but they have distinct lines of accountability to each (Guston, 1999, 400–401).

key characteristics. In many complex polycentric situations, as Folke et al. (2005) have argued, co-operation requires leadership, because it can provide key functions such as ‘building trust, making sense, managing conflict, linking actors, initiating partnerships among actor groups, compiling and generating knowledge and mobilizing broad support for change’ (58). This type of leadership manifests itself in efforts by governments and non-governmental actors to secure an appropriate balance (Pahl-Wostl, 2009) between formal rules enforced by sanctions and self-governance of user communities (Ostrom, 1990).

‘An effective cross-organization knowledge management system can provide a host of benefits: It can help develop new knowledge, flesh out solutions to daily problems, enhance learning across the network, build trust and help people learn from each other’s successes and mistakes. These capabilities can help government to better integrate and align its own strategic objectives with those of its partners.’ (Goldsmith and Eggers, 2004, 108)

Network relationships are defined by consensus building, which is a powerful tool for reaching agreements in a complex and controversial multi-issue, multi-player context, such as climate change (Innes et al., 1994). However, self-organization of networks does not always lead to collaborative interactions and successful outcomes. In fact, there is tension between competitive and cooperative dynamics as ‘achieving both goal congruence and partner cooperation is often complicated by the reality that providers who collaborate in one network must also compete vigorously against each other for contracts and funds elsewhere’ (Goldsmith and Eggers, 2004, 46). Beyond a possible competitive dynamic, it is also challenging to hold network members accountable for their actions or inactions, especially when there are no sanctions in place. Ultimately, mistrust and goal incongruence among members can undermine the network itself. This shows that dysfunctions of self-organization can occur and that actors are still believed to pursue egoistic goals.<sup>5</sup> In other words, a policy network can only be successful if it systematically addresses (1) the bargaining dilemma or prisoner’s dilemma, which describes situations in which defection from cooperation is more rewarding than compliance and (2) solving the structural dilemma, which is the inter-organizational structure of horizontal co-ordination itself (Boerzel, 1998; Scharpf, 1992).

According to Ostrom et al. (1994) these issues are often addressed through social capital and the inherent balance between market and government forces in long-standing community and local networks. Social capital refers to ‘features of social organization, such as networks, norms, trust, which facilitate coordination and cooperation for mutual benefit’ (Putnam, 1993, 67). *But the emergence of this trust and capital is not automatic.* Studies have shown, for example, that less favoured regions (LFRs) have low levels of social capital, preventing them from seeking joint solutions or

develop institutional capacity to face current problems (Doeringer and Terkla, 1990; OECD, 1993). LFRs are those areas which lack the factors for an innovation system, such as critical mass of innovative firms and institutions, and a significant range of interactions among the different actors involved in the innovation process.

Compared to Ostrom, we argue that the establishment of a physical network with a leader is a key factor in commons governance and that these dynamics will be missed if analysis focuses only upon the basic rules actors establish. Thus, Ostrom et al. (1994) emphasize the ‘operational-level rule configurations’ (300) and any changes to those rules as well compliance and non-compliance lead to a change in actor’s incentives and choices. But this excludes any face-to-face interaction, in which tacit knowledge – a key for innovation – can be exchanged. Ostrom et al. (1994) state that face-to-face communication is only possible if interests are symmetric and that they expect individuals to select rules that are ‘already known to them. . . , easy to learn, follow and monitor; likely to reduce the complexity of the situations; and perceived as likely to improve joint outcomes’ (323).

In contrast, the ability of a network manager to set some of the rules and thus give actors a platform to interact and exchange knowledge is a key determinant of network activity and effectiveness (Provan and Kenis, 2007). This reduces the complexity and uncertainty of the relationships and makes face-to-face communication more likely. Ideally, such management activities establish larger, tighter networks and reduce uncertainty about the establishment of key inter-organizational and inter-personal relationships while also reducing the costs of maintaining existing ones.

Often (potential) network members run into issues dealing with delays of possible cooperation benefits, as well as the dynamics and costs of breaking and forming links. This is especially true for start-up companies that are in the process of establishing themselves in a region and do not have the resources – financially and time-wise – to form relationships with stakeholders. They often also have limited information about the incentives of others or in fact are missing information on the actual and potential structure of the network as a whole (Powell and Grodal, 1998; Larson, 1992). Also, in some cases actors have to deal with overlapping networks, which complicates their ability to calculate their own cost and benefits as well as form ties and built trust with other members. Basically, ‘individuals form and sever links based on the improvement that the resulting network offers them relative to the current network’ (Jackson and Watts, 2002, 266). This implies that they will not commit until they have the knowledge required to make that assessment. Taking the previous conditions into account, often they can only make that assessment if they have a manager that is able to see the whole network and its values to each member.

The manager is able to see the ‘big picture’ without looking for personal gain. From this position, a leader can find valuable members that fill a knowledge gap within the network or connect parties that benefit from working together. In terms of funding, the manager also knows about possible government resources and can establish plans for competing in those. The representation of the cluster at different levels by the manager also contributes to possible

<sup>5</sup> For a discussion of utility maximization of individuals and the effect of networks, see Lejano and Fernandez (2013). They argue that network interactions can lead to normative considerations in decision-making.



investments and new connections. This manager could be a formal associational one, a specific individual or organization or some combination of these. In this process, the leadership function would not be defined through reward, coercive or ecological power, but focuses on the informational and expert powers as well as legitimacy given through close relationships to government (Svetina et al., 2004).<sup>6</sup> For this, the manager earns recognition, while government has the role of enforcing sanctions and holding members accountable (Mansbridge, 2013). The activities pursued by such leaders in networks include:

- Activating the right players (Agranoff and McGuire, 1999; Scharpf, 1978);
- Framing, which includes: establishing and influencing the operating rules of the network (Mandell, 1990; Klijn, 1996; Gray, 1989), influencing its values and norms (Klijn and Teisman, 1997; O'Toole, 1997), and altering the perceptions of the network participants (Termeer and Koppenjan, 1997);
- Mobilization (Agranoff and McGuire, 1999);
- Synthesizing the network by creating the environment and enhancing the conditions for favourable, productive interaction (Klijn & Teisman, 1997).

And while the network manager is performing these tasks, the incipient network in return has to be flexible and open to change. Individual agents of the network can support leadership efforts by adopting behaviours that enhance their interactive contributions. For example, they can enlarge and foster their personal links to increase the amount of access and network resources they can bring to the table (Uhl-Bien et al., 2007).

The expectation is that the network manager creates new links or ties among stakeholders where direct contact otherwise would not have been established (Burt, 2003). Such ties can be weak or strong. Weak ties are less redundant and more flexible than strong ones. They also often link network members with actors outside the boundaries of the network. But they are less suitable to create trust, shared values and norms. Strong ties on the other hand, are not as flexible while facilitating bilateral trust and collective action routines. Thus, they are more prone for non-learning as similar views are developed (Bodin et al., 2006). Ties therefore have a dual nature – both enabling and constraining. Their link to learning shows the importance of a mix of weak and strong ties for single- and

double-loop learning. Single-loop learning is referred to as adaptive learning, as it describes a change in the knowledge base, competences or routines without changing the fundamental nature of a process or product. Double-loop learning is essential for any innovation coming out of networks, as it occurs when in addition to the detection and correction of errors, the network questions and modifies existing norms, procedures, policies and objectives (Steiner and Hartmann, 1999).

## 8. Concluding remarks

In a 2009 article, Ostrom asks 'how diverse polycentric institutions help or hinder innovativeness, learning, adapting, trustworthiness, levels of cooperation of participants, and the achievements of more effective, equitable, and sustainable outcomes at multiple scales' (Ostrom, 2009b, 436). Traditional administrative practices have not successfully managed the complexity and the uncertainty involved in this innovative environmental field. Instead, it has often been argued that networking processes have more potential for addressing a wider range of concerns and complex interactions than standard bureaucratic approaches, as well as greater capacity to develop solutions tailored to the uncertain and unique contexts of particular regions (Dryzek, 1987, 1990; Innes et al., 1994). As Ostrom highlights (2009b), there is no – and there should not be – a single blueprint to tackle environmental challenges in different locations. Networks are more flexible and less limited than, for example, rigid government programmatic practices and routines. They also have an increased reach in order to connect the many knowledgeable actors, resources and multiple government entities involved in climate change mitigation and adaptation efforts (Goldsmith and Eggers, 2004).

In this paper, we focused on the role of network leaders and how they frame self-organization in a climate change context. The Australian example showed that network leadership is different from direct government involvement or networking on the ground. Instead, it is an additional layer in the middle of a polycentric system, balancing hierarchical and horizontal dynamics. A network manager is able to minimize costs for players to join the network, establish cooperative structures and create trust among participants. This leads to the development of social capital. In turn, social capital is the basis for knowledge-exchange and innovative processes – the intellectual capital. For innovation, especially tacit knowledge contributes to new ideas, which needs to be experienced or communicated face-to-face. In a well-established and functioning network, members are able to do exactly that.

Scholars in network research even go one step further and suggest that when social and intellectual capital is present, the cooperative dynamics loop back to the political level. The idea is, when managers guide or frame a network, it is able to agree on common goals more easily, implementation of those goals goes more smoothly and the network grows. Also, scientific disagreements are solved faster and closely related to the local environmental context. These factors make it easier for government to agree on next steps and implementation initiatives (Innes et al., 1994; Gruber, 1994).

<sup>6</sup> The leader poses a third-party organization implemented by government or comes from the network itself to organize and coordinate cooperation. At arm-length of government, the leader faces a different set of challenges than being 'one of the network'. A manager implemented by government might have more upfront legitimization, but this can also become problematic: 'network managers must retain as much flexibility as possible without acquiescing to constant and unwarranted requests for change in performance targets and standards' (Goldsmith and Eggers, 2004, 149). On top of that, it adds an additional layer to the multi-level governance structure of climate change, which in most settings already includes national, federal, regional and local stakeholders. A leader coming from the group of network participants has to prove that there is no personal gain to managing the collaboration and that the goal is to be a neutral node for all current and future members.



Analyzing the Australian case has shown that Ostrom's eight principles apply in the climate change context, as Australia chose a tight-knit structure of monitoring while allowing for guided networks to be established. What we add to the eight principles is that these rules are monitored by the network leader. Government remains in the role of sanctioning and posing a 'shadow' of conformity (Mansbridge, 2013). But first and foremost stands the establishment of social capital, from which intellectual and political capital can follow.

Once network leadership is established, this set-up reduces transaction costs of collaboration, provides social incentives to stakeholders to invest in building trust, and identifies common interests and resource conflict. Ultimately it helps to build the capacity to adapt to change (Folke et al., 2005).

Leadership is a prerequisite and precondition to the creation and effectiveness of the commons. The management takes on an interactive form between network and leader, in which the catalytic impetus from the manager leads to concerted action of heterogeneous actors to produce new modes of operating and knowledge exchange (Uhl-Bien et al., 2007).

On the basis of this analysis, new questions arise regarding the research of the commons: what structure do collaborative arrangements need, to establish trust and reciprocity and what role does the state play in this set-up? Also, for future analysis, more attention needs to be paid towards network failure and what we can learn from it for the leadership of networks.

## REFERENCES

- Agranoff, R., McGuire, M., 1999. Big questions in public network management research. *J-PART* 11 (3) 295–326.
- Araral, E., 2013. Ostrom, Hardin and the Commons: a critical appreciation and revisionist view. *Environmental Science & Policy* (this issue).
- Arino, A., de la Torre, J., 1998. Learning from failure: towards an evolutionary model of collaborative ventures. *Organization Science* 9 (3) 306–325.
- Australian National Audit Office (ANAO), 2009. Commonwealth Scientific and Industrial Research Organisation — National Research Flagships Initiative. Available at: <http://www.anao.gov.au/bpg-innovation/case-6.html> (accessed 14.01.13).
- Benz, A., Fuerst, D., 2002. Policy learning in regional networks. *European Urban Regional Studies* 9 (1) 21–35.
- Bodin, O., Crona, B., Henrik, E., 2006. Social networks in natural resource management: what is there to learn from a structural perspective? Response to Newman and Dale. 2005. 'Network Structure, Diversity, and Proactive Resilience Building: a Response to Tompkins and Adger'. *Ecology and Society* 11 (2) Response 2.
- Boerzel, T.A., 1998. Organizing Babylon – on the different conceptions of policy networks. *Public Administration* 76, 253–273.
- Bulkeley, H., 2000. Discourse coalitions and the Australian climate change policy network. *Environment and Planning C: Government and Policy* 18, 727–748.
- Burt, R., 2003. The social capital of structural holes. In: Guillen, M.F., Collins, R., England, P., Meyer, M. (Eds.), *The New Economic Sociology: Developments in an Emerging Field*. Russell Sage Foundation, New York, pp. 148–189.
- Cassi, L., Corrocher, N., Malerba, F., Nicholas, V., 2008. Research networks as infrastructure for knowledge diffusion in European regions. *Economics of Innovation and New Technology* 17 (7–8) 663–676.
- Commonwealth Scientific and Industrial Research Organisation (CSIRO), 2009. Climate Adaptation National Research Flagship. Available at: <http://tinyurl.com/b854a67> (accessed 14.01.13).
- Commonwealth Scientific and Industrial Research Organisation (CSIRO), 2010. Flagship Collaboration Fund – Cluster Specification. Available at: <http://tinyurl.com/d8lvpmv> (accessed 01.01.13).
- Commonwealth Scientific and Industrial Research Organisation (CSIRO), 2012a. Dr. Andrew Ash: Director, Climate Adaptation Flagship. Available at: <http://www.csiro.au/en/Organisation-Structure/Flagships/Climate-Adaptation-Flagship/AndrewAsh.aspx> (accessed 15.01.13).
- Commonwealth Scientific and Industrial Research Organisation (CSIRO), 2012b. Flagship Collaborative Research Program (FCF projects and clusters), Guiding Principles. Available at: <http://www.csiro.au/en/Organisation-Structure/Flagships/AboutNationalResearchFlagships/Collaborative-Research-Program-Guidelines.aspx> (accessed 09.01.13).
- Department of Climate Change, 2009. Australian Climate Change Science, A National Framework. Available at: <http://www.climatechange.gov.au/~media/publications/science/National-Framework-Climate-Change-Science.pdf> (accessed 31.12.12).
- Doeringer, P., Terkla, D., 1990. How intangible factors contribute to economic development. *World Development* 18 (1) 295–308.
- Dryzek, J.S., 1987. *Rational Ecology, Environment and Political Economy*. Basil Blackwell, Oxford.
- Dryzek, J.S., 1990. *Discursive Democracy: Politics, Policy and Political Science*. Cambridge University Press, New York.
- Folke, C., Hahn, T., Olsson, P., Norberg, J., 2005. Adaptive governance of social–ecological systems. *Annual Review of Environment and Resources* 30, 441–473.
- Goldsmith, S., Eggers, W.D., 2004. *Governing by Network, The New Shape of the Public Sector*. Brookings Institution Press, Washington, DC.
- Gray, B., 1989. *Collaborating, Finding Common Ground for Multiparty Problems*. Jossey-Bass Publishers, London/San Francisco.
- Gruber, J., 1994. *Coordinating Growth Management through Consensus Building: Incentives and the Generation of Social, Intellectual, and Political Capital*. Working Paper 617. Institute of Urban and Regional Development.
- Gunningham, N., Kagan, R., Thornton, D., 2003. *Shades of Green: Business, Regulation and Environment*. Stanford University Press, Palo Alto, CA.
- Guston, D.H., 1999. Stabilizing the boundary between us politics and science: the role of the office of technology transfer as a boundary organization. *Social Studies of Science* 29 (1) 87–111.
- Henry, A.D., Dietz, T., 2011. Information, networks and the complexity of trust in commons governance. *International Journal of the Commons* 5 (2) 188–212.
- Hite, J.M., Hesterly, W.S., 2001. The evolution of firm networks: from emergence to early growth of the firm. *Strategic Management Journal* 22 (3) 275–286.
- Holley, C., Gunningham, N., Shearing, C., 2012. *The New Environmental Governance*. Earthscan, New York.
- Hormiga, E., Batista-Canino, R.M., Sanchez-Medina, A., 2011. The role of intellectual capital in the success of new ventures. *International Entrepreneurship and Management Journal* 7 (1) 71–92.

- Howlett, M., Ramesh, M., Perl, A., 2009. *Studying Public Policy, Policy Cycles and Policy Subsystems*, Third Edition. Oxford University Press, Oxford.
- Innes, J.E., Gruber, J., Neuman, M., Thompson, R., 1994. *Coordinating Growth and Environmental Management Through Consensus Building*. California Policy Research Center Papers. Institute of Urban and Regional and Development, University of California, Berkley.
- Jackson, M.O., Watts, A., 2002. The evolution of social and economic networks. *Journal of Economic Theory* 71, 44–74.
- Klijin, E.-H., 1996. Analyzing and managing policy processes in complex networks. *Administration and Society* 28, 90–119.
- Klijin, E.-H., Teisman, G.R., 1997. Strategies and games in networks. In: Kickert, K., Koppenjan, (Eds.), *Managing Complex Networks*. SAGE, London.
- Lafferty, W.F., Meadowcroft, J., 1996. Democracy and the environment: congruence and conflict – preliminary reflections. In: Lafferty, W.M., Meadowcroft, J. (Eds.), *Democracy and the Environment, Problems and Prospects*. Edward Elgar, Cheltenham/Brookfield, pp. 1–18.
- Larson, A., 1992. Network dyads in entrepreneurial settings: a study of the governance of exchange relationships. *Administrative Science Quarterly* 37 (1) 76–104.
- Lee, T., van de Meene, S., 2012. Who teaches and who learns? Policy learning through the C40 cities climate network. *Policy Sciences* 45 (3) 199–220.
- Lee, E., Jung, C.S., Lee, M.-K., 2013. The potential role of boundary organizations in the climate regime. *Environmental Science & Policy* (this issue).
- Lejano, R.P., Fernandez, F., 2013. Social dimensions of the environment: the invisible hand of community. *Environmental Science & Policy* (this issue).
- Lev, B., 2001. *Intangibles – Management, Measurement and Reporting*. The Brookings Institution, Washington.
- Mandell, M.P., 1990. Network management: strategic behavior in the public sector. In: Gage, R.W., Mandell, M.P. (Eds.), *Strategies for Managing Intergovernmental Policies and Networks*. Praeger, New York.
- Mansbridge, J., 2013. The role of the state in governing the Commons. *Environmental Science & Policy* (this issue).
- Merrill-Sands, D., Sheridan, B., 1996. *Developing and Managing Collaborative Alliances: Lessons from a Review of the Literature*. Organizational Change Briefing Note 3. Simmons Institute for Leadership and Change, Boston.
- OECD, 1993. *Territorial Development and Structural Change: A New Perspective on Adjustment and Reform*. OECD, Paris.
- OECD, 2007. *Environmental Performance Reviews: Australia 2007*. OECD Publishing, <http://dx.doi.org/10.1787/9789264039612-en>.
- O’Riordan, T., Jaeger, J., 1996. *Politics of Climate Change: A European Perspective*. Routledge, London.
- Orton, J.D.K.E., 1990. Loosely coupled systems: a reconceptualization. *Academy of Management Review* 15, 203–223.
- Ostrom, E., 1990. *Governing the Commons: The Evolution of Institutions for Collective Action*. Cambridge University Press, New York, USA270.
- Ostrom, E., 2001. Vulnerability and Polycentric Governance Systems. IHDP (International Human Dimensions Programme on Global Environmental Change) Newsletter, UPDATE no. 3, 1, 3–4.
- Ostrom, E., 2005. *Unlocking Public Entrepreneurship and Public Economies*. Working Papers DP2005/01. World Institute for Development Economic Research (UNU-WIDER).
- Ostrom, E., 2009a. *Beyond Markets and States: Polycentric Governance of Complex Economic Systems*. Prize Lecture. Available at: [http://ideas.repec.org/p/ris/nobelp/2009\\_004.html](http://ideas.repec.org/p/ris/nobelp/2009_004.html) (accessed 20.12.12).
- Ostrom, E., 2009b. *A Polycentric Approach for Coping with Climate Change*. World Bank Policy Research Working Paper No. 5095. .
- Ostrom, E., Gardner, R., Walker, J., 1994. *Rules, Games and Common-Pool Resources*. The University of Michigan Press, Ann Arbor.
- O’Toole, L., 1997. Treating networks seriously: practical and research-based agendas in public administration. *Public Administration Review* 57 (1) 45–52.
- Pahl-Wostl, C., 2009. A conceptual framework for analysing adaptive capacity and multi-level learning processes in resource governance regimes. *Global Environmental Change* 19, 354–365.
- Powell, W.W., Grodal, S., 1998. Learning from collaboration: knowledge and networks in the biotechnology and pharmaceutical industries. *California Management Review* 40 (3) 228–240.
- Powell, W.W., Grodal, S., 2005. Networks of innovators. In: Fagerberg, J., Mowery, D., Nelson, R.R. (Eds.), *The Oxford Handbook of Innovation*. Oxford University Press, Oxford, pp. 56–86.
- Powell, W.W., Grodal, S., Koput, K.W., Smith-Doerr, L., 1996. Interorganizational Collaboration and the locus of innovation: networks of learning in biotechnology. *Administrative Science Quarterly* 41, 116–145.
- Provan, K.G., Kenis, P., 2007. Modes of network governance: structure, management, and effectiveness. *J-PART* 18, 229–252.
- Putnam, R., 1993. *Making Democracy Work: Civic Traditions in Modern Italy*. Princeton University Press, Princeton.
- Ross, A., Dovers, S., 2008. Making the harder yards: environmental policy integration in Australia. *The Australian Journal of Public Administration* 67 (3) 245–260.
- Sabatier, P.A., Jenkins-Smith, H.C., 1993. *Policy Change and Learning: An Advocacy Coalition Approach*. Westview Press, Boulder, CO.
- Scharpf, F.W., 1978. Interorganizational policy studies: issues, concepts and perspectives. In: Hanf, K.J., Scharpf, F.W. (Eds.), *Interorganizational Policy Making: Limits to Coordination and Central Control*. Sage, London and Beverly Hills, pp. 345–370.
- Scharpf, F.W., 1992. Koordination durch Verhandlungssysteme: Analytische Konzepte und institutionelle Loesungen. In: Benz, A., Scharpf, F.W., Zintl, R. (Eds.), *Horizontale Politikverflechtung. Zur Theorie von Verhandlungssystemen*. Campus, Frankfurt a.M./New York, pp. 51–96.
- Steiner, M., Hartmann, C., 1999. Interfirm co-operation and learning within SME Networks – two case studies from the Styrian Automotive Cluster. In: Fischer, M.M., Suarez-Villa, L., Steiner, M. (Eds.), *Innovation, Networks and Localities*. Springer, Berlin and Heidelberg, pp. 85–110.
- Sullivan, P.H., 1999. Profiting from intellectual capital. *Journal of Knowledge Management* 3 (2) 132–142.
- Svetina, A.C., Jaklic, M., Hugo, Z., 2004. Leadership in clusters: the applicability of existing leadership theories to the concept of clusters. In: *The Competitiveness Institute 7th Global Conference, Building Innovative Clusters for Competitive Advantage*, Ottawa, Canada.
- Termeer, C.J.A.M., Koppenjan, J.F.M., 1997. Managing perceptions in networks. In: Kickert, Klijin, Koppenjan, (Eds.), *Managing Complex Networks: Strategies for the Public Sector*. Sage, London, pp. 119–136.
- Uhl-Bien, M., Marion, R., McLKelvey, B., 2007. Complexity leadership theory: shifting leadership from the industrial age to the knowledge era. *The Leadership Quarterly* 18, 298–318.

UN Office for the Coordination of Humanitarian Affairs, 2012. Interview with Nobel prize winner Elinor Ostrom on climate change. IRIN GLOBAL Available at: <http://www.irinnews.org/printreport.aspx?reportid=95355> (accessed 30.12.12).

Urbaniec, M., Gerstlberger, W., 2011. Innovation in environment-oriented networks. *Management of Environmental Quality: An International Journal* 22 (6) 696–704.