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Information and Knowledge for Water Governance in the Networked Society

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ABSTRACT: In the last few years, parallel evolutionary processes in the socio-political, governmental and technological arenas have been providing new pathways for the collaborative generation, coordination and distribution of polycentric information. From a technological perspective, the proliferation of information and communication technologies (ICTs) has boosted the availability of information about our planet, along with its storage, processing and dissemination capabilities. The Worldwide Web and satellite and electronic sensors combined with smart phone technologies have also opened new means for social, political and scientific innovation. From a socio-political standpoint, the implementation of policies that encourage the reutilisation of data and protect the right to information of interested parties, together with growing social demands for transparency, have resulted in an increasing number of governments drawing strategies to open up public data. In this context, this paper addresses two main topics that we deem will be key drivers for improved water governance in the near future. First, it discusses new practices of collaborative and distributed generation and disclosure of information for water governance, and the resulting challenges and opportunities afforded by the use of ICTs. Second, it looks at the interplay between the uptake of ICTs and institutional frameworks, social dynamics and technological structures within which they operate to understand the extent to which ICTs affect decision-making processes and contribute to creating alternative spaces for the production of common services or alternative discourses. Despite the advances in open data policies, findings suggest that there remain significant challenges to take full advantage of the opportunities offered by ICTs, mostly derived from the structural conditions of existing models of decision-making, and information generation and management. It seems that the potentialities of ICTs as transformative tools are conditioned by the regeneration of the context within which decisions are made, that is, the democratic process itself.

KEYWORDS: Water data, open data, polycentric information, networked society, technopolitics, water governance

INTRODUCTION

The proliferation of information and communication technologies (ICTs) is driving profound changes in the availability of information about our planet, its storage and processing capabilities, its distribution and dissemination. The Worldwide Web and satellite and electronic sensors combined with smart phone technologies have opened new means for social, political and scientific innovation. In what pertains to water information and governance, the increasing availability of water data and the new modes of information production and sharing can influence evolving institutional frameworks and water management paradigms.

While there is a relatively broad consensus on the potentially transformative effects that ICTs can have on political processes and the management of the public sphere, there is also a burgeoning debate around the significance and character of that transformation. As Fung et al. (2013: 31) point out many pioneer researchers of the distinctive dynamics of new digital media platforms – social media and collaborative knowledge production – look with optimism at the role that ICTs can play in improving democratic governmental practices, stressing the culture and perspectives of the Open Source community (Benkler, 2006; Shirky, 2008; Noveck, 2009 in Fung et al., 2013). On the other hand, a parallel current of scholars explores the actual impacts of new modes of knowledge production on political systems in terms of improving equality and democracy and arrives at rather sceptical conclusions (Hindman, 2009; Morozov, 2011; Schlozman et al., 2012 in Fung et al., 2013: 31; Taylor, 2014). These lines of research and intellectual debates are being undertaken in many realms of the public sphere but little progress has been made in the field of natural resources management in general and in the area of water governance in particular. The collection of papers presented in this special issue is meant to contribute to this emerging field of research.

The origins of this special issue date back to January 2013, when the SWAN project team at the University of Seville organised a workshop to identify evolving data needs to inform decisions over water resources and risk management. The starting point of the workshop was a reflection on the changes in information requirements that result from the implementation of the Water Framework Directive (WFD) in the European context (Del Moral et al., 2014). The WFD, an ambitious legislative development of the Integrated Water Resources Management (IWRM) framework, emphasises ecological integrity of water ecosystems, the use of price incentives to encourage more efficient water use and a governance approach that heavily relies on public information and participation processes – the 'ecological modernisation' model already described by Hajer (1995). Furthermore, IWRM and other concepts currently dominating water resources management frameworks, such as the emerging water security concept, recognise the complexity inherent in the management of multifaceted and interrelated resources and processes: the water, land, food and energy nexus (Giampietro et al., 2012; Giampietro and Aspinall et al., 2014) and the broader linkages between environmental, socioeconomic, cultural and political processes (Del Moral, 2009). Data requirements are consequently increasingly diverse, interlinked and demanding.

The current context for water management is one of complexity and uncertainty, where divergent economic and political interests are at stake, and where cultural and identity discourses play a significant role (Funtowicz and Ravets, 1992). In such a context, the effective incorporation of diverse actors and the quality of decision-making processes is of particular importance. Access to information over which deliberation can be arranged is a prerequisite in any participatory process. Information must be relevant to the specific management questions, easily accessible and understandable for all types of stakeholders, adapted to the decision-making context and time frame, and traceable.

Following up on the ideas discussed in the seminar, the SWAN project organised the International *Conference on data, information and knowledge for water governance in the networked society*[1] in Seville in June 2014. The conference built on the premise that information requirements for natural resources management are influenced by the emergence of the networked society. From a technological perspective, these influences derive from the ever-expanding possibilities provided by polycentric and changing sources of information generation, the rapid development of earth observation technologies and the existence of different avenues for sharing and disseminating data and information. From a socio-political standpoint, the implementation of policies that encourage the standardisation and reutilisation of publicly produced data and protect the right to information of interested parties, together with growing social demands for information and transparency, also expand the requirements on data producers and managers. The aim of the Conference was to reflect upon current debates and innovations regarding collaborative generation, processing and disclosure of data and information, with a focus on water governance. It also analysed the socio-political implications of these innovations, in terms of citizen engagement with decision-making processes and the reshaping of socio-natural constellations and power balances between social actors due to the potential for political participation provided by new technologies.

This special issue was launched in coordination with the International Conference. It aims to contribute to the debate on whether and how the emerging networked society paradigm is generating new avenues to address water governance challenges. We do so by discussing two particularly relevant lines of research that are reflected in the papers presented here.

First, it seems certain that emergent ICTs facilitate new practices of collaborative and distributed – polycentric – generation of information. However, it is more debatable how they are helping to meet the demands of transparency, open data and the new information needs for water governance. What are the conditions that have to be observed to enable information quality control, ensure the consistency of information on water throughout its life cycle, guarantee information sustainability, ensure free access, optimise generation efforts and minimise overlaps? How is this information transformed into useful knowledge for water governance in the era of big data? What is the role of knowledge and information in relation to unequal social relations, legitimisation of hegemonic positions or key politically contentious issues?

Second, rapidly developing ICTs are indeed influencing discussions on water policy paradigms and affecting the way water governance is patterned in different geographical settings. Nevertheless, these effects are conditioned or contextualised by wider socio-political processes – neoliberal globalisation, post-political age, post-democracy, etc – and thus must be understood in that context. What are the key theoretical and policy issues that can help us understand how the emerging ways of generating, accessing, and managing information reshape social relations of power in water use, management and governance? Will social actors take advantage of the new political participation potential provided by new technologies or are new control mechanisms being constructed to avoid it? What are the key issues concerning the relation between power, information and the policy process?

This introductory paper discusses these questions based on the evidence gathered from the articles included in this special issue, a review of the relevant literature, findings from the SWAN project and the outcomes from the International Conference. The paper is structured in four sections. Following this introduction, we address the first set of questions mentioned above, discussing new practices of collaborative and distributed generation and disclosure of information for water governance, and the resulting challenges and opportunities afforded by the use of ICTs. The following section looks at the

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[1] For recordings of the sessions and access to the speakers' presentations please see:
https://swanproject.arizona.edu/international-conferences (accessed 25 May 2015). The conference developed a twitter profile: @waterP2P and #waterP2P

interplay between the uptake of ICTs and institutional frameworks, social dynamics and technological structures within which they operate to understand the extent to which ICTs affect decision-making processes and contribute to create alternative spaces for the production of common services or alternative discourses. We conclude with some final remarks.

POLYCENTRIC INFORMATION FOR WATER GOVERNANCE IN THE INTERNET ERA

Water data are by nature polycentric, generated by networks of actors involved in its management. From local irrigation communities and municipalities to river basin authorities, private entities or research institutions, water data and derived information are produced at multiple scales of planning, research and decision-making. Because of the polycentric character of its generation and storage, water data collection and integration is a very complex task. Water data *prosumers* are first of all management authorities who generate large volumes of centralised data and at the same time – presumably - handle the collection and integration of the data sets produced by other multiple actors. These other actors are located in what Hamilton (2014) calls the long-tail of water data distribution, that is to say, small amounts of data sets being produced by a great number of operators working independently from each other without sharing or coordination.

In the last few years, parallel evolutionary processes in the socio-political, governmental and technological arenas have been providing new pathways for the coordinated production, integration and distribution of polycentric information. As pointed by Waller (2011), the capability of internet-based technologies to make data and information previously held within the limits of governmental institutions publicly available and, what is more important, (re)usable, has concurred with a political will, at least in some countries, to make governments more transparent and accountable. The assumptions underlying open government policies point to ICTs' potential for enabling transformational change by enhancing transparency, accountability, and collaboration, which will in turn facilitate civic engagement and yield new innovative businesses (Bertot et al., 2010 in Jaeger et al., 2012). The development and implementation of 'open data'[2] strategies by governments respond to three primary motivations: (1) increase democratic control and political participation; (2) foster services and product innovation, recognise the value of data for the development of new products and services in the knowledge economy; and (3) strengthen law enforcement (Huijboom and Van den Broek, 2011).

Other key arguments underlying open data policies are increasing efficiency in public administration and adding value to data generated with public funds by establishing effective reusability and interoperability standards.[3] Both goals inspired the pioneer open data efforts undertaken under the United States' Clinton administration. Since President Clinton declared geographic information as being "critical to promote economic development, improve our stewardship of natural resources and protect the environment",[4] the advances in this field have been significant. The US National Spatial Data Infrastructure (NSDI) Program was launched in 1994 with the goal of avoiding the duplication of data-gathering efforts and promoting efficient resources management within federal agencies. The NSDI was conceived as an umbrella for the technologies, policies, standards, and human resources necessary to acquire, process, store, distribute, and improve the utilisation of geospatial data. The policy recognised that it is necessary to promote the proper technological and institutional conditions to enable

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[2] Open data are defined as data accessible online in machine-readable format at reasonable reproduction costs and with universal reusability licenses (Open Knowledge Foundation at https://okfn.org/opendata/). The term is usually, but not exclusively, applied to data generated by public administrations with public funding that meets these characteristics.

[3] See for example, the European Directive on the reuse of public-sector information, known as the Public Sector Directive (PSI) (Directive 2003/98/CE and following amendments), or the Open Government Partnership (OGP) launched in 2011 by US President Obama.

[4] Executive Order No. 12906, 59 C.F.R. 17671 (April 11, 1994).

coordination of polycentric data generation in order to optimise generation efforts, minimise overlaps and foster access and reutilisation. Public access to information was promoted through this initiative and the Clinton Administration identified the creation of the NSDI as one of the necessary initiatives to 'reinvent government'.[5]

Following the NSDI initiative, other countries have also worked towards common Spatial Data Infrastructures that allow the coordinated production, discovery and (re)use of geospatial information internationally (Maguire and Longley, 2005). The European Union started to work in 2001 towards a common European Spatial Data Infrastructure that developed into the INSPIRE Directive (2007/2/EC) (Bernand et al., 2005; Rodriguez et al., 2007). This has resulted in the unprecedented disclosure of all manner of public geospatial data on the Internet, including water-related data.[6] Undoubtedly, the international coordination of these initiatives would not have been possible without the adoption of the Open Geospatial Consortium[7] standards that make geographic information interoperable and reusable.

In spite of these advances, progress is slow, even in what Huijboom and Van den Broek (2011) call 'the front runner countries' on open data strategies. A study by the Netherlands Organisation for Applied Scientific Research (TNO) in some of these countries (Australia, Denmark, Spain, the United Kingdom and the United States) identified some key barriers for the effective implementation of open data policies such as: (1) Closed government culture; (2) Privacy legislation; (3) Limited quality of data; (4) Limited user-friendliness/information overload, and (5) lack of standardisation of open data policy (ibid., 2011: 11).

Indeed, the barriers imposed by closed government cultures are extensively mentioned in the literature and discussed by practitioners dealing with data generation and sharing between public administrations (Reddick and Aikins, 2012; Prasai and Surie, this issue). In this sense Ruza (2014) highlights that, as a practitioner responsible for water-data reporting within the Spanish administration, the main lesson learnt from the experience of the Water Information System for Europe (WISE)[8] is that, to make polycentric information available to managers, agencies and the public, paramount attention needs to be placed on standardisation, institutional arrangements, organisational aspects and, especially, the promotion of a reliable collaborative culture within public administrations. Education and training are also considered key instruments to implement successful open data policies (Huijboom and Van den Broek, 2011). Of course, sharing information and data implies sharing power. Any transformation in institutional arrangements inevitably has supporters and detractors because it alters the power balance.

Prasai and Surie (this issue) identify many of these challenges in the case of South Asia through an analysis of the effectiveness of right to information (RTI) legislation in three co-riparian countries of the Ganga Basin: Bangladesh, India and Nepal. The authors found hydrological and climate data to be fragmented, generated at different governmental levels (federal, state, local) without clear guidelines and standards. Record-keeping and, more broadly, data management practices within governments were generally poor. The study shows that "[w]here information was available i.e. either proactively

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[5] Federal Geographic Data Committee, The 1994 Plan for the National Spatial Data Infrastructure, Office of Management and Budget, (March 1994) cited in *The Graphic Information System* available at http://landuse.law.pace.edu/ (accessed 13 April 2015).

[6] See for example the Spanish River Basin Authorities' Spatial Data Infrastructures at http://www.idee.es/centros-de-descarga (accessed 13 April 2015).

[7] OGC is an international industrial consortium of more than 500 companies, government agencies and universities.

[8] WISE is an information clearinghouse on European water issues. It comprises a wide range of data and information collected by EU institutions to serve several stakeholders. It is a partnership between the European Commission (DG Environment, Joint Research Centre and Eurostat) and the European Environment Agency. See http://water.europa.eu/

disclosed by a government department or supplied via RTI – it was often found to be incomplete, difficult to interpret or provided in a format that was not very user friendly". Additionally, a closed government culture and a lack of knowledge and understanding of the law on the part of government officials hampered the successful implementation of RTI legislation. In their view, existing institutional structures limit the ability of co-riparian states to "utilize the power of technology in overcoming political impediments to cooperation".

Sternlieb and Laituri (this issue) also look at the challenges resulting from the polycentric nature of water data generated by governmental and non-governmental actors within a system of overlapping jurisdictions at multiple scales, but in a very different geopolitical setting. Specifically, the authors analyse access and consistency of water data related to the agriculture sector in the Colorado River Basin. They develop a geodatabase to integrate three different types of data based on physical, political, and organisational boundaries. In their study, data availability was dependent on the source (federal, state, or local), on the type of data (with hydrogeological data widely available online), and on whether parties, particularly private irrigation companies, were willing to share what they often considered private and confidential data. In this case, the reluctance to share information does not derive from a closed government culture but, rather, from the private nature of some data generators. The spatialisation of these data confirmed the dominance of a polycentric governance system in the basin. The authors emphasise the complications that stem from this type of management configuration and the urgency to improve the quality and availability of water governance data systems. In their view, in the current governance system this is only possible through improved coordination among actors operating at various scales in order to ensure compatibility of data sets, minimise duplication in collection efforts and thus better meet water governance information requirements.

In a general context of open government policies and coordinated information production and sharing, the papers included in this special issue suggest that, unlike geographic information, the deeply political nature of decisions over water (Hernández-Mora et al., this issue) as well as its vital importance, make water data and information specially sensitive and difficult to handle, notwithstanding the technical and institutional advances towards an open data and collaborative information scenario.

This challenge is particularly significant in the case of transboundary basins, as Prassai and Surie (this issue) illustrate. For instance, the authors found India's securitised approach to water and climate data as the main reason explaining the reluctance of Indian authorities to share water-related information, in spite of existing transboundary water treaties and recently approved RTI laws. These results align with the work by Gerlak et al. (2013) who found that although the number of transboundary water agreements has increased worldwide in the recent past, the requirements for water resources data and information exchange within these treaties are increasingly ambiguous, minimising states' commitments to formal schedules and procedures for exchange of information. While Prasai and Surie's study focuses on three countries, authors highlight that the situation of data and information access and sharing in other South Asian countries is not significantly different. Regional cooperation on water remains contentious, especially because of deep mistrust and chronic political tensions. Concurring with other authors on the potentially transformative effects of effective open data policies (Lyon, 2014; Carvalho, 2015), they believe that progress in the implementation of open data regimes would help improve transboundary cooperation by helping lower nationalistic fervour on water, promoting political contestation in agenda-framing and providing alternative imaginations or narratives. In their view, the rapid advancement in ICTs might just be able to "neutralize the information asymmetries between stakeholders, discourage secrecy regimes and allow the articulation of broadly acceptable goals on transboundary water management". Hernández-Mora et al. (this issue) also stress the important role citizen organisations can play exercising quality control over official information and contesting decisions over water.

In addition to the increasing availability of data generated by governments and public administrations, citizens, NGOs and research institutions have also become Internet-content producers, altering the way information is generated, gathered, accessed, and understood. While the Web evolves towards more cooperative designs, the transformation of collaboratively produced information into useful knowledge becomes particularly relevant. This is the case of what are known as 'citizen sensing' or 'human sensor web' initiatives whose common factor is that they rely on the use of geospatial web applications for gathering and displaying of information. Such applications are also referred to as 'crowdsourcing' applications, since they rely on the power of 'crowds' and citizen input, some in real time, to achieve their goals (Kamel Boulos et al., 2011).

We highlight three emerging trends that are relevant for water research and governance. The first is crowdsourcing for scientific production, the quickly developing field of 'citizen science' (Bonney, et al., 2009; Dickinson, et al., 2010; Buytaert et al., 2014, International FreshWaterWatch Project[9]). A second application is the use of participatory geoweb tools to support the work of social movements, for instance contributing to integrate local knowledge into global advocacy for water justice like the Remunicipalisation Tracker[10] (Kishimoto, 2014) or to support environmental monitoring efforts such as the IPE's pollution digital maps in China.[11] A third important application is the development of ICTs (mostly mobile device apps or mApps) to monitor public service delivery, especially in state-weak administrations (Hellstrom, 2010). These mApps have been particularly applied to the improvement of water supply and sanitation services (Jimenez and Perez-Foguet, 2011; Wesselink et al., this issue; Water Point Mapper[12]).

According to Wesselink et al. (this issue), the usefulness of ICT innovations for public service improvement is heavily conditioned by the institutional and sociopolitical contexts in which they are developed and implemented. In their study, they set out to develop an action research project on eGovernance technologies to improve rural water supply in Tanzania, a "clearly transformative, political goal". Their work demonstrates that the hybrid nature of water service provision (a mix of public, private, communal and informal institutions) and the sociopolitical conditions of the Tanzanian context challenge the transformative promises of eGovernance. These are based on the premises that services are provided by the state or by a state-sanctioned monopoly and that the lack of information is an important bottleneck to better governance of services. Therefore, the reasoning goes, if citizens are able to provide this information through ICTs, the increased transparency through public displaying of information will 'name and shame' responsible organisations into action, and public service delivery will improve as a result. The development of mApps for improved water service provision rests on these assumptions.

The authors use their experience in designing and implementing a mApp to report water delivery failures in rural water systems to challenge these premises. In the case of Tanzania, as in many other developing nations, the state is not the sole (or even primary) provider of water services in a centralised manner that can be enhanced with better information. Furthermore, lack of information is not the core constraint for current water governance problems. The pre-existing complex network of formal and informal institutions determine that "formal accountability mechanisms, where formal reporting plays a

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[9] The International FreshWaterWatch *Project* aims to investigate the health of the world's freshwater ecosystems on a global and local scale. https://freshwaterwatch.thewaterhub.org (accessed 29 April 2015)

[10] The Water Remunicipalisation Tracker is a mapping tool to share information regarding the global remunicipalisation wave of urban water supply and sanitation services. http://www.remunicipalisation.org/ (accessed 29 April 2015).

[11] The Institute of Public & Environmental Affairs (IPE) gathers hard-to-find public environmental data on water and air quality and environmental violations records across China through a citizen engagement web-based platform that makes pollution information widely available. http://www.ipe.org.cn/en/pollution/index.aspx (accessed 25 May 2015).

[12] The Water Point Mapper is a free tool to report and mapping the status of water supply and sanitation services in sub-Saharan Africa. http://www.waterpointmapper.org/ (accessed 29 April 2015).

role, are outstripped by informal mechanisms where information is not generally publicly exchanged". Finally, the reluctance of the population to record in writing concerns or complaints about government actions and the general mistrust on institutional willingness to solve citizen problems, are key factors making efforts toward cooperative information and knowledge generation fail. They conclude that crowdsourcing for empowerment and accountability regarding public services is not a viable approach in Tanzania at the present time. In contrast with the success of collaborative knowledge-gathering initiatives such as Wikipedia or Open Street Map, the use of ICTs for the co-production of services has governance goals and, because of that, they are political in nature. This makes them 'political apps' and, therefore, likely to raise more controversy and resistance which condition their success.

These findings suggest that there remain significant challenges to take full advantage of the opportunities offered by ICTs, mostly derived from the inertia of existing models of decision-making and information management. Public administrations are reluctant to accept the public right to access to information and, to a large extent, have not reorganised their information management procedures in order to facilitate knowledge generation and information integration. The pending issue for water policy in the field of information is to ensure that information gives rise to knowledge truly useful for participatory planning and management. This implies facilitating the conditions in which knowledge is produced through collaborative methods, considering the needs of all actors and using open standards, in accordance with the potentialities of the networked society. The collaborative generation of information has institutional implications concerning alterations in the geometries of power, that is, potential changes in the identity of the actors that control information and, as a result, the decision-making processes.

In the next section we turn to the second set of questions we had set out to address, that is, the sociopolitical implications of the emergence of the networked society in the field of water resources management.

THE NETWORKED SOCIETY, POWER AND WATER POLITICAL PROCESSES

The extent to which the emergence of ICT technologies is providing new avenues for participated decision-making and contributing to alter the dominating power balance in different arenas of the public sphere is now the centre of debate and research (Della Porta and Mosca, 2005; Iosifidis, 2011; Subirats, 2011; Castells, 2012; Fuster Morell and Subirats, 2013; Calderaro and Kavada, 2013; Taylor, 2014; Earl et al., 2014; Agarwal et al., 2015). Does social media constitute a new type of public sphere with enhanced participation and deliberation (Dahlgren, 2005 as cited in Mancilla, this issue)? Does it encourage the expression of marginalised and underrepresented discourses and provide access to those who had been previously excluded from decision-making processes? Do ICTs create new democratic spaces and venues for fulfilling democratic ideals?

There is extensive literature that defends the potential of ICTs and their socio-political product, the networked society, to give birth to a new society, with qualitatively different decision processes. According to this perspective, Internet is not just a 'new hammer' to do better 'business as usual', but a context for policy-making that implies new actors, new resources, new ways of policy diffusion (Subirats, 2014). This transformative potential implies not only the adoption of ICTs, what some call using the Internet, but rather, being the Internet, accepting its effects in decision-making processes and organisational rules (Sábada, 2012).

Over the past few years the burgeoning use of ICTs has enabled the emergence and consolidation of new forms of social action by opening new possibilities for previously powerless stakeholders to share information and improve the effectiveness of their political activism in different realms of the public domain. ICTs and social networks can act as catalysts for the emergence of innovative democratic practices that challenge post-democratic consensual forms of government and generate egalitarian political spaces. Citizens can use the Internet to become more effective in their efforts to influence

public policies and self-organise to generate solutions when they perceive the administration to be unresponsive (Subirats, 2011). This emerging networked citizen politics has been conceptualised as 'technopolitics' (Toret, 2013; Jurado, 2014) to emphasise the key role of the appropriation of ICTs for political action (Hernández-Mora et al., this issue). As Barassi and Treré (2012) explain, some scholars (Castells, 2007; Gillmor, 2004; Shirky, 2008) have argued that the interactive features of Web technologies, such as Flickr, YouTube, Twitter, MySpace and Facebook, offer unprecedented democratic possibilities for individual engagement and empowerment. Furthermore, Web 2.0 technologies have enabled a new form of mass communication of the self, which has given rise to new expressions of 'insurgent' politics (Barassi and Treré, 2012: 1271-72).

On the other hand, there is also substantial literature that questions ICTs' transformative potential. What is more, given the context of neoliberal globalisation in which these new techno-social developments unfold, critical authors predict negative effects of ICTs on the quality of democracy (Terranova, 2004; Andrejevic, 2005; Cammaerts, 2008; Everitt and Mills, 2009; Van Dijck and Nieborg, 2009; Taylor, 2014). These scholars have argued that, far from being democratic, the new online economy is linked to trends of neoliberal surveillance, corporate control, the exploitation of users' immaterial labour, commoditisation, state censorship and market appropriation. It is for this reason that Sandoval and Fuchs (2010) relying on Herbert Marcuse´s work argue that "the participatory culture of the Web is today nothing more than repressive tolerance" (Sandoval and Fuchs, 2010: 144–145, quoted by Barassi and Treré, 2012: 1271-72).

Particularly significant in this discussion is the contribution of those scholars who explore how everyday working life is structured around multiple and complex human processes of interaction and negotiation with technologies. By focusing on contextual experiences and practices, as the articles included in this special issue do, it is possible to shed light on the social impacts of technologies, highlighting the dynamic relationship between technological structures and social use. A focus on practice theory enables researchers not only to explore how structural models are internalised but also to consider how actors interact and shape technologies in significant ways. The debate about potentialities of emergent technologies has much to gain if, rather than starting with the 'technology' and examining how actors appropriate its embodied structures, research starts with 'human action' and examines how people enact emergent structures through recurrent interaction with the technology at hand (Barassi and Treré, 2012: 1274-75).

Understanding technological uptake as an iterative process of interaction between institutional frameworks, social dynamics and technological structures (Fuch, 2010) can help us understand the extent to which ICTs affect decision processes and can contribute to create alternative spaces for the production of common services or alternative discourses. This analytical approach helps explain, for instance, how institutional structures and social norms condition the introduction of advanced ICTs applications for improving rural water supply in Tanzania (Wesselink et al., this issue); how the availability of ICTs is enhancing scales of organisation for social actors defending participatory and ecosystem-based water resources management in Spain (Hernández-Mora et al., this issue); how, in spite of available technologies for data generation, integration and dissemination, institutional and socio-political barriers hinder progress for inter-administrative cooperation (Prasai and Surie, this issue); or how limited use of ICTs has the potential to empower networked citizen organisation for the provision of rural water services in Colombia. In this last case, members of community aqueducts come mainly from rural areas and talking is more familiar to them than the use of digital technologies. In that context, vis à vis dialogue constitutes an essential component of participatory communication, "allowing communication to perform its true function: to bring together different meanings and build commonalities amongst the members of a group who are willing to transform their current situation" (Llano-Arias, this issue).

The conceptual debates outlined above have not been extensively applied to the domain of water resources management. Paradoxically, participatory governance was first institutionalised through

legislative developments of the IWRM paradigm such as the WFD in the European Union. Outside the EU, other countries have attempted to institutionalise participatory water management practices through similar IWRM-inspired national legislations (Giordano and Shah, 2013; Pita et al., 2014), or through more grassroots-led collaborative approaches to watershed management (Sabatier et al., 2005). However, there is little work looking at the impact the emergence of the networked society is having on governance approaches to water resources management.

Some of the papers included in this special issue make an attempt to fill this gap. To do so, they bring together different veins of academic literature, such as combining the analysis of networked citizen action and ICTs' potential with the literature on rural water supply and privatisation struggles (Llano-Arias, this issue); water governance and social movements (Hernández-Mora et al., this issue); or political ecology, analysis of power constellations and hegemony (Mancilla, this issue). The common thread that unites these papers is the emergence of virtual and physical social networks at different geographical scales (local, basin-wide, regional, national or international) where actors unite to provide alternative understandings and proposals to the dominating (hegemonic in Mancilla's gramscian terms) discourses over water. Whether the challenges are communal provision of rural water supply and sanitation services in the face of strong service privatisation pressures (Llano-Arias, this issue), enhancing ecosystem-based and participatory river basin planning (Hernández-Mora et al., this issue) or altering dominating discourses on an international level (Mancilla, this issue), all these papers look at the emergence of hybrid physical-virtual social networks that aim to contest hegemonic discourses over water, and question the role ICTs can play in strengthening these networks.

As Hernández-Mora et al. (this issue) show, "current water management paradigms aim to bring about a shift from hierarchical-administrative management approaches to multi-level and participated governance—what is known as the transition from government to governance in natural resources management" (Page and Kaika, 2003). Practical experience, however, has shown that, even under deliberative processes, final decisions on particularly contentious issues often remain outside the public sphere and respond to power dynamics that are not explicit. In their view, governance-beyond-the-state management approaches, focused on reaching consensus and the rational establishment of priorities, force actors to collaborate within a given framework that cannot be questioned or altered and that profoundly condition the terms of the debate and thus the final policy outcome (Peck and Tickell, 2002; Molle, 2009; Swyngedouw, 2011). Following Parés (2010), the authors argue that "by promoting governance approaches to the management of the public sphere activists are 'de-activated' and compelled to replace acts of contestation and political (antagonist) protest by processes of collaboration with the state".

As the SWAN January 2013 Seminar in Seville concluded (Pita el al., 2014), the emergence and consolidation of IWRM can be understood as being a part, inside the particular water policy arena, of a whole historical shift from the post-war Keynesian regulation model to the current neo-liberal globalisation system (Raco, 2013) or, in more specific terms, from the 'administrative rationalism' stage to the current 'neo-privatisation' trend (Swyngedouw, 2007; Castro, 2011). As Mancilla says, IWRM incorporates elements of both the technical and market-oriented discourses and of their counter-discourses (people-centred, environmentally aware). While IWRM claims to accommodate all perspectives, it is uncertain that some of them, such as the technical approach and the ecological perspective, are compatible since they defend a radically different view of water and its place in society (Mancilla, this issue). From this critical perspective, increasing attention is paid to the potential interconnection between the encouragement of water governance approaches with wider global socioeconomic processes that question current democratic institutions and devolve power towards higher (EU, WTO, IMF, etc.) or lower institutional levels (regions, municipalities, etc) (Swyngendow, 2011).

The emergence of new forms of social networked organisations triggered by the appropriation of ICTs for political action is relevant in this debate. If indeed governance processes may have failed to

produce improved outcomes in terms of equity or democratic quality, it can be argued that ICTs can provide new avenues for previously disenfranchised actors to access information, mobilise politically and ultimately increase their presence and weigh in public decisions (Castells, 2012; Fuster Morell and Subirats, 2013; Toret, 2013; Jurado, 2014). However, according to some scholars (Earl and Kimport, 2011; Barassi and Treré, 2012), the potentially transformative effects of ICTs on social movement organisations depend on the degree to which acts of contestation and social mobilisation leverage the *affordances*[13] provided by ICTs. Earl and Kimport (2011) identify two key affordances: reducing the cost of organising and participating in protest and contestation on the one hand, and removing the need for physical co-presence. Depending on the extent to which social organisations leverage these affordances, they identify a continuum from e-mobilisations, where ICTs are used to share information and facilitate or enhance offline activities, all the way to e-movements, where the organisation of, and participation in, actions occur entirely online. In their view, these affordances affect the way we think about the production of public or common goods, since the limitations associated with such production (the 'free rider' problem identified by Olson in 1965) are greatly reduced as the cost of participation diminishes. The effects of ICTs on the functioning and characteristics of different social organisation efforts will, therefore, depend on how much these efforts rely on ICTs. However, as Barassi and Treré (2012) acknowledge, the uptake and use of ICTs by social entrepreneurs does not clearly fall at one point in this continuum. On the contrary, social actors use different strategies simultaneously, relying on offline or online tools and strategies depending on the context and requirements of specific situations, actions and goals. The different papers presented in this special issue offer a clear illustration of this continuum, with ICTs becoming more essential and transformative as the geographical scale (from local to global) and the nature of the good being produced (from local supply and sanitation services to global discourses over water) change.

The changing political-ecological metabolism of nature and the related social networks are invariable, articulated with territorially organized institutional and governmental arrangements. Territorial scales of management – from local institutions to transnational governance – and social or political networking are made and remade in and through the contentious process that shape, stabilise, and transform particular socio-ecological configurations (Swyngedouw, 2015: 25). The changing role of ICTs is inevitably intertwined with this social and political networking related to diverse specific scales.

In their paper Hernández-Mora et al. analyse if, and in what way, ICTs may be providing new avenues for participated water resources management and contributing to alter the dominating power balance in decisions over water in Spain. The authors analyse the changes that have been brought about by the process of implementation of the WFD, which have effected a "shifting geography of players, scales of action, and means of influencing decisions and outcomes". In this shift, social and environmental activists that had resorted in the past to actions of protest and political contestation saw an opportunity to have their opinions heard "in conditions of equality". ICTs have been instrumental in the creation and consolidation of citizen water networks on a basin-wide, regional or national scale. However, while these networks rely on ICTs to question the official discourses and generate alternative understandings and proposals to existing water management challenges, they stop short of altering existing power structures. In fact, the authors conclude that "without a real willingness to open up true spaces of deliberation where all actors can participate in conditions of equality, the role of ICTs will remain one of strengthening citizen networks' organisational capabilities and ability to obtain and generate information, but will not alter the basic framework of water policy making".

The Internet is indeed not just a new tool for communication (Subirats, 2014). It is triggering structural changes in the way citizens organise and reclaim politics. Rapidly developing ICTs are indeed

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[13] Earl and Kimport (2011) define affordances as "the actions and/or characteristics of usage that a technology makes qualitatively easier or possible when compared to prior like technologies".

influencing discussions on water policy paradigms and are affecting the way water governance processes unfold in different geographical settings. These effects are conditioned or contextualised by wider socio-political processes as well as by local institutional contexts and sociocultural conditions. Political aspirations, visions of development and change, ideals of community life, imaginaries of a 'good' society—however diverse they may be invariably rely on transforming concrete environmental conditions and imply the production of new socio-natural assemblages. The multiple characteristics of water environments, together with contentious demands and uses are invariably mediated through specific technological systems, scientific knowledge, political institutions, economic forces, social practices, and policy networks and regimes (Swyngedouw, 2015). The different contexts condition the way in which emerging ways of generating, accessing, and managing information reshape social relations of power in water use, management and governance (Ekers and Loftus, 2008).

The contextual importance of these debates is clearly apparent in the analysis of the papers included in this special issue. Llano-Arias highlights how oral and direct communication are the main tools for water struggles at the local scale but also stress that the appropriation of ICTs may allow these communities to open new democratic spaces in which decisions on water policies are taken. Limited access to digital technologies in the rural Colombian settings analysed in the paper clearly hinders the potential for ICTs to empower disenfranchised communities and effect social change. What has been termed the 'digital divide' appears as an important limitation to the development of the full potential of ICTs, as well as a reinforcer of existing power and access inequalities. However, the paper highlights how co-production of knowledge and governance capacities can help more effectively meet the needs defined by local communities for water supply and sanitation services. These enhanced capacities are powerful tools to resist and provide alternatives to strong impulses to privatise these services as part of neoliberal-inspired governmental reforms. Furthermore, the incipient use of ICTs is empowering these communities by allowing them to share information and knowledge and reach out to national and international networks with similar objectives and goals.

In her paper on the role social media can play in facilitating the development of counter-hegemonic discourses about water, Mancilla moves one step further and analyses the role played by international networks in creating alternative discourses to the way we relate to, and understand, water management challenges. She conducts a qualitative analysis of the use of two of the main social networking services (Facebook and Twitter) by nine organisations working on water, selected considering their likelihood to champion different water discourses. Specifically, the paper argues that while social media presents an interesting potential for alternative discourses, it also offers important tools for dominant discourses to consolidate themselves. The article concludes that social media does not structurally challenge the status quo.

The papers included in this special issue coincide with observations of other scholars that have studied the role of Internet and ICTs in the organisation, operation and effectiveness of other social movements (Della Porta and Mosca, 2005; Kevada, 2010; Earl et al., 2014; Agarwal et al., 2014). They reveal that ICTs have allowed antagonistic social movements that oppose the *status quo* to organise and work collaboratively across large geographical areas and facilitated their ability to more easily access, generate and disseminate information. However, post-democracy conditions reduce water decisions to management, that is, to decisions located at the level of 'policies' and not in the realm of the 'political' (Swyngedouw, 2011).

It seems that without a real willingness to open up true spaces of deliberation where all actors can participate in conditions of equality, the role of ICTs will remain one of strengthening social movements' organisational capabilities and ability to obtain and generate information, but will not alter the basic framework for water policy-making. The potentialities of ICTs as transformative tools is linked to the regeneration of the context within which decisions are made (Hernández-Mora et al., this issue). In the absence of substantial political transformations, ICTs and social media run the risk of working as a

technological façade behind which power dynamics that benefit actors in a dominant position can continue to flourish (Mancilla, this issue).

FINAL REMARKS

This special issue contributes to a relatively unexplored field of research, that is, the intersection between increasing interest on the transformative potential of ICTs, and ongoing debates on water governance. Recent research has analysed, in an increasingly critical manner, the sociopolitical dimensions of the digital age. This critical view is being applied to different fields: communication and the media, intellectual production, mobility or energy, to name a few. However, very few studies have attempted to combine the literature on the sociopolitical implications of the networked society, what some authors are calling 'technopolitics', and its impacts on the management of the socio-hydrological cycle.

The papers included in this special issue attempt to do just that by presenting a close analysis of case studies in different institutional and geopolitical contexts. In the selection of the papers for this issue we were forced to turn down some interesting and worthwhile projects that either analysed the use of ICTs to address specific water management challenges but failed to analyse the sociopolitical implications of these efforts, or did not sufficiently focus on the material 'water', the primary focus of this Journal. While all the papers finally included focus on key issues of information, power and the political process, they present a wide spectrum in what pertains to the importance of ICTs, although they all deal with the polycentric and collaborative production of knowledge and meaning.

What are the factors that can help explain the paucity of studies that integrate the two perspectives? Probably the nature of water and the network of economic, cultural, and physical relationships that forge the world of water policy. As Jean Bennett (2010) says, "matter matters politically" and water is one of those emblematic forms of matter whose specific and differential physical, chemical, biological, and cultural acting, as well as the forms of its socio-technical mediation, scientific understandings, and discursive representations, matter significantly in the political-ecological process. While there is a broad literature about the 'special nature of water' (Illich, 1985; Aguilera, 1992), this perspective is far removed from any deterministic interpretation of the role of nature in general, and water in particular, in socioeconomic development. It is one that recognises that matter matters but this mattering is invariably socially, politically, and culturally filtered (Bennett, 2010).

In what pertains to this special issue, we can reaffirm the interest – even the need – of our insistence on the integration of the technological and sociopolitical perspective along with the reflection on an object, water, which is essential to understand as a socio-natural process. "H_2O is politically active and significant, enrolled in specific ways in all manner of technical, cultural, political, and social assemblages. The matter of water and the way it relationally articulates with other actors and actants shapes the hydro-social edifice" (Swyngendouw, 2015: 201-202).

Through the papers gathered, reviewed in the light of the conclusions of the SWAN project, we can confirm that the rapidly developing ICTs are indeed influencing discussions on water policy paradigms and are shaping water governance processes in different geographical settings. These effects are contextualised of course by wider socio-political processes (neoliberal globalisation, post-political age, post-democracy) and thus they must be understood in that context. Back in 2005, David Harvey denounced the connection between the mercantilism inherent to neoliberalism, that sees prices as a mechanism of information transmission, and, further, coordination, and the symbolic centrality that ICTs have reached in contemporary global culture (Harvey, 2005). Consistent with this view, in recent years there has been a significant increase in research aimed at questioning the central dogma of cyber-utopianism (Rendueles, 2013).

But even accepting this backdrop, the extraordinary diversity of contexts and scales that affect, while building, the dynamic techno-political-hydrological processes, require a differentiated and nuanced reflexion on the questions posed in this special issue: Would social actors in diverse contexts be able to take advantage of the new political potentiality provided by new technologies? If so, a) in which aspects of the contentious process of decision-making? b) with which specific tools among the rapidly developing socio-technological machinery available? The fact is that the analysis of contextualised practices unveils that sharing information and data, a process that ICTs facilitate, is a potentially empowering process that can, in some circumstances, enable the development of alternative meanings and narratives. As Kishimoto (2014) explains with regard to the Remunicipalisation Tracker, when the tool was launched in 2007 the term 'remunicipalisation' was rarely used in water social movements, academic circles or among water-sector professionals. Since then it has been popularised and become a key political demand for many citizens' campaign for democratic control over water services. At the same time, ICTs may allow the emergence of social networks at different scales, connecting the local to the global, reinforcing each other through the sharing of information and the production of collaborative knowledge. This is particularly important in terms of information that questions the official and hegemonic discourses over water resources management, contributing to creating alternative antagonist meanings, rationalities and opinions.

Without questioning the importance of these debates, a crucial question remains as to whether there really is a need to generate more knowledge or, rather, what we need is to better communicate and use existing knowledge in the decision-making process (La-Roca, 2014). Along the same lines we agree with Swyngedouw's (2014) statements: Yes, it is true, there are things we know we know; there are things we know we don't know and there are things we don't know we don't know. But what is most important is that *there are things we do not know we know*. Among the latter there is indeed a crucial idea that emerges clearly from the contents of this special issue: the potentialities of ICTs as transformative tools are linked to the regeneration of the context within which decisions are made, that is, the democratic process itself.

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