NWPP New Water Policy & Practice Journal
A Platform for the World's Emerging Water Leaders and Thinkers

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Editorial Welcome

Welcome to the second issue of New Water Policy and Practice Journal: *A platform for the world's emerging water leaders and thinkers*.

On 22nd March 2015 – the 22nd World Water Day – the United Nations released its World Water Development Report: Water for a Sustainable World. In his Foreword, Ban Ki-moon, Secretary-General of the UN, referred to the fact that this report "*…illustrates the complex linkages between water and critical areas such as human health, food and energy security, urbanization, industrial growth and climate change*." In her foreword, Irina Bokova, Director-General of UNESCO, also noted that the report "*…comes at a critical moment, when freshwater resources face rising pressure to provide for the social, economic and environmental needs of a growing world population*". She also noted "*More than two decades after the first summit on sustainable development, many countries still face the challenges of eliminating poverty and promoting economic growth, ensuring health and sanitation, preventing land degradation and pollution, and advancing rural and urban development. Around 748 million people today still do not have access to an improved source of drinking water, and water demand for manufacturing is expected to increase by 400 per cent between 2000 and 2050 globally*."

As pressure on the world's water resources increases, the issues are growing and connecting, changing from local to regional and even global challenges. These interconnections at all scales are increasingly the focus of attention for the world's water managers and the communities that their work aims to support. The need for new water leaders and innovations in water management is abundantly apparent.

It is with great pleasure, therefore, that this second issue of New Water Policy and Practice Journal leads with a feature article *Understanding Six Water Leadership Roles: A framework to Help Build Leadership Capacity* by André Taylor, Wouter T. Lincklaen Arriëns and Mathew Lang. In this extended paper, the authors describe six leadership roles that often feature in processes of change that drive more sustainable forms of water management. They argue that understanding these roles can help to build the leadership ability of emerging water leaders and therefore the capacity of the water sector to drive change. We congratulate Andre, Wouter and Mathew on their contribution to water leadership and note with great interest that their framework is now being used to inform the design of water leadership development programmes around the world.

Water leadership development is a critically important field and we encourage readers of New Water Policy and Practice Journal to contribute further papers on this topic for our next edition in November 2015.

In the second paper in this issue, Nehwon Macpherson David and Amos T. Kabo-bah evaluate the water quality risks in the Burl river basin, Liberia, a valuable freshwater

resource suffering from increasing pressure from waste disposal, climate change and population growth. Using GIS tools to analyse the problems, the authors suggest ways towards more informed and better management of the Burl river basin, with a view to adapting the learning to other parts of Liberia and West Africa.

Water disputes between Punjab and Sindh provinces in Pakistan are the focus of the third paper, authored by Amit Ranjan. The history of long-standing water disputes between the two provinces, which continue to pose a challenge to the existing federal–state relationship, are analysed and by the author who points to the need for political leadership for improved water management.

In the fourth article, Robert Brears describes some of the European experiences in managing transboundary flood risk, specifically focusing on the European Union Flood Directive and using the Rhine and Danube river basins as case studies. The author then discusses the potential application and adaptation of this learning to support integrated flood risk management in South East Asia.

The adoption of Australian Drinking Water Guidelines in Western Australia as part of the dramatic shift in water management over the past two decades is the focus of the final paper in this issue. Authored by Neil Coles, this paper evaluates the changes in the water industry, the way in which water resources are managed, and how water is licensed and regulated to deliver quality drinking water.

In this issue we also introduce a new section in which we aim to share inspiration about new water leadership and thinking from recent key water events, such as conferences and workshops. The aim of this section is to provide a mechanism for readers to inform each other about particularly important or invigorating events and we encourage all New Water Policy and Practice Journal readers to send us their ideas and help spread the word about what they found particularly inspiring. Articles should be a maximum of 500 words and written in English.

Finally we are very pleased to announce that Mr. Jaime Melo Baptista has agreed to join the New Water Policy and Practice Journal International Advisory Board. Jaime, who is based in Europe, brings lengthy experience in water and environmental regulation along with a strong international presence.

We hope you enjoy reading this second issue of New Water Policy and Practice Journal and look forward to your contributions to the next issues.

With our very best wishes.

Susana Neto Jeff Camkin
Editors-in-Chief
New Water Policy and Practice Journal

Understanding Six Water Leadership Roles: A Framework to Help Build Leadership Capacity

André Taylor[A], Wouter T. Lincklaen Arriëns[B] and Matthew Laing[C]

This paper describes six leadership roles that often feature in processes of change that drive more sustainable forms of water management in developed and developing countries. These are referred to as the champion leader, enabling leader, cross-boundary team leader, thought leader, strategic leader and trusted advisor roles. The paper also highlights some of the key leader competencies (e.g., skills) and leadership strategies (e.g., behaviours) associated with these roles. Understanding these roles can help to build the leadership ability of emerging water leaders and therefore the capacity of the water sector to drive change. It helps to 'cut through the complexity' of leadership development by providing a practical framework to identify which leadership roles are most relevant to a developing leader, and therefore the types of knowledge, skills, leadership models, case studies and leadership strategies to include in tailored leadership development activities. It also helps to identify which roles an emerging water leader is most suited to, and provides a framework to help analyse how people in different leadership roles typically work together to drive major processes of influence in the water sector. This framework is now being used to inform the design of water leadership development programmes around the world.

***Keywords**: Capacity building; change; influence; leadership; leadership development; water leadership.*

1 - Introduction

1.1. The need for greater leadership capacity in the water sector

The scope and magnitude of the challenges facing water practitioners around the world are profound, especially in developing countries. The United Nations (UN WWAP 2014 and 2015) estimates that 3.5 billion people have inadequate access to safe drinking water and a further 2.5 billion people currently have inadequate sanitation. By 2050, global water demand is expected to increase

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by 55%, driven by factors such as population growth, changing patterns in rainfall and runoff, industrialisation, urbanisation and the use of water-intensive methods of generating energy. This is predicted to place 40% of the global population under severe water stress by 2050. The poorest people are likely to be most adversely affected.

Such water challenges have as much capacity to adversely impact the health and prosperity of people living in urban areas as those in non-urban areas. They also represent a significant threat to the health of ecosystems that are sensitive to changes in hydrology and water quality. Put simply, "water resources, and the range of services they provide, underpin poverty reduction, economic growth and environmental sustainability" (UN WWAP 2015, p. 2).

To illustrate the magnitude of global water challenges, consider the driver of urbanisation. Urbanisation is expected to result in an additional 2.5 billion people living in urban areas by 2050, an increase of 66% on current levels (UN DESA 2014). Such growth will increase the pressure on urban water management systems that are already struggling to service the needs of urban communities (see ADB and APWF 2013; UN DESA 2014). In this context, the United Nations has concluded that "managing urban areas has become one of the most important development challenges of the twenty-first century. Our success or failure in building sustainable cities will be a major factor in the success of the post-2015 UN development agenda" (UN 2014, p1).

In the twenty-first century, water practitioners also need to address substantial risks. For example, the World Economic Forum (2015) has rated "water crises" as the most significant global risk in terms of "impact" and in the top eight risks in terms of "likelihood." The level of this risk has been increasing over the last decade.

Given this context, many water practitioners now recognize the need to be change agents, as adopting a "business as usual" mindset will simply not meet the challenges facing the water sector in the twenty-first century. Examples of significant change initiatives in the water sector include efforts to advance more integrated forms of river basin management (see Te Boekhorst et al. 2010; Subijanto et al. 2013), "water sensitive cities" in urban areas (see Cooperative Research Centre for Water Sensitive Cities 2014; Mukheibir et al. 2014), and greater water security (see Ait-Kadi and Lincklaen Arriëns 2012; ADB and APWF 2013).

In this change-focused environment, the water sector requires leadership capacity to complement existing technical and management capacity. As Kotter (2006, p. 14) emphasised, "producing change is about 80% leadership … and 20% management." Awareness of the importance of leadership capacity to initiate and steer change is in part being driven by findings from case studies from the water sector (e.g., Herrick and Pratt 2012; Meijerink and Huitema 2010; Taylor 2011) and the broader literature involving policy innovation and change, environmental leadership, change agents and champions of innovation (e.g., Dunphy et al. 2007; Howell et al. 2005; Kingdon 1995; Mintrom and Norman 2009).

In addition to the general need for greater leadership capacity, the abundance of complex challenges (also known as "wicked problems") in the water sector requires leadership to come from many sources and not just from positions of authority such as

executive and political roles (see Carson et al. 2007; Conger 1993). Gordon and Berry (2006, p. 90) emphasised this important point, stating that "… complex problems and rapidly changing solutions require more leadership from everyone ... Leadership skills that were appropriate to the few are now necessities for the many."

Researchers exploring barriers to change and keys to successful change in the water sector have identified many factors (Brown and Farrelly 2009; Lloyd et al. 2002; Mukheibir et al. 2014). The most frequently cited factors relate to leadership (e.g., the lack of a shared vision, coordination of efforts and political will). In this paper, we define "leadership" as a *process of influence* that accomplishes three outcomes: direction - a shared understanding of common goals and strategy; alignment the joint coordination of resources and activities; and commitment - a commitment to collective success (Drath et al. 2008; Ernst and Chrobot-Mason 2011). Using this definition, leadership is seen as a group-based process, typically involving several people and organisations. Water leadership case studies commonly highlight a number of people contributing to the leadership process ('leaders'), who play different roles, share a vision for change, and work in a coordinated, cooperative manner (e.g., Brown and Clarke 2007).

As more research is published on the nature of leaders driving change in the water sector, it has become clear that there are a number of distinct leadership roles that are common and significant. In addition, there is growing evidence that some of these roles share similar features regardless of where they are played around the world. For example, as part of an impressive research project involving 16 case studies from developing and developed countries, Meijerink and Huitema (2010) identified a set of leadership strategies that champion-type leaders commonly employed when they successfully influenced water policy. In short, our knowledge is growing as to what it takes to be a successful leader in the water sector.

1.2. Efforts to build leadership capacity

Broad acceptance of the need to drive substantial change in the water sector and the importance of leadership in this process has led to calls for increased efforts to build leadership capacity. For example, at the fourth Delft Symposium on Water Sector Capacity Development, there was a call for 1,000 water leaders to be developed in Africa and Asia (Lincklaen Arriëns and Wehn de Montalvo 2013).

Subsequently, tailored leadership development programmes and short courses for water leaders are now emerging. For example, in Asia the International Water Centre (IWC) in Australia has been running a nine-month Water Leadership Program for emerging water leaders every year since 2011, and has now worked intensively with 91 water leaders from seven countries. This Centre also delivers tailored water leadership short courses and 'master classes' for approximately 70 water practitioners every year from a wide range of developed and developing countries. The Peter Cullen Trust's Science to Policy Leadership Program also operates in Australia, and focuses on helping water scientists to influence policy and politicians. A new International Water Leadership Programme (IWLP) is also being built by the UNESCO Institute for

Water Education (UNESCO-IHE), the IWC and Nyenrode Business University in the Netherlands to help emerging water leaders from developing countries. UNESCO-IHE also runs water leadership short courses for masters students from developing countries.

All of the previously mentioned leadership programmes, short courses and master classes focus on 'emerging leaders' rather than leaders at the executive or political level. Typically, these emerging leaders are responsible for leading challenging, cross-boundary project teams, are team leaders (i.e., have direct reports), or are mid-career leaders who are preparing for senior professional or executive roles. They are targeted, as they typically have enough time to attend a comprehensive programme; they have many years left in their careers to apply new knowledge and skills; and are not yet 'set in their ways' (see Adair 2005). This focus also reflects a new paradigm where "leadership is no longer seen as limited to the domain of executives" (Lincklaen Arriëns and Wehn de Montalvo 2013, p. 20) and the concept of leadership is not confused with authority (Flower 1995).

The process of delivering tailored leadership programmes and short courses to water leaders from different countries is a cyclical process of learning and adaptive management. Typically, each programme generates new knowledge about the nature of water leadership in different contexts, such as the relevance of different leadership roles, and keys to successfully playing these roles. Knowledge gained from this process has helped the authors to identify six important leadership roles, and build confidence that they are relevant to water practitioners around the world.

1.3. The contribution of this paper

This paper provides a practical tool (i.e., a framework describing the nature of six common water leadership roles as well as the leader competencies and leadership strategies/behaviours typically associated with them) that can be used to inform the design and content of tailored water leadership development interventions such as leadership development programmes, short courses, training programs and coaching conversations. It can also be used directly by developing leaders to reflect on the leadership roles they want to play, which ones suit their nature, the abilities they need to perform well in these roles, and the leadership strategies they will probably need to apply.

More specifically, the paper describes six leadership roles that are commonly seen in the water sector and often feature in successful case studies of positive change in both developed and developing countries. As such, the *key message of this paper* is that people seeking to develop water leaders (including themselves) should be aware of the nature of these leadership roles, identify those that are most relevant to these developing leaders, and build leadership development interventions and materials that focus on helping these leaders to excel in these roles.

The paper begins by describing how the six leadership roles have been identified and how they are being used in the context of leadership development activities. It then communicates some of the key leader competencies and leadership strategies

(i.e. key behaviours) that water leaders typically need to perform well in each role. The practical implications of understanding these roles are then explored such as how they could be used to help water leaders to be more effective, and how they could be used to analyse and understand how leaders playing different roles work together to collectively drive processes of change. Finally, the paper concludes with a summary of its key messages.

2 - Methodology

This section describes five bodies of work conducted by the authors over eight years (2007–14) which have helped to identify and characterise the leadership roles outlined in this paper. This work involved traditional forms of research as well as gaining knowledge by working closely with many developing water leaders from around the world during leadership development activities (e.g., programmes, short courses and coaching).

2.1. 2007–10: Ph.D. research on water leadership

An international literature review focusing on water leaders was conducted as part of a Ph.D. research project by Taylor (2010a). Although this research focused on champion-type leaders (i.e., emergent leaders who excel at initiating change) who promoted sustainable urban water management, the literature review was broader. It sought to identify what is known about leaders and leadership in the water sector. It identified significant contributions to the water leadership literature such as those made by Brown (2003), Brown and Clarke (2007), Huitema and Meijerink (2010) and White (2006).

This research also involved a multiple case study analysis of six champion-type leaders who were instrumental in initiating change in different cities within Australia (Taylor 2008, 2010a). This analysis identified the significance of individuals playing different roles in major processes of influence. For example, in one of these case studies (see Taylor 2011), the project-level champion for sustainable water management was strongly supported by a local politician (a mayor), his organisation's chief executive officer (who actively managed the organisation's culture), an executive (who acted as his mentor), and a small group of colleagues in different functional units within the organisation (who acted as a cross-boundary team to advance significant water projects). This research helped to identify and characterise important water leadership roles and to understand how people in these roles worked together to affect change (e.g., Taylor 2011).

2.2. 2010–11: Background research to build a new water leadership program

In 2010, following a successful trial (see Taylor 2010b) work commenced within the IWC to design a new, nine-month water leadership programme. This programme

primarily targeted emerging leaders from the program's host country (Australia), but its design ensured that it could also service the needs of leaders from other countries, including developing countries. As described by Taylor and McIntosh (2012), this work involved the following three steps. First, another review of the international water leadership literature was conducted, building on the work by Taylor (2010a) to identify and characterise common leadership roles. This process identified three key non-executive leadership roles, namely the project champion, enabling leader and team/project leader roles. It was, however, recognised that these roles were not exhaustive.

Second, a diverse group of water industry practitioners from across Australia were consulted to test the relevance and validity of the three preliminary role descriptions to different organisational types (e.g., consulting firms, publicly managed water agencies, local government agencies, etc.). The role descriptions were consequently refined.

Third, in June 2011 a national survey was conducted with the help of the Australian Water Association to further examine the relevance of the three leadership roles to a range of organisational types, as well as to validate the role descriptions and specific leadership attributes (e.g., key leadership behaviours) associated with each role. This survey produced strong evidence from surveyed water practitioners across Australia that the three roles had a high degree of relevance to water organisations such as state government departments, local government agencies, privately owned consulting firms and publicly managed water agencies. For example, for the project champion role, 92% of survey respondents ($n = 42$) agreed that the role was relevant to organisations like theirs, with equivalent results for different organisational types varying from 78% to 100%. For this particular role, the relevance of 37 leader attributes (e.g., behaviours) was examined in the survey. All of these were found to be "highly relevant" to project champions working in some organisational types, and an additional two attributes were identified through the survey process.

2.3. 2011–14: Experience working with developing water leaders

Over the period from 2011 to 2014 the authors have collectively worked with hundreds of emerging water leaders from developing and developed countries. Within the IWC, this has provided many opportunities to assess the relevance of the three previously mentioned water leadership roles (see Section 2.2). This assessment has been done formally and informally. For example, every participant in the IWC Water Leadership Program undertakes a 360° feedback process which gathers data from the participant, their supervisor, their peers and their staff/direct reports (where relevant). This feedback includes assessing the relevance of the three roles to the participant. To date, this feedback is indicated that at least one of these roles has been relevant to every participant in the programme.

The research has also benefited from the authors' experience in working with emerging water leaders in developing countries in the contexts of project development, regional knowledge sharing, and on-the-job leadership coaching. While most leaders

readily identified with the importance of the project champion and team leader roles from their experience, many were intrigued by the enabling leader role, which they recognized to be of great value in projects with multiple disciplines and stakeholders. Participants in the first UNESCO-IHE water leadership course in 2014 also suggested that enabling leaders can foster collaboration in complex water projects, and stimulate the development of water leaders around them.

Whilst this experience has helped to confirm that these three roles are indeed important in the water sector, it is equally important to emphasise that every leadership context is unique. For example, two water leaders playing the same leadership role in different countries or organisational cultures may apply similar strategies (e.g., anticipating 'windows of opportunity' to influence water policy), but will need to be highly sensitive to their local context in the way they apply these broadly applicable strategies (e.g., to work within appropriate cultural norms) in order to produce a positive outcome.

2.4. 2013–2016: Research within the Cooperative Research Centre for Water Sensitive Cities

In 2013, the Australian-based Cooperative Research Centre for Water Sensitive Cities began a three-year research project looking at the issue of science-policy translation in government with a specific emphasis on the role of scientists and sustainable water management advocates within the policy process as people who strongly influence the outcome. Through interviews and in-depth consultation with around 100 water bureaucrats, science advisors and politicians; consistent patterns began to emerge that confirmed findings from other studies in the water sector, as well as long-standing policy leadership observations established in other countries and other issue areas. Several in-depth case studies of policy development within different political contexts found ample evidence to underscore pre-existing theories regarding the importance of leaders within the policy processes, both in general theory (e.g., Kingdon 1995; Mintrom and Norman 2009; Mintrom and Vergari 1996) and in studies specifically relating to water (e.g., Crow 2010; Huitema and Meijerink 2010; Keremane 2015).

These interviews have gone further than many studies to incorporate detailed analysis of specific water policy development cases to closely examine how key decision makers used and were influenced (or not) by scientific inputs. This approach contrasts with the more common focus on procedural structures in policy studies (Laing 2015; Laing, Thwaites, and Walter 2015).

This research has highlighted the important contribution that political science approaches can make to the refinement of water leadership strategies and role definitions. For example, it identified the increasing need to understand the important role played by 'trusted advisors' within government to achieve policy outcomes. It has also identified the general need for people playing leadership roles in the water sector to demonstrate political savvy when seeking to influence water policy development, and to develop a wider set of skills and tools when using science to build a case for

policy change in bureaucratic contexts (Laing 2014; Laing, Thwaites, and Walter 2015). To this end we see the lobbying and science advocacy literature (e.g., Godwin et al. 2012; Keller 2009) to be highly relevant in sharpening the leadership strategies water leaders could use to drive change in policy.

2.5. 2013–14: The design of a new international water leadership programme

In 2013, a partnership between UNESCO-IHE, the IWC, and Nyenrode University was formed to build a new IWLP. This initiative aims to help mid-career, emerging water leaders from developing countries to build the capacity to exert influence and drive change to deliver more sustainable forms of water management (see Lincklaen Arriëns and Wehn de Montalvo 2013). In comparison with the established IWC Water Leadership Program, the IWLP proposes to have a more diverse target audience, greater involvement of leaders from developing countries, and greater capacity to address a broader range of water leadership roles. The design of this programme also provided the opportunity to build on the preliminary role descriptions developed by the IWC to incorporate more recent descriptions of water leaders, such as descriptions provided by Brouwer and Biermann (2011), Herrick and Pratt (2012), Lincklaen Arriëns and Wehn de Montalvo (2013) and Subijanto et al. (2013).

The design of this programme is continuing at the time of writing. One significant outcome of this process has been the identification and characterisation of six water leadership roles that are likely to be relevant to the target audience of the IWLP. These roles are the focus of this paper and help to inform the design and content of the IWLP. For example, the 360° feedback, challenging on-the-job leadership assignments, training and coaching activities potentially included within the IWLP will provide opportunities to assess the relevance and suitability of these roles to each participant, build knowledge and skills to more effectively play these leadership roles and build understanding of how people playing these roles often work together. These activities also provide participants with tools to use in these roles (e.g., relevant leadership models), relevant case studies and the opportunity to identify specific actions that the participants can take to improve their performance in these roles.

3 - Six water leadership roles

This section describes six common water leadership roles that are potentially relevant to emerging, non-executive water leaders in developing and developed countries. Additional roles may exist, and some of these roles can also be played by executive and political leaders (e.g., the enabling and strategic leader roles). Table 1 provides a brief summary of each role and some examples of water practitioners who have played these roles (i.e., examples known to the authors).

Table 1: Examples of water leaders who perform each of the six roles

Role Title	Brief Role Description	Examples
The champion leader	Involves *initiating* processes of influence (change) in the water sector.	• A water practitioner who is strongly advocating for the adoption of integrated water management principles within a new river basin or urban planning process. • A practitioner working for a local waterway-focused community group who is lobbying government agencies to invest in a waterway rehabilitation project.
The enabling leader	Involves *enabling* (rather than directing) others to collectively 'learn by doing' to find solutions to complex water challenges.	• A middle manager in a water agency who creates a cross-sectoral 'community of practice' for practitioners in a city to develop and trial innovative solutions for the most challenging water issues through collaboration by the public and private sector. • A senior water leader in a government department who establishes a cooperative research programme to bring practitioners and academics together to trial new technologies to address pressing water management challenges in a local river basin.
The cross-boundary team leader	Involves being the assigned leader for a water team (e.g., a project team) that *crosses boundaries* relating to geography, organisations, professional disciplines, etc.	• A water practitioner who is responsible for a team of technical experts from different organisations who are building and monitoring programme for an estuary. • A water practitioner leading a multi-disciplinary team to design a new urban development that incorporates integrated water management principles.
The thought leader	Involves using high levels of *credibility and expertise* to exert influence (e.g., by promoting technological innovations).	• A technical specialist with rich and diverse expertise who works part-time for a local university as a researcher and part-time as a water manager in a government agency. • An experienced consultant from a niche consulting firm who pushes the boundaries of 'best practice' water management by encouraging their clients to consider innovative approaches.
The strategic leader	Involves working with stakeholders to build a *shared vision* of the future direction of a team or organisation, and a *strategy* to achieve the vision.	• The leader of a programme in a large government department tasked with developing new strategies for increasing water security in a region of the country. • The head of a large, water-focused capacity building programme that aims to change stakeholder behaviour in order to improve integrated river basin management.
The trusted advisor	Involves working as a credible, independent agent to *influence the political system* through communication, networking and advocacy.	• An experienced academic who is called upon to review the scientific research on point source pollution for a government water minister. • A former water utility executive who uses their networks and familiarity with government to communicate policy priorities and get industry agreement on strategic issues.

3.1. The champion leader

A role that primarily involves initiating processes of influence (change) to advance water management projects, innovations, and policies. Leaders occupying this role are variously described as champions, policy entrepreneurs, emergent leaders and key change agents. They are highly motivated, stand out early in processes of change, and excel at exerting influence. The literature on champions distinguishes between 'project/product champions' and 'executive champions' (see Howell and Higgins 1990; Howell et al. 2005; Maidique 1980). 'Project/product champions' drive initiatives on a day-to-day level, unlike more senior 'executive champions'. Project/product champions typically become executive champions later in their careers. They often promote innovations, take personal risks, question the status quo, meet substantial resistance, and communicate clear and compelling visions for projects. They are outstanding communicators, often engage in 'extra role behaviours', and frequently use transformational leadership behaviours (see Bass 1985; Kouzes and Posner 2012; Northouse 2013). Although they stand out as individuals early in processes of change, they work closely with other leaders to deliver projects. The extent to which a champion can fulfill this role is often limited by their local context (e.g., available support from senior management and resources). Once their initiatives are underway, their visibility tends to decrease and there is a risk of them leaving the initiative, or being transferred, before it is fully delivered (Meijerink and Huitema 2010).

Table 2 provides a summary of the key competencies (i.e., the skills, knowledge, personality traits, forms of power, and/or types of social networks) that the leaders who excel in this role typically possess. It also includes a summary of the leadership strategies (i.e., behaviors) that are typically used by such leaders when playing this role. Tables 3–7 provide equivalent information for the other five roles.

3.2. The enabling leader

A role that involves enabling (rather than directing) others to collectively find solutions to complex water management challenges. Leaders occupying this role create environments where people from across organisational boundaries can interact, collaborate, experiment, take risks, and learn together (i.e., 'learn by doing'). Senior enabling leaders may also help leaders at the project level by gathering political and executive support for initiatives, providing resources, sharing risks, and building supportive organisational cultures. Leaders in this role commonly work across organisational boundaries and often link people within an organisation to external people (e.g., linking industry practitioners with researchers). They can be innovative in the way they approach problem solving and help to foster innovations at a technical level. They are typically senior in organisations with access to position power/authority (i.e., typically at the middle management to the executive level). They are adept at seeing 'the bigger picture' and the systemic way in which projects and policies interact both within and outside the water sector.

Table 2: Key leader competencies and leadership strategies typically associated with the champion leader role

Leader Competencies	Leadership Strategies
• A willingness to challenge the status quo by promoting alternative approaches and taking some personal risks. • Strong communication skills both verbally and in writing. • The ability to frequently use transformational leadership behaviours, when appropriate (e.g., displaying energy, enthusiasm and confidence). • Persistence and personal resilience. • Advanced social networking skills, including building networks, alliances, and coalitions across organisational boundaries. This includes the ability to build cooperative relationships with a broad range of stakeholders, including those with authority (e.g., executives). • Strong interpersonal skills (e.g., active listening, providing constructive feedback, negotiation, conflict management, and understanding different perspectives). • The ability to carefully plan and execute influence attempts using a variety of principles and tactics, and choosing the right set of tactics for a particular person, place and time. • Political savvy (Braddy and Campbell 2013) and a thorough knowledge of the institutional system they are working in in order to identify opportunities to exert influence. • Personal credibility that is built over time by delivering successful initiatives, setting a positive example, demonstrating expertise, building relationships and trust, keeping promises, and always acting in accordance with espoused personal values. • Awareness that the nature of this role usually evolves through three phases over time. These being the initiation (start-up), endorsement (when an approval or resources are needed to progress an initiative), and implementation (when an initiative needs to be delivered typically through a team) phases (Taylor et al. 2011). Specific leadership strategies become relevant in each phase.	• Using pilot (trial) projects to test new ideas, generate some small 'wins' when tackling large challenges, build credibility, influence others, strategically build important relationships, and 'learn by doing'. • Taking the time to work with others to build a genuinely shared vision for new initiatives that are clear, compelling and reflect shared values of key people and groups. • Anticipating, planning for, and using windows of opportunity to exert influence and drive change. For example, a severe drought may create an opportunity to persuade politicians to adopt a new water recycling policy. • Monitoring their work environment to identify trends, opportunities and threats. • Finding, altering or creating 'venues' in which they can successfully exert influence (e.g., river basin organisations, professional associations or expert panels). • Not leaving a change initiative until it is fully delivered. In other words, displaying the self-awareness and self-discipline needed to resist moving on to the next initiative until the job is fully done. • Using a combination of bottom-up (emergent) and top-down (formal) leadership strategies to drive change and institutionalise new approaches. • Using narratives to strategically frame issues (e.g., a crisis involving water resources) and thereby justify change and attract supporters.

Table 3: Key leader competencies and leadership strategies typically associated with the enabling leader role

Leader Competencies	Leadership Strategies
• The ability to correctly diagnose complex challenges ('wicked problems') and apply an enabling leadership style to address them (see Uhl-Bien et al. 2007; Snowden and Boone 2007). Such challenges are difficult, evolve over time, are perceived differently by different stakeholders, have many interdependencies and there is no obvious or agreed solution (Rittel and Webber 1973). • A propensity to enabling others (e.g., affected stakeholders and technical experts) to find solutions to complex challenges, rather than directing them how to solve problems. This typically involves trusting others, 'letting go' of the detail, and being comfortable with uncertainty, ambiguity and experimentation. • Advanced inter-personal skills, including communication (e.g., storytelling, active listening, and strategic framing), facilitation, conflict management, and managing stakeholder relations. • Advanced social networking skills, including building networks, alliances, and coalitions across organisational boundaries. • The ability to take a systemic approach to problem-solving, see the 'big picture', take a long-term perspective, and interpret change for colleagues (e.g., explaining why there is resistance to change). This includes the ability to use systems thinking techniques to help stakeholders to build a shared vision of the problem and possible solutions. • Patience and the ability to work on complex challenges characterised by conflict, set-backs, uncertainty, and long time frames. • The ability to use transformational leadership behaviours to build shared visions for projects that are clear and inspiring, inspire confidence, build commitment and influence people across organisational boundaries. Enabling water leaders who are good at shaping organisational cultures are also usually strong transformational leaders (see Taylor 2010a).	• Working with others to create environments for collaboration, innovation, experimentation, responsible risk-taking, and 'learning by doing'. These environments may include demonstration projects, learning alliances, communities of practice, task forces or research projects. Often enabling leaders in the water sector build bridges between practitioners and researchers. • Shaping the culture of the organisational team so that it values the previously described behaviours (e.g., experimentation). This includes modeling these behaviours and frequently reinforcing their importance through positive feedback, corrective action and storytelling. • Building and supporting teams working on challenging projects by providing resources, mentoring and coaching, sharing information and knowledge, and connecting them to other teams or people. These teams often across organisational boundaries and require a champion-type leader to get started. • Fostering innovation and creativity within teams (e.g., using creative thinking techniques and external thought leaders to stimulate discussion). • Facilitating activities that involve frequent interaction between stakeholders and encourage task-focused, productive conflict. • Maintaining an atmosphere where the status quo is no longer acceptable, there is an impetus for change, but people are not overwhelmed by the challenge (see Heifetz et al. 2004). Heifetz and colleagues use the analogy of a pressure cooker, where heat and pressure are needed to cook but a valve is also needed to reduce the pressure if it becomes too great. • Monitoring for the emergence of potential solutions and leaders to champion them. • Managing conflict between forces that promote the status quo and those that advocate for change. For example, managing the tension between organisational leaders who want traditional water services to be delivered more efficiently and champion-type leaders who are promoting radical change towards more sustainable water services. • Celebrating 'small wins' and scaling-up successful trials. • Looking for ways to institutionalise new approaches (e.g., through formal policies and legislation) to embed new practices.

3.3. The cross-boundary team leader

A role that involves being responsible for meeting the objectives of a cross-boundary water management team. Typically, these boundaries include: geography; functional organisational units ('silos'); levels of management in bureaucratic organisations; professional disciplines (e.g., multi-disciplinary teams); and demographics. This role includes building and monitoring the performance of teams. It also involves building and communicating shared visions for projects, clarifying objectives and roles, and managing conflict. Leaders in this role also need to manage resources and information, may engage in coaching and mentoring behaviours, and engage in activities outside the team (e.g., networking and advocacy). Often, members of the team are not the team leader's staff (direct reports). Consequently, the leader needs to rely on his/her personal power to exercise influence rather than the power of their position (authority). Often, the nature of the challenge facing the team is complex with some technical/complicated components, requiring the team leader to adapt their leadership style (see Snowden and Boone 2007). This is a relatively common but challenging water leadership role that can be undertaken in combination with the champion or enabling leader roles. For example, a champion may initiate a new project, and then become the official project team leader to deliver it.

3.4. The thought leader

A role where a water practitioner influences policy or practice by promoting new ideas, fostering innovation, conducting and using research, brokering information, and/or being a hub of specialist knowledge. Leaders in this role typically have high levels of expertise and credibility, as well as broad, diverse networks. They are comfortable questioning the status quo, and search for venues to promote alternative approaches (e.g., local conferences). Leaders in this role often work in universities, small consulting firms or on their own which provides them with freedom to publicly challenge conventional approaches. They are often involved with pilot projects and cooperative research activities. They also work closely with champion, enabling and trusted adviser leaders who use their ideas to help drive change.

3.5. The strategic leader

A role that is typically occupied by experienced/senior water practitioners who are given significant authority (position power) to introduce and manage change, and develop capacity to make newly developed systems work. The role involves working with stakeholders to build a shared vision of the future direction of a team or organisation. Leaders in this role engage in 'scanning behaviours' to identify opportunities, threats and trends. They also invest time in strategic networking in and outside the organisation to build relationships with key partners, and draw on a range of information sources to help determine a suitable strategic direction. They also excel at strategic planning and team leadership. Throughout their careers, these

Table 4: Key leader competencies and leadership strategies typically associated with the cross-boundary team leader role

Leader Competencies	Leadership Strategies
• The ability to accurately interpret what is happening within a team (e.g., what is stifling performance). • The ability to understand the 'big picture' from a systemic perspective, and how the team's work contributes to higher order goals and is affected by external factors. This includes understanding 'cause and effect' relationships, and being able to identify opportunities to effect change. • The ability to manage issues related to the team's tasks (e.g., clarifying objectives and roles, building action plans, and establishing performance monitoring systems). • The capacity to manage the team's internal relationships (e.g., managing conflict between team members and accommodating individual needs). • The ability to manage factors outside the team that affect its performance (e.g., engaging in advocacy, secure additional funding, and garnering political support). • The capacity to inspire and motivate others by demonstrating competence, setting a positive example, and frequently using transformational leadership behaviours such as displaying energy, enthusiasm, confidence and persistence, coaching and mentoring, and providing encouragement. • Strong communication and interpersonal skills (e.g., active listening, providing constructive feedback, facilitation, managing emotions, negotiation, conflict management and demonstrating empathy). • An understanding of the technical (or detailed) issues the team must face in order to achieve its objectives. Often effective team leaders for integrated water management projects are 'T-shaped water professionals' (McIntosh and Taylor 2013). In other words, they have deep knowledge in at least one technical area but also broad general knowledge which helps them to collaborate with a diverse range of stakeholders. • Creativity and the ability to facilitate creative thinking processes within a team. • The ability to generate high levels of trust within the team. This is often linked to recruiting the right people, being willing to trust others, demonstrating integrity and keeping promises.	• Frequently monitoring the performance of a team, diagnosing what the team needs at a particular point in time and taking action to ensure this need is met. This includes constructively confronting and resolving issues associated with inadequate performance by team members. • Creating an environment (culture) where team members feel comfortable openly discussing any issue related to the team's success (e.g., how the team could improve its performance). • Recruiting team members who are highly motivated to achieve the team's vision. Ideally, the shared vision of the team would reflect the personal values of the team members. • Managing the membership of the team over time. For example, ensuring that the members have the necessary knowledge and skills, and are capable of collectively playing roles within the team that relate to thinking, doing, challenging, supporting and leading (Honey 2007). • Clarifying the team's vision, objectives and priorities, as well as the roles and responsibilities of team members. • Coordinating the team's activities, including acquiring and aligning resources to help the team meet its objectives. • Fostering innovation, creativity and constructive conflict (e.g., healthy debates) to identify better ways of achieving objectives. This includes matching people to tasks in order to access people's intrinsic motivation. • Frequently monitoring the team's environment to identify trends, opportunities and threats. For example, they are aware of broad trends affecting the water industry. • Looking for opportunities to deliver and celebrate tangible outcomes in the short term when working on challenging, long term projects.

Table 5: Key leader competencies and leadership strategies typically associated with the thought leader role

Leader Competencies	Leadership Strategies
• Very high levels of expertise in a particular area, as well as a broad general knowledge to identify connections with other aspects of water management. • A propensity to question conventional wisdom and take some personal risks. • Cultivated networks with people in positions of power (e.g., policy specialists and political advisers). • Credibility, including a track record of demonstrating expertise over many years. • Independence (e.g., the freedom to speak freely). • Often connected to academia (e.g., an adjunct staff member of a university) to provide access to new ideas and information. • Passion for their subject, including the ability to strongly advocate for the adoption of new approaches (i.e., strong communication skills).	• Building and maintaining very high levels of expertise (expert power) and ensuring that stakeholders are aware that this expertise is held. Methods may include the strategic use of technical publications, presentations, awards and demonstration projects. • Engaging in strategic networking to build strong relationships with key people who have the potential to adopt new ideas (e.g., senior policy bureaucrats and political advisers). • Becoming politically savvy in order to influence policy processes. • Being prepared to work with stakeholders to drive change from the top-down (e.g., via policy processes) as well as from the bottom-up (e.g., through working with local stakeholders on demonstration projects). • Building credibility over time by demonstrating integrity, avoiding conflicts of interest, delivering high quality projects, keeping promises, and acting in accordance with espoused personal values. • Finding work environments which provide the freedom to maintain independence and question conventional wisdom when necessary. • Shopping for venues that provide opportunities to build power and exercise influence (e.g., executive roles within professional associations). • Using 'scanning behaviours' to monitor their environment and anticipate windows of opportunity to promote new approaches (e.g., the local media showing interest in a water management issue). • Maintaining civil relations with other respected thought leaders who hold different views.

leaders often demonstrate the ability to make the transition from a technical specialist focused on day-to-day challenges to a forward thinking, strategic leader who is able to build a capable team, delegate day-to-day tasks, and maintain their focus on the strategic direction of the organisation or work unit. These leaders typically have a strong commitment to professional development and continuous learning. They are also suited to executive leadership roles.

3.6. The trusted advisor

A role occupied by practitioners who are experts at communicating, networking and advocating at the political level. They are associated with a high level of trust/credibility within political circles and an expansive network of connections across government and politics. They are seen as independent, rather than being aligned with any political party. Their role involves brokering access and agreement amongst decision makers, and acting as trusted interlocutors between technical and political stakeholders or between government and affected stakeholder groups (e.g., community and industry groups). These leaders originate from diverse backgrounds, but have a long track record in technical–political translation. They have a good sense of political timing, a sophisticated understanding of political opportunities and government agendas, and are adept at communicating complex concepts simply to politicians and the public alike. They usually have strong networks and are trusted across several different areas of science and across stakeholder interest groups. They have a reputation as trusted advisors and/or 'fixers' to politicians. They often work as stewards of complex negotiations and collaborations regarding new policy, working to obtain consensus and agreement, but do so often without taking an overt role in driving the process or in developing specific technical solutions themselves.

Table 6: Key leader competencies and leadership strategies typically associated with the strategic leader role

Leader Competencies	Leadership Strategies
• The ability to use transformational leadership behaviours to build shared visions that are clear and inspiring, inspire confidence, build commitment, and influence people across organisational boundaries. • An active interest in change management, with the analytical skills for situational analysis, seeing the big picture, strategic planning and paradigm shifting. • Operational experience with the organisation's processes and procedures to understand opportunities for improvement. • Ability to reframe challenges and longer-term change into immediate opportunities for actions. • Appreciation of the need for cultural change including new behaviours, and the ability to shape organizational culture. • Excellent communication skills (e.g., active listening, providing constructive feedback, compelling public speaking with storytelling, persuasive writing, and using multiple perspectives). • Ability to frequently use transformational leadership behaviours, when appropriate (e.g., displaying energy, enthusiasm and confidence), backed up by patience, persistence and personal resilience to work on making change happen over time. • Advanced social networking skills (see Ibarra and Hunter 2007), including building networks, alliances and coalitions with partners across organizational boundaries. • The ability to carefully plan and execute influence attempts using a variety of principles and tactics, and choosing the right set of tactics for a particular person, place and time. • A propensity to enable others (e.g., affected stakeholders and technical experts) to find solutions to complex challenges, rather than directing them how to solve problems. This typically involves trusting others, 'letting go' of the detail, taking a systemic perspective, mentoring and coaching others, and being comfortable with uncertainty, ambiguity and experimentation.	• Creating space for change by allowing people to buy into a vision rather than choosing to agree or disagree with a new policy, using narratives to strategically frame issues to justify change, and making it attractive with a compelling storyline. • Overcoming resistance to change through better communication (from the inside) and pressure from partners (from the outside) to gain momentum. • Using short-term gains to show how the new strategy will save cost and time, multiply outcomes, and build more flexibility and resilience into operations to adapt to the increasing uncertainties. • Fostering new knowledge-driven cultures to operationalise the new strategy, involving younger staff as champions and catalysts, and specifying keys for success and rewards for individuals and teams working with clients and partners. Typical organisational culture strongly value innovation, adaptive management, collaboration, experimentation, and responsible risk-taking. • Introducing performance metrics that show progress in the new strategic direction, together with benchmarking, rewards, and increased access to budgets. • Ensuring that budgets are allocated and resources mobilized in time to support the strategic change process in the organisation. • Using staged implementation to incubate and accelerate the changes, starting with departments and teams with a track record of innovation and supportive leadership for learning while doing. • Anticipating, planning for, and using windows of opportunity to exert influence and drive the strategic change, including making best use of water crises to accelerate change, supported by incentives and rewards. • Arranging opportunities for executives who are still 'on the fence' to become supporters of the change process by inviting them to give keynote speeches at internal and external events that allow them to internalize and own the changes. • Using a combination of bottom-up (emergent) and top-down (formal) leadership strategies to drive the change process and institutionalize the new approaches and behaviours with the support of younger professionals. This typically involves mentoring and coaching emerging leaders as well as strategic networking to engage leaders in positions of authority.

Table 7: Key leader competencies and leadership strategies typically associated with the trusted advisor role

Leader Competencies	Leadership Strategies
• Very strong science communication skills, particularly as a translator between experts and non-experts, regardless of whether they are an expert themselves. • An ability to quickly and effectively create 'big picture' narratives that clearly elucidate outcomes and speak to political imperatives whilst maintaining technical credibility. • The capacity to 'remain above the fray' and avoid championing or becoming too closely aligned to particular policies, politics or outcomes. • Broad networks across various sectors, particularly those who have traditionally held different views (e.g., farmers and conservationists). • Strong networks in government and a track-record of working across different political parties to deliver practical policy outcomes. • Ability to work effectively within rapid time-frames and to a government agenda • A mindset that values negotiation, pragmatism and compromise. • Discretion, trustworthiness and honesty in dealing with government. • A broad knowledge-base, including the ability to work through concepts and ideas from multiple perspectives.	• Demonstrating a sound understanding of the political and institutional systems in which water policy decisions are made. • Building and maintaining credibility with all sides of politics and being perceived as independent from political and/or social causes. • Providing well-timed and well-reasoned advice to government and policy-makers in accord with emerging policy priorities, whilst avoiding politically charged areas • Building a broad knowledge of different aspects of water management rather than focusing too narrowly on specific areas. • Using networks to keep informed of developments in water policy and exploiting windows of opportunity for influence and change. • Maintaining broad networks and coordinating interactions between relevant stakeholders in the water community. • Communicating technical information and complex problems to governments and policy-makers, and acting as a 'broker' or provider of policy-relevant research to government and policy-makers (see Pennell et al. 2013). • Keeping conflicts and disagreements behind closed doors in order to strike consensus and agreement when presenting policy options and advice to government. • Providing clear and succinct policy options and priorities in advice that adhere to a broader narrative rather than specific technical questions. • Acting as a translator between 'research science' and 'regulatory science' (Jasanoff 1990) and building critical bridges between the research and policy communities. • Looking for opportunities for different stakeholders and interest groups to collaborate and harmoniously coordinate their efforts to achieve common goals. • Maintaining the interest of government by submitting to public and parliamentary enquiries, engaging the media and being continuously involved in water policy development processes. • Actively engaging in activities across different stakeholder groups so as to maintain a broad rather than narrow base of credibility, as well as broad social networks.

4 - Implications

4.1. Practical implications for individual water leaders

Water leaders who are seeking to build their leadership capacity could use the role descriptions in this paper in the following five ways.

1. They could reflect on this information to determine which roles are likely to suit their personality, values, strengths and weaknesses, and career aspirations. It is in these roles that they are more likely to excel. This is part of the process of self-leadership (see Drucker 2005; George et al. 2007).
2. They could use the descriptions of roles they currently play or aspire to play as an 'assessment tool' to identify *specific* leadership competencies they are likely to need and could benefit from strengthening. For example, a leader aspiring to succeed in the enabling leadership role may choose to develop their systems thinking ability. This process could involve a self-assessment and/or feedback from colleagues.
3. They could use the role descriptions as a tool to consciously modify their leadership style in different situations. The importance of this leadership competency has been highlighted by leadership researchers. For example, Goleman (2000) explored the relationship between leadership effectiveness and the ability to switch leadership style to best match the local context. He concluded that "the research indicates that leaders with the best results do not rely on only one leadership style; they use most of them in a given week - seamlessly and in different measure - depending on the business situation" (Goleman 2000, p. 78). So, a developing water leader may recognise the need to engage in the champion role to convert a good idea into a new project, and then switch to the team leader role once the project is running. The role descriptions in this paper provide guidance on key leadership behaviours and strategies typically used by leaders occupying such roles. Whilst emphasising the importance of being able to change leadership styles for different roles, we also note that it is *likely* that a particular water leader will be best suited to a small number of roles and will have the potential to excel in only some roles.
4. They could choose to work with others to play a particular leadership role, rather than undertake the role themselves, and use the role description to communicate the nature of the leadership role that is required. For example, they may recruit an enthusiastic, entrepreneurial employee to play the champion role to initiate a new project. This approach could also be taken by organisations in the water sector that seeks to identify and develop future leaders.
5. They could use the role descriptions as a framework to reflect on, and better understand significant leadership processes that involve several leaders playing different roles to exert influence in a coordinated manner, and potentially identify ways to participate in these processes. To illustrate, consider a water practitioner ('champion') who is seeking to advance integrated river basin management principles and practices. She works in a non-government organisation with little

authority or resources. Her organisation has recently completed some successful local pilot projects in partnership with local communities involving sustainable farming practices, but now needs government support and resources to promote these practices on a larger scale. The role descriptions described in this paper could be used as a tool to identify the people within the river basin who are playing different leadership roles, as a step towards analysing how they are interacting, and what role she could play to influence river basin management. For example, she might identify that an influential 'thought leader' in a local university has a close relationship with a 'trusted adviser' who frequently briefs local politicians on water management issues. As part of her strategic social networking activities (Ibarra and Hunter 2007) she may subsequently decide to strengthen her relationships with the thought leader and trusted adviser, and provide them with information on the successful pilot projects as part of a broader strategy to garner government support.

4.2. Practical implications for leadership development specialists

Leadership development specialists who design and deliver leadership programmes and short courses, or coach developing leaders could also use the role descriptions. For example, when designing a new water leadership programme, the role descriptions could be used as a framework to explore the following questions: which roles are most relevant to our target audience; what bodies of knowledge and skill sets do we need to focus on developing for this target audience; what leadership models and theories are most relevant to this audience; what case studies are most relevant to this audience; and which guest speakers or group mentors are likely to be most relevant and helpful to this audience? This approach was taken for the IWC Water Leadership Program, where a design decision was made to focus on three leadership roles and build a set of approximately 30 training modules that address the knowledge, networks, tools, and skills needed to perform well in these roles.

The role descriptions also provide a framework to 'cut through the complexity' of the leadership topic. Leadership is a highly complex social phenomenon. Many factors may contribute to a particular leadership outcome. There are a plethora of theories and models that are potentially applicable. Everyone's leadership context is unique. There is no universally applicable leadership style, and there are usually a number of people involved in a process of influence. It can, therefore, be conceptually challenging for developing leaders to make sense of such a complex situation and identify tangible actions they can take to improve. To some extent this complexity can be overcome by helping such leaders to identify when they need to play a particular leadership role (or build a relationship with another person to play this role) and understand the nature of this role (e.g., key behaviours and strategies to use). This understanding can then lead to practical developmental activities such as an assessment of their ability to perform well in the role, the identification of actions that can be taken to improve (e.g.,

specific skills to be developed), practising new approaches, gathering feedback from colleagues, and getting assistance from a coach and/or mentor.

The role descriptions also represent a potentially useful communication and learning tool. For example, a coach or trainer may use a case study to highlight some leadership lessons. Water leadership case studies often involve a number of people interacting to collectively drive a process of influence (Brown and Clarke 2007; Taylor 2011; Vedpuriswar and Kolakaluri 2009). The role descriptions in this paper could be used to identify water leaders playing specific roles in a case study and foster a discussion that explores the importance of each role, keys to success in each role, why certain roles were needed, and the interplay between leaders playing different roles.

4.3. Implications for researchers and opportunities for future research

The role descriptions also provide a conceptual framework that researchers who are interested in institutional change, leadership, capacity building, and governance could use when exploring aspects of change in the water sector. It is common for such researchers to broadly highlight the importance of leadership capacity to successfully driving change (e.g., Herrick and Pratt 2012; Mukhebir et al. 2014). It is, however, rare to see an analysis of the factors contributing to a leadership process in the water sector, including a description of the different leadership roles being played and how they are interacting over time. This is an exciting opportunity for future research and learning. The roles described in this paper provide a framework that researchers could use to help structure an analysis of a leadership process. Such research could explore the importance of specific roles in different situations, the relationships between each role (e.g., the potentially symbiotic relationship between the enabling and champion leader roles), and whether some patterns of interaction between roles are consistent across different contexts.

Future research could also explore different leadership roles being played in circumstances where 'top-down' and 'bottom-up' processes of influence are combining to produce more sustainable water management outcomes. The effective combination of top-down and bottom-up processes of influence has been frequently cited in the sustainability leadership literature (see Benn et al. 2006). It is hypothesised that this pattern of leadership creates a demand for certain leadership roles, such as project-level champions driving change from below and senior enabling leaders facilitating change from above, as well as the necessity for people in these roles to operate in concert. Indeed, recent case studies have highlighted the need for leaders operating at multiple levels of governance and interest to effectively shepherd change in the water industry (Daniell et al. 2014), and should inspire further research as to how these multi-level, multi-role networks might be developed.

5 - Conclusions

Given the magnitude of the water-related challenges that face society in the twenty-first century, particularly in developing countries, we believe there is no more important task than to nurture the next generation of water leaders. To do this well we need to better understand water leaders and leadership processes, improve our methods to enhance the leadership capacity of water practitioners, and share this knowledge. This paper was written to help this process.

In this paper, the authors described six leadership roles that are commonly seen in the water sector and often feature in successful case studies of positive change in both developed and developing countries. These were the champion leader, enabling leader, cross-boundary team leader, thought leader, strategic leader and trusted adviser roles. Each description provided an overview of the role, and some of the key leader competencies and leadership strategies (i.e., behaviours) typically associated with the role. It is noted, however, that these six roles are not exhaustive.

These role descriptions represent a practical tool (framework) that can be used by developing water leaders, leadership development professionals, and water leadership researchers. Those seeking to enhance leadership capacity can use the framework to identify which roles are most suited to a developing leader and which specific abilities (e.g., skills) need to be strengthened to perform well in these roles. They can also use the framework as a communication and learning tool to explore how leadership processes in the water sector typically involve a number of people playing different but complimentary roles (e.g., when examining case studies within a leadership programme).

Researchers exploring processes of change, governance, and leadership in the water sector could also use the framework to structure their analysis of processes of influence. They could, for example, identify the people and organisations playing different leadership roles, the relationships between these roles, and explore whether these relationships are unique to each context or transferable to other contexts. Such an approach represents an opportunity for future research and learning.

This paper has been written for people with an interest in building the leadership capacity of emerging water leaders to drive positive change, which may include developing themselves as well as others. Its key recommendation is to facilitate three outcomes. First, help developing water leaders to understand the nature of the six leadership roles described in this paper, including the leader competencies and leadership strategies typically associated with each role. Second, ensure that these leaders have an opportunity to identify which roles are most relevant to them now and in the future, as well as those that best suit their nature. Third, connect these leaders to tailored leadership development interventions (e.g., programmes) and materials (e.g., training modules and case studies) that focus on helping them to excel in relevant roles as well as collaborate with leaders in other roles to collectively drive processes of influence to deliver more sustainable forms of water management.

References

Adair, J. 2005. *How to Grow Leaders*. London: Kogan Page.

Ait-Kadi, M., and Lincklaen Arriëns, W. 2012. *Increasing Water Security—A Development Imperative*. Perspectives paper of the Global Water Partnership Technical Committee. Stockholm: Global Water Partnership.

Asian Development Bank (ADB) and Asia–Pacific Water Forum (APWF). 2013. *Asian Water Development Outlook 2013*. Manila: Asian Development Bank.

Bass, B. 1985. *Leadership and Performance beyond Expectations*. New York: Free Press.

Benn, S., Dunphy, D., and Griffiths, A. 2006. "Integrating Human and Ecological Factors." In *Handbook of Environmental Technology Management in Business Practices*, ed. D. Marinova. Cheltenham, England: Edward Elgar, 222–241.

Braddy, P., and Campbell, M. 2013. *Using Political Skill to Maximize and Leverage Work Relationships*. A White Paper. Greensborough, North Carolina: Center for Creative Leadership.

Brouwer, S., and Biermann, F. 2011. "Towards Adaptive Management: Examining the Strategies of Policy Entrepreneurs in Dutch Water Management." *Ecology and Society* 16 (4): 1–14.

Brown, R. 2003. *Institutionalisation of Integrated Urban Stormwater Management: Multiple-case Analysis of Local Management Reform Across Metropolitan Sydney. PhD dissertation. Sydney*: School of Civil and Environmental Engineering, University of New South Wales.

Brown, R., and Clarke, J. 2007. *Transition to Water Sensitive Urban Design: The Story of Melbourne, Australia*. Melbourne: Facility for Advancing Water Biofiltration and National Urban Water Governance Program, Monash University.

Brown, R., and Farrelly, M. 2009. "Delivering Sustainable Urban Water Management: A Review of the Hurdles We Face." *Water Science and Technology* 59 (5): 839–846.

Carson, J., Tesluk, P., and Marrone, J. 2007. "Shared Leadership in Teams: An Investigation of Antecedent Conditions and Performance." *Academy of Management Journal* 50 (5): 1,217–1,234.

Conger, J. 1993. "The Brave New World of Leadership Training." *Organizational Dynamics* 21 (3): 46–57.

Cooperative Research Centre (CRC) for Water Sensitive Cities. 2014. Annual Report 2013/14. Melbourne: CRC for Water Sensitive Cities.

Crow, D. 2010. "Policy Entrepreneurs, Issue Experts and Water Rights Policy Change in Colorado." *Review of Policy Research* 27 (3): 299–315.

Daniell, K, Coombes, P., and White, I. 2014. "Politics of Innovation in Multi-Level Water Governance Systems." *Journal of Hydrology* 519: 2415–2435.

Drath, W., McCauley, S., Palus, C., Van Velsor, E., O'Conner, P., and McGuire, J. 2008. "Direction, Alignment, Commitment: Towards an Integrative Ontology of Leadership." *The Leadership Quarterly* 19 (2008): 635–653.

Drucker, P. 2005. "Managing Oneself." *Harvard Business Review*, January (reprinted from a 1999 edition): 1–11.

Dunphy, D., Griffiths, A., and Benn, S. 2007. *Organisational Change for Corporate Sustainability*, Second Edition. London: Routledge.

Ernst, C., and Chrobot-Mason, D. 2011. *Boundary Spanning Leadership: Six Practices for Solving Problems, Driving Innovation, and Transforming Organizations*. New York: McGraw-Hill.

Flower, J. 1995. "Leadership Without Easy Answers: A Conversation With Ronald Heifetz." *The Healthcare Forum Journal* 38 (4): 30–35.

George, B., Sims, P., McLean, A., and Mayer, D. 2007. "Discovering Your Authentic Leadership." *Harvard Business Review*, February: 129–138.

Godwin, R., Ainsworth, S., and Godwin, E. 2012. *Lobbying and Policymaking: The Public Pursuit of Private Interests*. Washington, DC: CQ Press.

Goleman, D. 2000. "Leadership that Gets Results." *Harvard Business Review*, March–April: 78–90.

Gordon, J., and Berry, J. 2006. *Environmental Leadership Equals Essential Leadership*. New Haven, Connecticut: Yale University Press.

Heifetz, R., Kania, J., and Kramer, M. 2004. "Leading Boldly." *Stanford Social Innovation Review*, Winter 2004: 21–31.

Herrick, C., and Pratt, J. 2012. "Sustainability in the Water Sector: Enabling Lasting Change Through Leadership and Cultural Transformation." *Nature and Culture* 7 (3):

285–313.

Honey, P. 2007. *Teams and Teamwork*. Maidenhead, England: Peter Honey Publications Ltd.

Howell, J., and Higgins, C. 1990. "Champions of Technological Innovation." A*dministrative Science Quarterly* 35: 317–341.

Howell, J., Shea, C., and Higgins, C. 2005. "Champions of Product Innovations: Defining, Developing, and Validating a Measure of Champion Behavior." *Journal of Business Venturing* 20: 641–661.

Huitema, D., and Meijerink, S. eds. 2010. *Water Policy Entrepreneurs: A Research Companion to Water Transitions Around the Globe*. Camberley, United Kingdom: Edward Elgar Publishing.
Ibarra, H., and Hunter, M. 2007. "How Leaders Create and Use Networks." *Harvard Business Review* 85 (1): 40–47.

Jasanoff, S. 1990. *The Fifth Branch: Science Advisers as Policymakers*. Cambridge, Massachusetts: Harvard University Press.
Keller, A. 2009. *Science in Environmental Policy: The Politics of Objective Advice*. Cambridge, Massachusetts: MIT Press.

Keremane, G. 2015. "Role of Sustainability Policy Entrepreneurs in Building Water-Sensitive Cities to Respond to Climate Change: A Case Study in Adelaide, Australia." In *Managing Water Resources Under Climate Uncertainty*, eds. S. Shrestha, A. Anal, P. Salam, and M. Van der Valk. London, United Kingdom: Springer, 359–375.

Kingdon, J. 1995. *Agendas, Alternatives and Public Policies*, Second Edition. New York: Harper Collins.

Kotter, J. 2006. "Transformation: Master Three Key Tasks." *Leadership Excellence* 23 (1): 14.

Kouzes, J., and Posner, B. 2012. *The Leadership Challenge*, Fifth Edition. San Francisco: Jossey-Bass.

Laing, M. 2014. *The Science-Policy Nexus and Influencing Decision-Makers*. Conference Presentation, Cooperative Research Centre for Water Sensitive Cites National Conference 2014. Melbourne: Monash University.

Laing, M. 2015. *Scientists and Policy Influence*. Research Report. Cooperative Research Centre for Water Sensitive Cites. Melbourne: Monash University.

Laing, M., Thwaites, J., and Walter, J. forthcoming 2015. *Missed Opportunities or Lost Causes? Science, Policy and Water Reform in Victoria 2004–2014*. Research Report. Cooperative Research Centre for Water Sensitive Cites. Melbourne: Monash University, forthcoming.

Lincklaen Arriëns, W., and Wehn de Montalvo, W. 2013. "Exploring Water Leadership." *Water Policy* 15: 15–41.

Lloyd, S., Wong, T., and Chesterfield, C. 2002. *Water Sensitive Urban Design—A Stormwater Management Perspective*. Melbourne: Cooperative Research Centre for Catchment Hydrology.

Maidique, M. 1980. "Entrepreneurs, Champions, and Technological Innovation." *Sloan Management Review* 21 (2): 59–76.

McIntosh, B., and Taylor, A. 2013. "Developing T-Shaped Water Professionals: Reflections on a Framework for Building Capacity for Innovation Through Collaboration, Learning and Leadership." *Water Policy* 15: 42–60.

Meijerink, S., and Huitema, D. 2010. "Policy Entrepreneurs and Change Strategies: Lessons from Sixteen Case Studies of Water Transitions Around the Globe." *Ecology and Society* 15 (2): 1–21.

Mintrom, M., and Norman, P. 2009. "Policy Entrepreneurship and Policy Change." *Policy Studies Journal* 37 (4): 649–667.

Mintrom, M., and Vergari, S. 1996. "Advocacy Coalitions, Policy Entrepreneurs and Policy Change." *Policy Studies Journal* 24 (3): 420–434.

Mukheibir, P., Howe, C., and Gallet, D. 2014. "What's Getting in the Way of a 'One Water' Approach to Water Services Planning and Management?" *Water* 2014 (May): 67–73.

Northouse, P. 2013. *Leadership Theory and Practice*, Sixth Edition. London, England: Sage.

Pennell, K., Thompson, M., Rice, J., Senier, L., Brown, P., and Suuberg, E. 2013. "Bridging Research and Environmental Regulatory Processes: The Role of Knowledge Brokers." *Environmental Science & Technology* 42 (21): 11985–11992.

Rittel, H., and Webber, M. 1973. "Dilemmas in a General Theory of Planning." *Policy Sciences* 4 (1973): 155–169.

Snowden, D., and Boone, M. 2007. "A Leader's Framework for Decision Making."

Harvard Business Review, November: 1–8.

Subijanto, T., Harianto, R., and Hidyayat, F. 2013. "Key Success Factors for Capacity Development in the Brantas River Basin Organisations in Indonesia." *Water Policy* 15: 183–205.

Taylor, A. 2008. *Leadership in Sustainable Urban Water Management: An Investigation of the Champion Phenomenon*. Industry Report. Melbourne: National Urban Water Governance Program, Monash University.

Taylor, A. 2010a. *Sustainable Urban Water Management: The Champion Phenomenon*. PhD Thesis. Melbourne: National Urban Water Governance Program, Monash University.

Taylor, A. 2010b. "Building Leadership Capacity to Drive Sustainable Water Management: The Evaluation of a Customised Program." *Water Science and Technology* 61 (11): 2797–2807.

Taylor, A. 2011. "City of Mandurah: Champions of Change." In *Cases in Corporate Sustainability and Change: A Multidisciplinary Approach*, eds. S. Benn, D. Dunphy and B. Perrot. Melbourne: Tilde University Press, 9–27.

Taylor, A., and McIntosh, B. 2012. "Building Leadership Capacity to Drive Change: Lessons from a New Program." *Proceedings of the Environment 2012 Conference*, July 24–26, 2012. Adelaide, South Australia. Brisbane: International Water Centre.

Taylor, A., Cocklin, C., Brown, R., and Wilson-Evered, E. 2011. "An Investigation of Champion Driven Leadership Processes." *The Leadership Quarterly* 22 (2011): 412–433.

Te Boekhorst, D., Smits, T., Li, T., Lei, G., and Zhang, C. 2010. "Implementing Integrated River Basin Management in China." *Ecology and Society* 15 (2): 1–23.

Uhl-Bien, M., Marion, R., and McKelvey, B. 2007. "Complexity Leadership Theory: Shifting Leadership from the Industrial Age to the Knowledge Era." *The Leadership Quarterly* 18 (2007): 289–318.

United Nations (UN). 2014. "World's Population Increasingly Urban with More Than Half Living in Urban Areas." Online article at www.un.org, dated July 10, 2014, accessed December 10, 2014.

United Nations (UN) World Water Assessment Programme (WWAP). 2014. *The United Nations World Water Development Report 2014: Water and Energy*. Paris: UNESCO.

United Nations (UN) World Water Assessment Programme (WWAP). 2015. *The United Nations World Water Development Report 2015: Water for a Sustainable World*. Paris: UNESCO.

United Nations (UN), Department of Economic and Social Affairs (DESA), Population Division. 2014. *World Urbanization Prospects: The 2014 Revision, Highlights*. New York: United Nations.

Vedpuriswar, A., and Kolakaluri, R. 2009. *Promoting Water Management in India: Chennai's Initiative in Rainwater Harvesting*. Case Study. Hyderabad, India: IBS research Centre.

White, J. 2006. *Sustainable Water Management: Achieving a Culture of Change*. Melbourne: Melbourne Water.

World Economic Forum. 2015. *Global Risks 2015: Insight Report*, 10th Edition. Geneva, Switzerland: World Economic Forum.

Environmental Pollution Potential within the Burl River Basin of Liberia, West Africa

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The recognition that water provides values for life and is an essential factor for conservation worldwide has led to an increasing need for research and best management practices. As a result, Graphical Information System (GIS) applications were developed to figure out the environmental pollution potential within the Burl River Basin. Burl River Basin has over the years experience minor cases of pollution resulting from diverse human activities; however, the current situation is becoming apocalyptic and needs further attention. Burl River of Liberia is a valuable freshwater resource providing water supply to households, industries, and local farm owners, but the recent increase in subsistence farming, low scale mining, logging, settlement construction and other damaging activities such as indiscriminate waste disposal, climate change and population growth is damaging the river's support towards consumptive water uses. Hence, this paper evaluates the water quality risks in the river by using DIVA-GIS, Shuttle Radar Topographic Mission (SRTM) 90 digital elevation model to derive the land-use, slope, soil, and as well population growth factor in assessing the potential sources of pollution and suggested ways through which a more informed and better management approach can be adopted. Our hope is that lessons from the Burl River Basin can be replicated to other parts of Liberia and West Africa.

***Keywords**: Freshwater, GIS application, Human population, Marine or Coastal Environment, Water quality*

1 - Introduction

Increased human activities along the freshwater to marine or coastal environment have exponentially triggered a significant change, thereby endangering the integrity of water uses across Liberia. The nation-wide comprehensive food-security and nutrition survey (CFSNS) carried out in 2006 concluded that 68 percent of Liberians rely on untreated wells, rivers, ponds, creeks, and swamps for drinking water (Pruss and Havelaar, 2006). The Mano and St. John rivers in Grand Cape Mount and Nimba Counties, respectively, are increasingly polluted from dumping of iron ore tailings, and the coastal waters from oil residue and dumping of untreated sewage and waste water,

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Environmental Protection Authority/United Nations Environment Programme (EPA/UNEP, 2007). As indicated by World Water Assessment Program (WWAP), there are no substitutes for water; it is, therefore, a critically important resource that needs to be well managed, especially as it becomes scarcer and more in demand. Studies of the role of water in ecosystems are improving our abilities to value it and, understand to a larger scale the long term ecosystems processes as well as the flow of water they require (Oki, T. and Shinjiro Kanae, 2006). The finite nature of the resource and its essential role as a major life enhancing factor has placed a premium on water resource management. Alterations in the natural quality and distribution of water have environmental impacts that unequivocally evoked a devastating disease burden. To prevent these scenarios, there must be a best management approach instituted to ensure the quality for water uses. The quality of water source cannot be overlooked in water supply development. Virtually, the use of water depends on the quality of sources. Therefore, all sources of water need some forms of treatment before portable use. However, as noted by Paerl (2009), human population growth, urbanization, agricultural and industrial expansions are causing an alarming rate of nutrient over-enrichment and accelerated contamination in receiving water bodies globally. The nutrients over-enrichment which promotes accelerated production of plant-based organic matter (i.e., eutrophication) to the extent that excessive production including harmful algae blooms, fuels expanding zones of bottom water hypoxia (dead zones), and leads to fisheries habitat destruction, translating into ecological and economic losses of impact waters (Nixon 1995; Boesch et al. 2001; and Turner 2003; Diaz and Rosenberg 2008).

The need to reducing water pollution and qualifying its sources has been widely recognized. Therefore, Burl being one of the major rivers supplying towns and villages along the Township of Kpaytuo, the need to assessing its pollution potential necessitated the development of GIS approach in order to inform future management decision. Although there are numerous cases of known environmental pollution potential identified, but the Burl River specific case remains a serious impediment to water quality improvement in the Burl basin. To date, it is glaringly apparent that the integrity of Burl River has come under question due to the many activities carried out by the locals. Said activities include subsistent farming or over land uses, logging/pit-sawing, and increased mining activities in the upstream regions connected to the Burl River (Bleevahlay). These activities have over time shifted the quantity and quality of the river. The occurrences of mining diamond and alluvial gold alone the Burl basin has altogether dwindled water quality improvement. Mineral extraction, though at a lower scale, has often had runoff from mines and mine wastes, quarries and well sites resulting to sediment, metals and other organic contaminants. However, agricultural activities (livestock) are on the other hand identified as a key environmental pollution potential within the Burl basin. As the Food and Agriculture Organization of the United Nations (FAO, 1990a) makes it quite clear, agriculture exists within a symbiosis of land and water, as such, appropriate steps must be taken to ensure that agricultural activities do not adversely affect water quality so that subsequent uses of water for different purposes are not impaired. Unlike the above, the Burl basin suffers indiscriminate cases of farming activities. This has often increased runoff from disturbed land. Most

damaging is the forest clearing processes, which is as a result of subsistence farming and settlement construction. Forest clearing has exposed the river to erosion, sedimentation and direct sun ray, thereby changing the temperature and impacting ecosystem health. Increase storm runoff and the discharge of other impurities into the river are among drivers influencing Burl River pollution. Rural sewage overloading and malfunctioning of septic systems is a burgeoning phenomenon accounting for water pollution. These factors coupled with the discharge of sugar cane related wastes upstream have induced contamination of various sorts impacting aquatic lives.

The GIS approach for identifying pollution concentration has been demonstrated in the mapping of pollution, flooding, erosion and hazards (PA Brivio, R. Colombo, M. Maggi 2002; Sauer, Schanze and Walze 2007; Palmer et al., 2009). Hence, this study aims to evaluate the environmental pollution potential within the Burl river basin and bring to the attention of stakeholders the need to set best management standards for quality control. Therefore, the study employs the application of GIS to identifying pollution sources and highlights the major causes of pollution as well the adverse impacts and suggests prudent measures for effective monitoring and control of pollutants.

Study Area

This study was carried out at one of the major rivers (Burl River) in Northern Liberia, Precisely Kpaytuo Township, Nimba County (Fig 1). Nimba County extends from latitude (in decimal degree) 6.75 and longitude (in decimal degree) 8.75 and latitude (in degrees, minutes, and seconds) 6o 45' 00" N and longitude (in degrees, minutes, and seconds) 8o 45' 00" W. Born in 1964, Nimba has a tropical climate with alternating wet and dry seasons. Generally, the wet and dry seasons are the two basic seasonal patterns of Liberia. The annual precipitation is as little as 200 cm towards the north. In most part of the County, the temperatures are moderate almost all year round. Apart from the higher altitudes that has a fewer savannahs, the county is predominantly rain forest. These fewer savannahs related areas formed (iron formation pebble conglomerate), thus ensuring the existence of extractive natural resources. This makes iron mining the largest industry of Nimba County, indeed of Liberia. Formerly, the Liberian American-Swedish Mining Co. (LAMCO) operated mines at Mt. Nimba. At present, LAMCO has been taken over and operated by Mittal Steel, one of the largest global steel giants. Regarded as one of Liberia's breadbasket counties, there are series of upland farming and life crops production in most parts of the county. There are rubber plantations, oil palm production and cocoa in several regions of the County. The county's largest rubber plantation is Cocopa plantation. Dominated by rain forest, Logging is also a common practice in Nimba County. In fact, logging is among the County's largest industry. Prior to the civil crisis in Liberia, there were selective logging practices that harvested hardwoods from the magnificent stands of timber in the Gio forest and Gbi Range areas. However, hard costs of living amongst inhabitants have intensified the logging activities across the county. Eminent among which is pit-sawing, a practice chiefly associated with the locals. This system employs the use of chainsaw to indiscriminately hunt down various tree species for building homes, fuelwood and

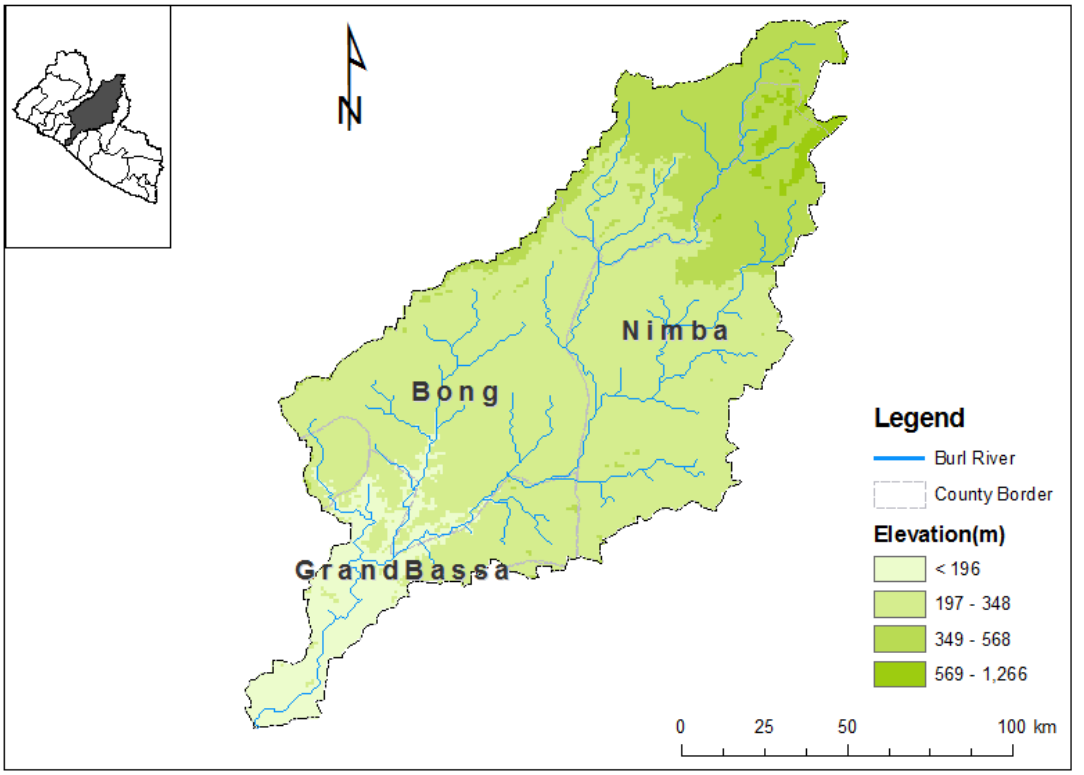

Figure 1: Burl River Basin, West Africa

Table 1. Data Inputs and their weighted properties

Parameter	Source
Landuse	Derived from land cover map downloaded at diva-gis.org
Slope	Derived from the SRTM 90M digital elevation model
Population	Projected population for the Burl River Basin obtained from the 2008 Population and Housing Census conducted by the Government of Liberia
Soil	Derived from the soil map downloaded at diva-gis.org

economic developments. Given the fact that rice is Liberia's stable food, majority of Liberians are engaged in subsistence farming. Therefore, upland farming is a major occupation for most residents in Nimba County. The practices of upland farming as carried out in Nimba, often ensured that some plots of timber are cleared annually and burned for the cultivation of rice and other vegetables. Geographically, Nimba County is situated in the Northeastern part of Liberia and borders Countries such as Guinea and Ivory Coast. It borders Guinea to the north and Ivory Coast to the east. On the other hand, Nimba internally borders Counties such as Grand Gedeh, Grand Bassa and Bong. Although emphasis of this paper is on the northern part of Liberia, but portion of this river lies in Guinea. This river was selected because no previous study had been carried out to assess its exposure to pollutants. Kpaytuo, being an area that forms a connecting network of rivers, has a water system that is badly degraded by the types of land uses described above.

2 - Material and Methods

2.1. Data Sources

Table 1 provides the various datasets which were used for the deriving of the estimated environmental pollution potential for the Burl River Basin.

The Burl River basin boundary was derived from the SRTM 90m DEM using the hydro-processing plug-in in ILWIS Open. The procedure involves the use of D-8 algorithm in the determination of flow direction. The D-8 algorithm used by ILWIS Open has been found to be sufficient for the delineation of catchments in the West Africa zone (Anornu, Kabo-bah, & Kortatsi, 2012). Based on the delineated boundary of the Burl River, the maps (land use, slope, population and soil) were masked to represent the study area. The key assumption in this study was that a combination of the land use activity, slope, soil and population growth can provide relevant information for deriving the potential environmental pollution. The environmental pollution potential (EPP) is explained as the degree to which the river resources get polluted and contaminated, as a result of basin's natural tendency, and human activities. In that case, the EPP map indicates the areas within the basin that has the potential to contribute to pollution or contamination of the river resources. Since non-point river pollution is a contribution of different sources and activities within a particular basin, land use map, slope and soil were considered as the most critical and important indicators for contribution to non-point pollution. The land use provided the existing purpose of the land and, based on the existing use of the land; it is possible to estimate the potential pollutant transport to the river. The slope is the catalyst for promoting the flow and hence was included as one of the core indicators. The soil media, an indicator of the geological formation, was included as a medium for transport and, therefore, depending on the characteristics of this medium, pollutant travel to the river could be faster or slower. The population growth was considered as the changing indicator that affects land use activity. As the population grows, issues such as urbanization and household and industrial waste also

Table 2. Weighted parameters

Parameter	**Classification**	**Weights**
Slope	Flat	2
	Gentle	5
	Medium	10
Soil	Silt	8
	Clay	3
	Gravel	5
	Sand	8
	Loam	4
Population	Moderately Dense (<140000)	4
	Dense (140000 – 300000)	6
	Very Dense (300000 – 520000)	8
	Extremely Dense (Above 520000)	10
Landuse	Trees	5
	Bush/Shrubs	5
	Trees/Shrubs	4
	Farms	10
	Bare Areas	1

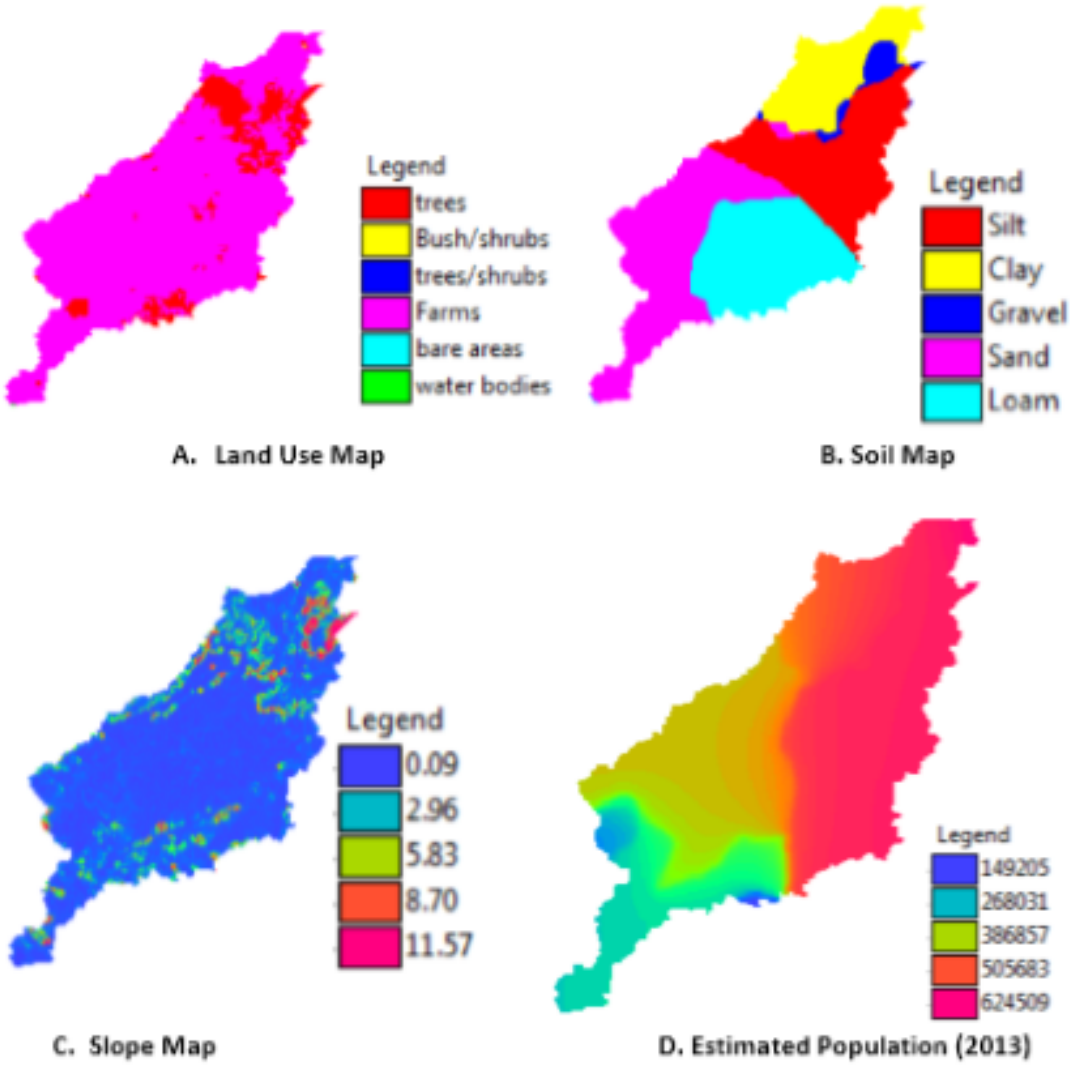

Figure 2: Input maps used for the estimation of the Environmental Pollution Potential (EPP)

The soil and the estimated population maps were again reclassified according as shown in the figure below.

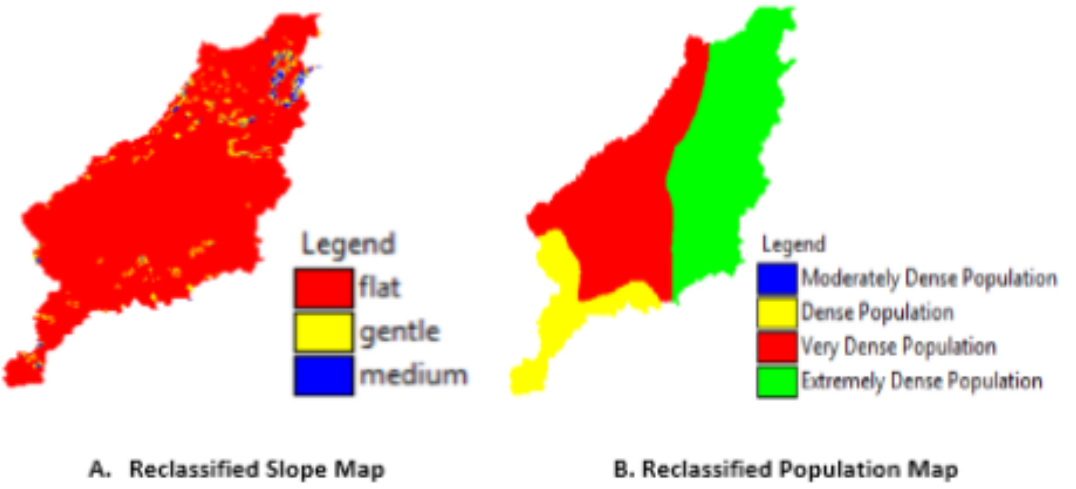

Figure 3. Reclassified Maps of Slope and Population

increase. Therefore, the population can significantly affect all other activities. Hence, it was assumed that the integration of the land use, soil, population and slope maps were adequate to provide the estimated environmental pollution potential within the basin.

2.2. Approach

The principle of weighting was applied as the basic approach for integrating the maps. Various classifications within each map were weighted according to a scale of [1-10]. The higher the number, the higher degree of contribution to pollutants in the river and vice-versa. The weights assigned for the maps have been shown in table 2, figures 2 and 3. The weights were basically assigned according to authors' experience and practical knowledge in the area. These weights may, however, differ for other river basins in West Africa.

The parameters were also weighed on a scale of 100% and integrated together according to equation 1. This estimated EPP then provided the degree of pollution within the basin. The higher the EPP, the more likelihood the pollution of the river near the zone. The lower the EPP, the low possibility of a particular zone to contribute to pollution.

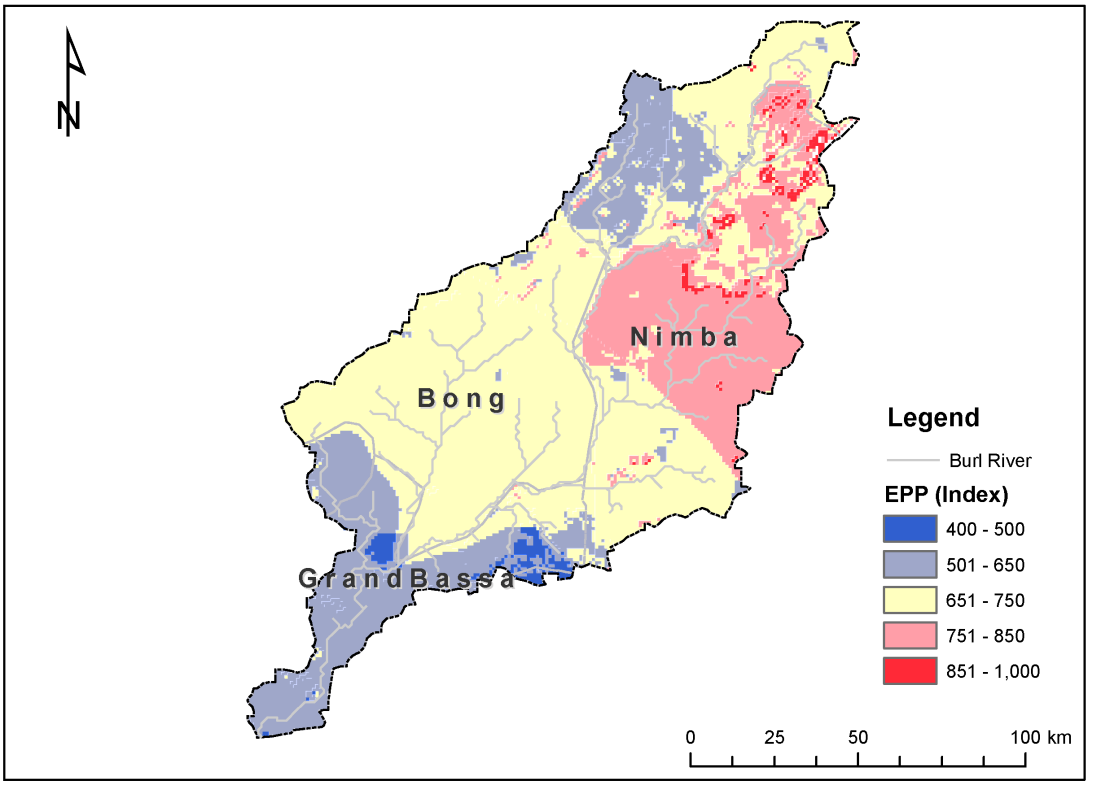

Figure 4. EPP of the Burl River Basin

$$EPP = 15 * LU_W + 20 * Soil_W + 20 * Sl_W + 45 * P_w$$

Where,

EPP is the Environmental Pollution Potential
LUw is weighted land use map
Soilw is weighted soil map
SLw is weighted slope map
Pw is weighted population map

The population was estimated using geometric approach with a population growth rate of 2.1% using the results of the 2008 Population and Housing Census as the base year.

3 - Material and Methods

Figure 4 shows the EPP for the Burl River Basin. The basin is characterized by high risk (1.2%), moderately high (28.5%), medium high (20%) and low risk (50.3%). This means about half of the basin is exposed to the high possibility towards a

contribution to river pollution. Nimba, as a region, appears to be contributing higher in terms of pollution. Since this is the upstream of the river, it implies that in the long term, the whole river system gets polluted as a result of pollutant travel downstream. The EPP provides a strategic based decisions support for prioritizing efforts in the basin towards a river remediation programs. In this case, the efforts in the Nimba and Bong counties need to be emphasized.

According to Clarke (1996), measurement and mathematical analysis of the configuration of the earth's surface and the slope dimension of its landforms are needed to understand the essential means in geomorphic study of the area. This understanding, though simple, is germane to determining surface erosion, slopes, and relative relief and terrain characteristics. The morphometric studies of different basins have been done by various scientists using conventional methods (Horton, 1945; Smith, 1950; Strahler, 1957) and earth observation data and GIS methods (Chopra et al., 2005). The importance of GIS analysis in the construction of maps showing the distribution of climatic elements has strongly increased during the last decade as many papers and projects reveal (Dyras and Serafin-Rek 2005; Dyras et al. 2005; Ustmul and Czekierda 2005; Wel Van der 2005; Bac-Bronowicz and Nobuyuki, 2007; Irimia and Patriche, 2009). Similarly, the analysis and construction of maps in this study employed Diva-GIS and STRM 90m digital elevation model to determine the land-use, soil and the slope of the study area. The slope of the study area is measured in geometric mean ranging from 2 to 10. 2 on the scale represent flat, 5 accounts for gentle slope while 10 represents a medium slope. This is an indication that the basin is characterized by flat, gentle and medium slopes. However, it was recorded that the terrain is predominantly flat, meaning that the slope of the area contributes greatly to the Burl basin pollution. The soil and land-use were both determined as a major contributing environmental factor influencing the Burl basin Pollution. Accordingly, the soil is mostly loamy. Though, at some point, it is shown to be sandy, silt with clay and gravel which supports mining activities. The soil map also shows that the soil is loose due to forest clearing activity during farming and as such, is prone to erosion and run-off carrying debris into surface water.

Predominantly, subsistence farming is a major activity carried out along the Burl basin. This is as a result of the extremely dense populated nature of the basin. These activities are among other environmental factors ballooning the Burl River pollution in Liberia. As indicated above, the Kpaytuo Community, particularly Bawotuo is a major Community chiefly engaged in subsistence farming and pit-sawing activities. These activities have over time exposed the river to eutrophication, thereby damaging the numerous water uses (which includes domestic, recreational, and industrial), as well as endangering aquatic lives. The farming practices carried out in the area induced deforestation or forest clearing leaving the river system vulnerable as the soil often lost its holding capacity resulting to erosion. Accordingly, the land in the study area is flat and loamy. During the rainy seasons, more diffused load of impurities is emptied into the river as a result of run-off. This means that the flat and loamy soil lacks the ability to retain the water quantity, and over time, seepages and overflow of non retained loads with various sorts of pollutants are cascaded into surface water bodies.

As mentioned by the United Nations Development Program State of the Environment Report (UNDP, 2006), about 70 percent of Liberia's rural households rely on food from their own farms or gardens. This suggests that forest clearing and cash crops production are major practices carried out in other rural parts of Liberia including Bong County. In fact, Bong County is the home of the Central Agricultural Research Institute (CARI). Therefore, meeting the growing demand for food and fiber suggests that farming is a key factor responsible for livelihood enhancement. In Liberia, Bong is considered as one of the three bread basket Counties alongside Nimba and Lofa Counties. Farming activities carried out in these regions employs the use of agrochemicals. These chemicals have the ability to negatively impact the cross-county water resource potential, thus damaging water uses. Benefiting from a share water resource and being situated upstream, activities and practices in Bong County are likely to affect water resources in Nimba and other regions of Liberia. The St. Johnson River, which forms the boundary between Liberia and Guinea in the north, also divides both Bong and Nimba Counties. As such, it is glaring that Burl River pollution is influenced potentially by the various human induced activities in Bong County, especially along the St. John River that forms the boundary between the two Counties.

Burl River like any freshwater globally is a natural resource key for the survival of its people, socioeconomic development and maintenance of the environment. This suggests that it must be protected from all forms of pollutants in order to meet its various uses. Unfortunately, the current state of the river suggests that the river is subject to several natural and human processes including climate change and variability, abstraction, indiscriminate waste disposal, alongside farming, mining, logging and settlement constructions. These variables have hence, induced the Burl river pollution, thereby posing severe health risk and disease burden. The exposure of the Burl River to many environmental phenomenons is becoming apocalyptic and thus presents critical threats to life. These threats are anticipated to be translated subsequently into major economic losses. Therefore, there exist needs for stakeholders' intervention in the following regards:

a. Institute relevant and well-coordinated management approach leading to increase treatment aims to address the problem
b. Determine broad base water quality standards that response primarily to water uses across Liberia
c. Ensure the formulation of a robust water resource management policies that genuinely portrays management agenda
d. Ensure periodic monitoring and evaluation of the resource to keep abreast of happenings along the freshwater, marine to coastal environments
e. Develop a strategic management plans that ensure the protection of river basin, watershed and wetlands
f. Formulate and strengthen water resource laws for better compliance and sustain water governance
g. Ensure that a periodic awareness is carried out to keep informing the general public relative to protective measures regarding water uses

4 - Conclusion

This study assesses the causes and impacts of environmental pollutants on the Burl River Basin and recommends appropriate measures necessary to preventing future relapses. The Burl River is a key water resource supporting diverse human activities in Kpaytuo Town and its surrounding areas. These include drinking, industrial and agricultural uses. Unfortunately, there is no identified or well-defined water quality standard set to direct the uses of water, particularly for rural communities including Kpaytuo. The lack of a well-defined water quality standard has undermined the issue of quality control, thereby resulting to severe abuses of the resource. This has; however, increase the vulnerability of the basin due to land-use, human induced factors, climate change and other stresses, thus demanding that attention be paid to the protection of the river. The life and safety of the entire Kpaytuo Community are tied to the health of the Burl River. Therefore, Environmental Protection Agency (EPA) and all Land Ministries involved should holistically institute an integrated approach that will proactively ensure the health of the Burl River. This can be achieved by fully implementing the above recommendations. As implementing the proposed management actions would help ameliorates the land use practices along the Burl Basin and in return enhances the Basin water Quality. Hence, this study can be adopted to help identify environmental pollution potential in river basin in West Africa and elsewhere.

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References

Anornu, G., Kabo-bah, A. T., and Kortatsi, B. 2012. Comparability studies of high and low resolution digital elevation models for watershed delineation in the tropics: case of Densu River Basin of Ghana. International Journal of Cooperative Studies, 1, 9-14

Bac-Bronowicz J. and Nabuyuki, M. GIS as a useful tool for spatial distribution of climate parameters observed in point over relatively long period of time. The Geospatial portal: Climate change, 2007

Boesch, D. F., Burreson, E., Dennison, W., Houde, E., Kemp, M., Kennedy, V, Newell,

R., Paynter, K., Orth, R. and Ulanowicz, R. 2001. Factors in the decline of coastal ecosystems. Science 293:629-638. Doi 10.1126/science 293.5535.1589c.

Brivio, P. A., Colombo, R., Maggi, M. and Tomasoni, R. 2002. Integration of Remote Sensing data and GIS for accurate mapping of flooded areas, International Journal of Remote Sensing, 23:3, 429-441, DOI: 10.1080/01431160010014729

Clarke, J. I. 1996. Morphometry from map, Essays in geomorphology. Elsevier Publishing Company, New York. pp 235-274

Chopra, R., Dhiman, R. D., Sharma P. K. 2005, Morphometric analysis of sub-watersheds in Gurudaspur district, Punjab using Remote Sensing and GIS techniques, Journal of Indian Society of Remote Sensing, 33(4) pp531-539

Diaz, R. j., and R. Rosenberg. 2008. Spreading dead zones and consequences for marine ecosystems. Science 321.926-929. Doi 10.1126/Science.1156401

Dyras I. and D. Serafin-Rek. 2005. The application of GIS technology for precipitation mapping in Meterological applications, London, Cambridge University Press. ISSN: 1350-4827, EISSN: 1469-8080., 12, 69-75

Dyras I., H. Dobesch, E.Gruter, A. Perdigao, D. E.Tveito, J. E. Thomas, F. J. M. Van der Wel and L. Bottali. 2005. The use of geography information systems in Climatology and meteorology: Metrology. Appl., 12, 1-5

EPA/UNEP. 2007. Reports on the Discharge of Petro-chemical and other Industrial wastes in water bodies

EPA/UNEP. 2007. National Report on the marine and coastal Environment in Liberia. Monrovia, Liberia: Environmental Protection Agency of Liberia (EPA)

FAO. 1990a. Strategy on Water for sustainable Agriculture Development, Chapter, 1

Horton, R. E. 1945. Erosion development of streams and their drainage basins; Hydro Physical approach to quantitative morphology, geological society of America Bulletin, 56(3), pp 275-370

Irimia, L and C. V. Patriche. 2009. Spatial distribution analysis of ecological factors in the Avereti wine growing Centre-Husi Vineyard Cercetari Agronomics in Moldova, 42, pp. 139

Nation-wide Comprehensive Food Security and Nutrition Survey – CFSNS. 2006

Nixon. S. W. 1995. Coastal Marine eutrophication: A definition, social causes and future

concerns. Ophelia 41:199-219

Oki, Taikan and Shinjiro Kanae. 2006. Global Hydrological Cycles and World Water Resources. Science Vol. 313. no. 5790, pp. 1068 – 1072. DOI: 10.1126/science.1128845

Palmer M., Lettenmaier, D., Poff, N., Postel, L., Richter, B. and Warner R. 2009. Climate Change and River Ecosystems: Protection and Adaptation Options. Environmental Management, 44(6) pp, 1053-1063

Paerl, H. W. 2009. Controlling eutrophication along the freshwater-marine continuum: Dual nutrient (N AND P) reductions are essential. Estuaries and coasts (2009) 32:593-601 DOI 10.1007/s12237-009-9158-8

Pruss, A. and Havelaar, A. 2006. The Global burden of disease study and applications in water, sanitation and hygiene. In: water eds. Fewtrell, L. and Bartram, J.) pp.43-60, London, UK: IWA Publishing (0n behalf of the WHO), UK

Smith, K. G. 1950. Standards for grading textures of erosional topography. American Journal of Science, 248(9) pp 655-668

Strahler, A. N. 1957. Watershed Geomorphology Transactions – American Geophysical Union, 38(6), 913-920

Sauer, A., Schanze, J. and Walze, U. 2007. Development of a GIS-based risk assessment methodology for flood pollutants. In Gomez, J., Sonnenschein, M., Muller, M., Welscch, H. and Routenstrauch, C., eds. Information technologies in Environmental Engineering. Berlin: Springe pp. 357-366

Turner, R.E., Nancy, N.N., Justic, D and Dortch, Q. 2003. Future aquatic nutrient limitations. Mar pollute Bull 2003b, 46:1032-4

UNDP. 2006. State of the Environment Report for Liberia 2006, United Nations Development Programme: Monrovia, Liberia

Ustmul, Z. and Czekierda, D. 2005 Application of GIS for development of climatological air temperature maps: An example from Poland. Meteorology. Appli., 12, 43-50

Wel Van der, F. J. M. 2005. Spatial data infrastructure for meteorological and climate data. Meteorology. Appli., 12, 7-8.

Water Disputes between Punjab and Sindh: A Challenge to Pakistan

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Water disputes between Punjab and Sindh provinces in Pakistan pose a challenge to its existing federal–state relationship. Sindh alleges that Punjab, due to its domination over state's machinery, diverts the water resources at the cost of others. This dispute is not a new rather it exists since the irrigation system was developed in this region. The colonial rulers constructed canals to promote loyalty and secure their interests. The loyalists and soldiers were provided with land to produce cash crops in canal colonies. The partition of India in 1947 also partitioned the existing irrigation system. Since 1947 many futile attempts have been made to manage the water disputes between Punjab and Sindh. The reasons for it are not only the physical availability of the water resources but many more.

***Keywords**: Mughal Period, Irrigation System, Indus Water Treaty, Eighteenth Amendment Act, WAPDA, Indus Apportionment Act 1991*

Inter-provincial water disputes between Punjab and Sindh in Pakistan exists, since irrigation system developed in both regions. Both the provinces have agriculture-based economy, which is mainly dependent on the waters from river Indus. During colonial years, the British rulers used the hydrological structures to implement their policy of "divide and rule". Water from one region was diverted to the other to suppress the rise of nationalism during the struggle for independence against the British rule. After Pakistan was formed, as a result of partition of India in 1947, Punjab is being alleged for diverting water resources for its use at the cost of Sindh. The increasing burden on available resources is cited as a reason for this, but the power asymmetry between Punjab and Sindh too is an important factor for water disputes. In this paper, an attempt is being made to address following questions: Why water disputes between Punjab and Sindh still exist? Why the policies adopted by the federal government have failed to manage inter-provincial water disputes in Pakistan? What could be a probable solution to address water disputes between Punjab and Sindh? Excluding the introduction and conclusion, this paper is divided into three parts. In the first part, the physical and political reasons for the disputes are discussed. The history of development of irrigation system is the focus of the second part. The water disputes between Punjab and Sindh are then discussed in the third, and last, part.

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Why Water Disputes?

Water disputes among the provinces are a challenge to the federal government. They cannot be easily managed, and it is very difficult for states to take a side; yet the federal governments, across the world, are alleged for being bias toward one or the other units. In matured democracy, this biasness is based on the consideration of number of political representatives a province elects to the upper or lower house of a country or the weightage of the votes from the units. In non-democratic system, the reason for biasness is the support the leader draws from a unit, and the degree of authority people from an administrative unit has over the institutional machineries of the state. As Pakistan, over the decades, has witnessed both forms of governance, the administrative units have experienced favour or ignorance due to both circumstances.

Primarily, Pakistan's economy is based on agricultural activities, which contributes about 24 percent in its gross domestic product (GDP); about 48 percent of overall labour force is employed in this sector and; 70 percent of Pakistani exports depend on agricultural products (Ahmedani 2014). This has been possible because it has the largest contiguous irrigation system in the world, which provides the backbone to its agriculture-based economy (Ali 2009). This entire agriculture activity depends on two major river systems: rivers flowing into Arabian Sea and Endorheic river basin. The former comprises: Indus river basin, Lyari river, Hingol, Hub rivers, and later includes: Mashkal, Siastan basin, Indus plain, etc. Among all, it is river Indus which along with its tributaries forms Indus River System (IRS) , and is considered to be the "hydrological lifeline" of Pakistan. As river Indus flows across Pakistan, all provinces and federal administrative units want to use maximum quantity of its water for agriculture, industries, and domestic consumption. This leads to competition, tensions, and disputes among the provinces.

Inter-state and also intra-state disputes over shared rivers are very complex, where many reasons are tenuously intertwined. In Pakistan, main reasons for the inter-provincial water disputes are as follows.

Water stress: The term water stress was developed by Mallin Falkenmark, who also developed Water Stress Index (WSI) (Falkenmark 1990). According to WSI, Pakistan is already water stressed country and by 2020 it will fall in a category of countries with acute water shortage. The per capita availability of water in Pakistan was 5,210 m3 in 1951, which reduced to 1,100 m3 in 2006 (http://www.wapda.gov.pk). In 2010, it was 1,038 m3 and is being projected to be around 877 m3 by 2020 (Xinhua 2010, also see PIDLAT 2011). Some global warming projections have estimated a decrease in the water availability in the IRS to a staggering 40 percent by the middle of present century, which if it were to happen would threaten the very survival of a population already swollen beyond sustainability (Ali 2009).

Phenomenon of climate change: The dispute over water is not only due to water stress, but also because of release of more than the required water, and occurring

of non-required floods. The upper riparian states do so to maintain their own water interests. However, this regulation and release and withdrawal of water cause droughts and floods in lower riparian state. This damages the standing crops and also brings disaster to human lives. Change in weather pattern is causing non-seasonal precipitation and increase or decrease in monsoon rains. A few times the increase in spell of rainfall raises the water level, which positively helps in managing water distribution disputes, though only for a season. In 2014, due to increased spell of rainfall it was possible for Indus Rivers System Authority (IRSA) to supply additional water to Punjab and Sindh (Ahmedani 2014). This avoided clashes between them that season.

Punjabisation of Pakistan: Scholars such as Yunus Samad, Ian Talbot et al. use the term "Punjabisation of Pakistan" (Samad 2007) to discuss the domination of Punjab province over the Pakistani state machinery. Punjab has attained this status because of the key role it plays in Pakistan's history. It is home to Pakistan Army which has wielded power directly for two and half decades and indirectly for longer still (Talbot 2002). Politically, it is such a powerful province that any head of the state in Pakistan cannot even think of surviving without its support. During her first (1988–1990) ministry, Benazir Bhutto found to her cost that a national administration in Islamabad could be undermined by a hostile provincial government in Lahore (ibid). Any challenge to Punjab's authority in Pakistan by the others is punitive. The Sindhi Prime Minister Zulfikar Ali Bhutto was hanged by the Punjabi military rulers on April 4, 1979, but for the same level of "conspiracy" and allegations, in 1999 then Prime Minister Nawaz Sahrif, a Punjabi, was deported to other, country, by a Mohajir (migrant) Chief of Army Staff. Later on he returned from his exile in 2008 and become the Prime Minister of Pakistan in 2013. Economically, the province constitutes around 56 percent of population of Pakistan. The massive irrigation projects introduced by the British in the late 1880s ensured the West Punjab would be the bread basket of Pakistan, just as it had been of British India. With the help of Green Revolution technology, introduced in the 1960s, in 1976–1977 Punjab was producing 76 percent of country's output of major crops and 67 percent of the food grains output (ibid). Even today Punjab is bread basket of Pakistan and also industrially developed than other provinces. The Punjabisation of Pakistan leads to cropping up of a sense of marginalization among people from other provinces. In past and present, many secessionist movements have grown up in Pakistan, due to this phenomenon.

Democratisation deficit: For the first time in the history of Pakistan, there was a peaceful and democratic transfer of power in 2013. This is an achievement for Pakistan, but still it is under the shadow of its Army which has suddenly amassed power due to its role in global war against terrorism in Afghanistan and Pakistan. Because of its being a praetorian state, there is a deficit of democratic decentralization in Pakistan, which leads to feud among the provinces on the issue of water sharing. The civil society has failed to engage itself into a serious debate over it; as a result, politicians exploit parochial and regional sentiments over the water issues (Habib 2005). Owing to non-democratisation of politics and social

inequality in Pakistan, all of the state's resources are effectively placed at disposal of the landed elite. If the poor want to save themselves or access these resources, they could only do so through feudal in their district. The system in Pakistan, at the best times, is based on political patronage (Shah 2011).

Development of Irrigation System

Both Punjab and Sindh have a good network of river system, which had been exploited by the rulers to encourage agriculture in the region and increase their revenues out of such activity. Mainly, during the Mughal period (1526–1857), the canals were built in both provinces for irrigation of agricultural land. During this period in Punjab proper, a small system of canals was brought into existence in the Upper Bari Doab. The best known of these was the "Shahnahr", excavated in the reign of Shahjahan. It took off from the Ravi at Rajpur (or Shahpur) close to the hills and carried water up to Lahor (Lahore)—a distance of about 37 *kurohs*, or 84 miles (Habib 2014, 37). In Sindh, in 1628–1629, a local *zamindar* (landlord), Mir Abra, cut a canal from the Indus into the waterless country of Northern Sindh, enabling kharif crops to be raised in an area of 100,000 *jaribs* (*bighas*), besides the rabi crops. Then the long Begar Wah in Upper Sindh, its very name signifying a canal excavated with forced labour (*begar*), and the Nulakhi in Naushahro Division, are supposed to have been dug before the beginning of the sixteenth century (ibid 38).

The real development in irrigation system in both provinces began during the imperial rule. After the British annexation of two important "irrigation provinces"—Sindh in 1842 and Punjab in 1849—hundreds of inundation canals which had served the valleys of the Indus and its tributaries for millennia came now under the management of the Public Works Department (Whitcombe 1983). In Punjab, plans were first completed for irrigation of East Punjab, and later in the valley of the Sutlej and the Indus itself. Projects were constructed (and in part renovated from pre-British works) for a total capital cost of barely Rs 200,000 in the districts of Multan and Montgomery, respectively, between 1886 and 1888. Within 10 years of these first experiments, the pace of canal colonization was greatly accelerated by the construction of the Lower Chenab Canal at a capital cost of Rs 900,000, and the development of colonial settlement in its command area (already, by 1899–1900, close on 1 million acres) over the years 1892–1905 (ibid). The transformation of 6 million acres of desert into one of the richest agricultural regions in Asia was seen as stupendous engineering feat that was seen as colonial government biggest achievement (Talbot 2007). The farmers were encouraged to grow "cash crops" instead of food grains (Surinder 2004,365-387) which was a reason for intermittent famines and starvation deaths in India, including in water-rich areas.

The building of canals was also related to the political imperatives of state building in the Indus Basin region. For the British, as much as for earlier Indus Basin states, the link between canal building, agricultural settlement, and political control was central to the construction of state power (Gilmartin 1994). Sir Charles Aitchison maintained: "It is of greatest importance to secure for these tracts manly peasantry

capable of self-support and of loyal and law-abiding disposition" (Talbot 2007). Many retired Sikh soldiers who helped the British rulers to suppress the 1857 rebellion and win many wars outside India were settled in those canal colonies. Besides them, caste, community, or individuals, who were thought to be loyal to British rule were preferred settlers in canal colonies. In 1914, Michel O. Dwyer (Butcher of Amritsar) developed the scheme for grant of land in colonies to the "landed gentry". The holders were to provide natural leadership to the settlers. Seven and half percent of Lower Bari Doab colony were reserved in this way. The main beneficiaries of it were large land holders such as Noons and Tiwanas, who were loyalist military contractors to the Raj (ibid). This led to emergence of feudals in Punjab, who were dependent upon waters from Indus to enrich and support their lavish lifestyles (ibid).

Disputes over Shared River System

The dilemma of the irrigation system developed in Punjab and Sindh was that both are fed by a single river system, therefore the disputes over water had to occur. For the first time in 1901, the issue of water dispute between Punjab and Sindh came to the force, when the Indian Irrigation Commission prohibited Punjab from taking even a drop of water from Indus without the approval of Sindh (Memon 2002). This was mainly because of rising nationalism in Punjab which had its impact in canal colonies also. Then in 1919, the then government of British India released the Sir Arthur Cotton Committee report, wherein it prohibited Punjab from undertaking any projects until Sukkur barrage was completed and water needs of Sindh were determinedly fixed (ibid). In 1925, Lord Reading, then British Viceroy of India, rejected Punjab's request for Thal canal from Indus considering the undue deprivation of Sindh's lower riparian rights. In 1937, however, the Anderson Commission allowed Punjab to withdraw 775 cusecs of water on experimental basis from Indus for Thal canal (ibid). This happened even with the absence of Thal canal in the terms of the commission and clearly constituted a direct violation of the viceroy's orders of 1925. In 1939, Sindh lodged a formal complaint with the government, under the Government of India Act of 1935. Consequently, in 1941, the Rao Commission recommended construction of two new barrages in Sindh on Indus, and ordered Punjab to pay 20 million Rupees of the construction cost of these barrages to ameliorate Sindh's losses due to the actions of Punjab (ibid). Following the provisions of the Rao commission, a committee comprising of the chief engineers of Punjab and Sindh came out with an agreement in 1945, known as "Sindh–Punjab Agreement" to resolve disputes between them (ibid).

The partition of the irrigation system in 1947 affected Punjab more than the Sindh because the former's hydrological headworks were divided between two sovereign countries. Though Sir Cyril Radcliffe, while demarcating boundary between India and Pakistan tried to not disturb the irrigation system, determinants made him to do so at some places (Chester 2009). After losing its own water to India, Punjab targeted Indus to siphon off its waters in violation of the existing agreements

between Sindh and Punjab. Punjab constructed a link canal called as "Bambanwala–Ravi–Bedian (BRBD) link canal" without the consent and approval of Sindh in a clear violation of Sindh–Punjab Agreement of 1945 (Memon 2002).

Soon after partition, water disputes between two Punjabs also developed. To resolve it, the chief engineers of East Punjab (India) and West Punjab (Pakistan) signed a Standstill Agreement on December 20, 1947 providing, *inter alia*, that until the end of the current *rabi* crop, on March 31, 1948, the status quo would be maintained with regard to water allocation in the Indus Basin irrigation system. After the given date, the authorities in East Punjab refused the renewal of the agreement upon expiration and on April 1, 1948, halted the supply of water to several canals in Pakistani territory (Salman & Uprety, 2002). In this situation one option Pakistan had was to go for war and many advocated for it but the government avoided it. Finally both sides ready for dialogue. Following extensive discussions in an Inter-Dominion conference held in New Delhi on May 3-4 1948, a new agreement was signed (commonly called the Delhi Agreement) on May 4 1948. Under the terms of that Agreement, East and West Punjab recognized the necessity to resolve the issues in the spirit of goodwill and friendship. Without prejudice to its own rights, the government of East Punjab granted to West Punjab the assurance that it would not suddenly withhold the supply of water without providing sufficient time for West Punjab to develop alternate sources. This arrangement was continued until the Indus Water Treaty (IWT), mediated by the World Bank, was signed in 1960 between India and Pakistan (ibid). According to IWT, India has been allocated 20 percent of water from the IRS while Pakistan receives 80 percent. Pakistan got rights over rivers Indus, Jhelum, and Chenab plus Kabul barring some limited uses for India in Jammu and Kashmir. India got the entire waters from three smaller rivers (Ravi, Beas, and Sutlej), and some minor irrigation uses for Pakistan from four nullahs that join the river Ravi. India was also permitted to develop additional irrigation of 1.34 million acres in Jammu and Kashmir. Further India is allowed 3.60 million acre foot (MAF) of storage (0.4 MAF on Indus, 1.5 MAF on the Jhelum, and 1.7 MAF on the Chenab) (Verghese 2006). Sindhis complaints that Dr. Saleh Qureshi, a Sindhi, was initially made a member of the negotiating team but was promptly removed, when the One Unit system was imposed in Pakistan in 1955, before the serious negotiations began. This they believe was to give water leverage to Punjab province in the treaty. Moreover, according to the provisions of the IWT, Pakistan got funds from various donor countries including India and the World Bank to construct barrages, canals, etc., to utilize its share of water (Memon 2002).

To resolve the internal water disputes, in 1968, under the chairmanship of Akhtar Hussain, the Water Allocations and Rates Committee was constituted by the Governor of (then) West Pakistan. Its objective was: to review barrage water allocations, reservoir release patterns and drawdown levels, and use of ground water in relation to surface water deliveries. The committee submitted its report in July 1970, but no attention was paid on this report (Mansur 2002; PILDAT 2011). Again in 1970, Justice Fazl-e-Akbar committee was constituted to recommend apportionment of water of river Indus and its tributaries. This committee submitted its report in 1971. During the same period, ad hoc distribution from Chasma barrage and later Tarbela

reservoir storage among the provinces was ordered (ibid). No substantive decision was taken on the Fazl-e-Akbar committee recommendations and water continued to be distributed on ad hoc orders by the government of Pakistan. In 1977, the government of Pakistan established another commission comprising the chief justices of the High Courts of the Province, headed by the Chief Justice of Pakistan to examine the issue of water apportionment (ibid). Then, there was Justice Halim Commission set up to look into the matter (Feyyaz 2011). All these commissions and committees failed to find a permanent solution to address the water disputes between Punjab and Sindh.

After series of discussions and debates, in 1991 Prime Minister Nawaz Sharif led government forced the signing of the Indus Water Accord to resolve all Indus water-sharing-related disputes. This accord was signed on March 16, 1991 at Karachi, in a meeting of the chief ministers of Punjab, Sindh, Balochistan, and Khyber Pakhtunkhwa (then North West Frontier Province). It was ratified by the Council of Common Interests (CCIs) on March 21, 1991 (PILDAT 2011). Under this accord, the IRSA, with headquarters at Lahore, was established to monitor the distribution pattern among the provinces. According to the accord, the three online reservoirs at Tarbela, Mangla, and Chashma and inter-river link canals are the key structural facilities for Indus Basin water management. The allocation of reservoir water shared by provinces was centralized, using "suggested operation criteria" established on a 10-day basis (Qutub and Parajuli 2004). According to the formula to distribute water from IRS, total water available in the system was estimated to be 114.35 MAF below rim stations. It was allocated as 55.95 MAF for Punjab, 48.76 MAF for Sindh, 5.78 MAF for Khyber Pakhtunkhwa, and 3.87 MAF for Balochistan (Water Apportionment Act 1991). The accord provided for the distribution of any surpluses and the shortages as well. The agreement left water discharge to the sea unresolved subject to a study; however, it allocated 10 MAF in the interim for discharge to the sea (ibid).

Soon after the apportionment an accord was signed, however it marred into controversy in 1994 when Sindh alleged that Punjab was not releasing its agreed quantity of water. Sindh was also blamed for not releasing water to Balochistan (Mansur 2002). It was alleged that Punjab continues to violate even this one-sided agreement with open connivance of Water and Power Development Authority (WAPDA), IRSA, and the federal and Punjab governments. Sindh's share of water is being diverted to Punjab unabashed under one pretext or another (ibid).

After the 1994 incident, the Ministry of Water and Power and WAPDA reverted to allocations on the basis of historical use, rather than accord. IRSA was dissolved in 1998, after the then Prime Minister announced controversial plans to build the Kalabagh Dam on the Indus River over the objections of Khyber Pakhtunkhwa and Sindh. The IRSA was revived in 1999, but as an agency attached to the Federal Ministry of Water and Power, with headquarters in Islamabad. In effect, it has been reduced from an autonomous inter-provincial bargaining arena to an executive agency for short-term operational decision making (Qutub and Parajuli 2004).

During the droughts of 2001 and 2002, IRSA failed to generate consensus over water allocation. Demonstrations in Sindh induced the President/Chief Executive (CE) to override its decisions. Technically, the resolution of such conflicts is a matter

for the CCI, but since it was inactive, the CE dealt with the problem at the apex. Subsequently, provinces have directly approached the Secretariat of the CE, much to the apprehension of IRSA (ibid). Further demonstrating a declining trust in IRSA's ability to ensure that its decisions are implemented, the government of Sindh decided to send inspectors to upcountry reservoirs to check storage and diversions in person. Increasingly during 2002, critical decisions were taken in the CE secretariat in consultation with provincial governors. In 2003, the situation changed again with the transfer of executive responsibilities by the President to elected governments at the federal and provincial levels (ibid).

In July 2010, on the issue of opening up Chashma-Jhelum (CJ) Link Canal, Sindh and Punjab came against each other. Sindh wanted reversal of the decision and removal of Shahfaqt Masood (a Punjabi) as a chairman, while Punjab stated it would not compromise with its due share of water. Later on, the matter was resolved by an intervention by then Prime Minister Gilani. In a compromised arrangement Raqueeb Khan from Khyber Pakhtunkhwa was appointed as chairman of IRSA (Daily Times 2010). To divert its attention from Punjab centric allegation over water diversions, Pakistan alleges India for water shortages but this was denied by former foreign minister Shah Quereshi, who categorically maintained that Pakistan's mismanagement of water leads to wastage of 35 percent of its Indus water share and so it is responsible for its own water woes (The Nation 2010). This does not absolve the upper riparian from all allegations.

In 2010, eighteenth amendment was inserted into Pakistan's constitution. This amendment has tried to address the inter-provincial water disputes also. Under the 1973 constitution, CCI is prescribed to formulate and regulate policies for matters in Part II of the Federal Legislative List such as railways, mineral oil, natural gas, and the Water and Power Development Authority (WAPDA) (Constitution of Pakistan 1973). The Federal Ministry of Water and Power is responsible for water sector policy formulation. This ministry has set up an autonomous agency, the WAPDA, for the development of water resources, including main dams, barrages link canals, public tube wells, and drainage projects, across the country. However, WAPDA retains the management of the multi-purpose reservoirs on the Indus and its tributaries and operates them in consultation with the IRSA and Provincial Irrigation Departments according to the water rights and seasonal allocations to the provinces (Qutub and Parajuli 2004).

Eighteenth amendment has inserted the following provisions (Eighteenth Amendment to Pakistan's Constitution 2010):

> Article 157 (i) "Provided that the Federal Government, prior to taking a decision to construct or cause to be constructed hydro-electric power stations in any Province, shall consult the Provincial Government concerned and
>
> (3) In case of any dispute between the Federal Government and a Provincial government in respect of any matter under this Article, any of the said Governments may move the Council of Common Interests for resolution of dispute".

These amendments have also tried to strengthen, the weak structures of CCI, to resolve inter-provincial water conflicts in Pakistan. Despite these arrangements, water disputes between two provinces are still there.

Conclusion

This paper has discussed the continuity of water disputes between Punjab and Sindh, since British colonial times. Since then, one of the major reasons for dispute is over reliance on supply-side management of water resources. The situation is same, even today. It is being alleged that through multi-purpose projects, Punjab diverts water or choke off the spigots. There are about 19 barrages and 43 canal systems with 48 off-takes on the IRS in Pakistan, creating world's largest contiguous man-made system of 61,000 km of canals and 105,000 water courses, irrigating 35 million acres of land (Memon 2002). Three storage reservoirs are also built, at Mangla on River Jehlum, at Tarbella, and at Chashma on river Indus, with total storage capacity of 20 MAF. Additionally, 12 link canals are built to transfer water from western rivers to eastern rivers or to the tributaries of the River Indus (ibid). Such a large number of hydrological projects give little space to natural flow of river. This system was exposed during 2010 flood when barrages like Taunsa, constructed to meet such challenges, failed to stop it (Shah 2011). Even in 2014 when floods occurred in Indian and Pakistan side of Jammu and Kashmir, these structures failed to do so. Instead, they were reasons for 2014 floods. The stake holders have used these structures to divert water in their interests instead of providing a space to the rivers for free flow. The silts have never been cleaned from the canals because it may affect the close-by agricultural lands. As the soil fail to hold on water, even a slight rise of water level leads to flood. To meet this sort of challenge, the feudal control over the canals and decision over it have to be checked by the Pakistani state.

Most of the hydrological constructions are cause of disputes between Punjab and Sindh. Kalabagh, in Mianwali district of Punjab bordering Khyber-Pakhtunkhwa is one of the most controversial multi-purpose project in Pakistan. In March 2011, three provincial assemblies—Sindh, Khyber Pakhtunkhwa, and Balochistan—have passed a resolution against its commissioning (Daily Times 2011). Punjab wants not just Kalabagh, but also two more large dams on the Indus, at Bhasha and Skardu/ Katzarah. It feels that the Kalabagh site is the most favourable, compared with the other two, and that it should be built finally (Abbasi and Kazi 2000). The Lahore Chamber of Commerce and Industry has estimated that the dam would produce enough energy to obviate the need to import 20 million barrels of oil (Vaughn et al. 2010). Another controversial multi-purpose project, which has been resolved, in Pakistan was Diamer-Bhasha. Its construction was opposed by Sindh but in 2014, CCI cleared it after breaking the impasse over it. In addition to these projects in August 2000 the federal cabinet of Pakistan approved the Vision-2025 programme to develop its water infrastructure, which has to be implemented in three phases. Priority hydroelectric generations project in phase I includes: Jinnah, Malankhand-III, Allai

Khaman, Golen Gol, New Bong, Khan Khawar, Duber Khawar, and Pehur high level (Rizvi 2001). To meet these challenges, prior consultations with the stakeholders and those who are going to be affected by the upcoming projects would be helpful. The fates of many such partially completed projects are hanging in the air because the people of catchment areas are strongly against their commissioning.

Growing militancy in Pakistan is making the Army stronger than the civilian leadership. The democratization process suffers during the military control of the state apparatus. As a result, the decisions are being taken in an authoritarian way by excluding a mass or majority's interests. This also affects the water-related or water-infrastructure related decisions.

Finally, political relationship between the two important provinces has to be improved if water disputes have to be managed between them. The domination of Punjab has already created a lot of tensions in Pakistan. In 1971, Pakistan lost its eastern wing due to it, in Balochistan secessionist movement is going on due to domination of Punjabis over the resources, and in some parts of the country strong opposition against Punjab has been unequivocally demonstrated. The units need an equal treatment from the federal government instead of deep seated favouratism towards dominant province.

References

Abbasi, A.N.G. and Kazi, A.M., 2000. "Kalabagh Dam: Look Before You Leap." http://www.angelfire.com/az/Sindh/indus4.html

Ahmadani, Ahmad. 2014. "Punjab–Sindh to have Water Ceasefire This Year." *Daily Times*, March 23.

Ali, Imran. 2009. "Political Economy and Post-2000 Development in Pakistan." In *Pakistan in Regional and Global Politics*, ed. R. Jetly. London, New York and New Delhi: Taylor & Francis Group, 235-261.

Chester, Lucy P. 2009. *Borders and Conflicts in South Asia: The Radcliffe Boundary Committee and Partition of Punjab*. Manchaster: Manchester University Press.

Cohen, Stephen P., 2005 Idea of Pakistan, New Delhi, Oxford University Press.

Constitution of Pakistan. 1973. (Accessed at) http://www.mofa.gov.pk/Publications/constitution.pdf

Daily Times. 2010. July 14.

Daily Times. 2011. March 27.

Eighteenth Amendment to Constitution of Pakistan. 2010. (Accessed at) http://www.comparativeconstitutionsproject.org/files/pakistan_2010 pdf

Falkenmark, Mallin. 1990. "Global Water Issues Confronting Humanity." *Journal of Peace Research* 27 (2): 177-190.

Feyyaz, Muhammad. 2011. "Construction of Kalabagh." *PILDAT Paper*. (Accessed at) http://www.pildat.org/Publications/publication/Conflict_Management/ConstructionOfKalabaghDamBackgroundPaper.pdf

Gilmartin, David. 1994."Scientific Empire and Imperial Science: Colonialism and Irrigation Technology in the Indus Basin." *The Journal of Asian Studies* 53 (4): 1127-1149.

Habib, Irfan. 2014. *The Agrarian System of Mughal India 1556–1707*, Third Edition. New Delhi: Oxford University Press, 37

Habib, Zaigham. 2005. "Water: Issues and Politics in Pakistan." *South Asian Journal* April-June (8): 35-43.

Mansur, Hasan. 2002. *Sindh's Struggle for Control of the Indus*. Katmandu: Himal South Asian.

Memon, Altaf. 2002. "An Overview of the History and Impacts of the Water Issue in Pakistan." (Accessed at) http://www.world sindhi.com

Ministry of Water and Power. 1991. *Water Apportionment Act*. Islamabad: Government of Pakistan. (Accessed at) http://www.boell-Pakistan.org/water_apportionment_accord_1991.pdf

PILDAT. 2011. "Inter Provincial Water Issues in Pakistan." Accessed at http://www.pildat.org/publications/publication/WaterR/Inter-ProvincialWaterIssuesinPakistan-BackgroundPaper.pdf

Qutub, Ayub S. and Umesh Parajuli. 2004. "Water Conflicts in South Asia: Managing Water Resource Disputes Within and Between Countries of the Region." Project Implemented by Global Environment and Energy in the 21st Century (GEE-21) and the School of Advanced International Studies, Johns Hopkins University (SAIS). Accessed at http://www.WaterConflictsInSouthAsia2004[pdfa].PDF

Rizvi, Shamim Ahmad. 2001. "WAPDA-Vision 2025." Industry & Economy.

Salman, M.A. Salman and Kishor Uprety. 2002. *Conflicts and Cooperation on South Asia's International Rivers; A Legal Perspective*. Washington, DC: The World Bank

Samad, Yunus Pakistan. 2007. "From Minority Rights to Majoritarianism." In *Fault Lines of Nationhood*, eds. G. Pandey and Y. Samad. New Delhi: Roli Books Pvt. Ltd. p 67-138.

Shah, Muhammad Azeem Ali. 2011. "Lessons from the 2010 Floods in Pakistan." *Seminar* (626)

Subramanium, Nirupama "Measures for Gilgit-Baltistan Generates Suspicions" 2009 *The Hindu*, September 1.

Surinder Jodhka "Agrarian Structures and their Transformations". In Das, Veena (2004) *Handbook of Indian Sociology*, New Delhi : Oxford University Press.

Talbot, Ian. 2002. "The Punjabisation of Pakistan: Myth or Reality?" In *Pakistan: Nationalism Without Nation*, ed. J. Christopphe. New Delhi: Manohar Publication, 51-62.

Talbot, Ian. 2007. "Punjab Under Colonialism: Order and Transformation in British India." *Journal of Punjab Studies* 14 (1): 1-10.

The Nation. 2010. "Qureshi Pleading India's Case on Water Issue: JI." *The Nation*, May 2.

Vaughn, Bruce et al. 2010. "Security and Environment in Pakistan." Congressional Research Service." Accessed at http://www.fas.org/spg/crs/row.Acessed
Verghese, B.G. 2006. "From Indus I to Indus-II." *Journal of Peace Studies*, New Delhi 13 (1) (January–March): 9-20

Whitcombe, Elizabeth. 1983. "Irrigation and Railways." In *The Cambridge Economic History of India Volume 2: c. 1757–c.1970*, ed. D. Kumar. Cambridge, London, New York: Cambridge University Press, 677-761.

Xinhua. 2010. "Population Growth Will Reduce Water Availability." *Xinhua*, June 28.

Endnotes

[1] This system constitutes river Indus and its tributaries, which are transborder rivers flowing in India, Pakistan, and Afghanistan. It includes rivers: Jhelum, Indus, Ravi, Chenab, Sutlej, Kabul, and Beas. Out of it Jhelum, Indus and Chenab's water is being used by Pakistan. Sutlej, Ravi, and Beas's water is being used by India. Major portion of river Kabul lies in Afghanistan.

[2] In Pakistan there are four provinces Punjab, Sindh, Balochistan, and Khyber Pakhtunkhwa (earlier known as North-west Frontier Province). Then there is an

almost province-like unit, Gilgit-Baltiastan. It is almost province because according to Gilgit-Baltistan (Empowerment and Self-Governance) Order 2009, it will have a Governor as Pakistan has in the other four provinces. The leader of the legislative assembly will be known as chief minister; the assembly will have 33 members, of whom 24 are to be directly elected and; has power to legislate on 61 subjects. The territory will have its own Chief Election Commission and Public Service Commission. This arrangement is almost what provinces in Pakistan have, sans the formal constitutional status. (Subramanium, 2009). Then there are federally administered units like "Azad" Kashmir and Federally Administered Tribal Areas (FATA).

[3] Like many developing countries, Pakistan too has faced many secessionist movements. In 1971, it lost its Eastern part, where there were grievances against the ruling west Pakistani elites. In Balochistan, the movement is still going on. Sindhis too in past had raised this issue. G.M. Syed, a politician who once supported the Pakistan movement and the two nation-theory became a trap for Sindhis, instead of liberating Sindh, it fell under Punjabi-Mohajir domination and until his death in 1995 he called for a separate Sindhi "nation" implying a separate Sindhi country. (Cohen, 2005).

[4] Till 1947 both East and West Punjab, which are now in India and Pakistan, respectively, were a single unit. The area is also spelled as Panjab (meaning land of five rivers).

Integrated Flood Risk Management, Lessons from the Rhine and Danube for South Asia

Robert Brears[A]

The South Asia region is one of the most vulnerable regions to climate change flooding events leading to severe economic losses. With flood risks being transboundary, there is the potential for instability and state fragility to lead to migration and displacement, weak governance and overall geo-political instability in the South Asia region. Europe has experience in managing transboundary flood risks, having implemented the EU Flood Directive, which calls for transboundary actions to mitigate flood risks. Using existing platforms for cooperation, Europe can transfer knowledge on Integrated Flood Risk Management expertise from the Rhine and Danube to the South Asia region to ensure regional economic and political stability.

***Keywords**: private sector; water governance; privatization; regulation; incentives*

Introduction

South Asia is one of the most vulnerable regions to climate change flood events. According to the Asia Development Bank India, in addition to Bangladesh, Nepal, Sri Lanka, Bhutan, and the Maldives would lose around 1.8% of their gross domestic product by 2050 and almost 9% by 2100 from climate change disasters if the world follows a "business as usual" approach to climate change mitigation: no change in the use of fossil fuels in the global economy (ADB 2014). It is projected that with climate change extreme weather events, including flooding the losses will be even greater. India and the rest of the region is already susceptible to flooding events: in June 2013 alone, the North India floods claimed over 5,000 lives while 100,000 people required rescuing after villages and towns were destroyed from landslides and flooding (Flood List 2013). Over the past decade Europe has suffered from numerous flooding events leading to loss of life, displacement of people, and damage to infrastructure and property: between 1998 and 2009, Europe suffered over 213 major flooding events causing 1,126 deaths, the displacement of half a million people and at least EUR 52 billion in insured economic losses. With climate change, the frequency of flooding in Europe is set to double by 2050 resulting in average annual flood losses of around EUR 23 billion (The Independent 2014).

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[1] This research was conducted as part of a Visiting Fellowship to the Free University of Berlin's NFG, Asian Perceptions of the EU

During the next decade, tension and conflict over water is likely to become more frequent, endangering stability and security in many parts of the world, potentially having a direct impact on European interests as well as international peace and security. As Europe has a long tradition of cooperation and vast experience and knowledge of managing transboundary rivers, there is the potential for knowledge and expertise in flood risk management to be transferred to the South Asian region with the objective to promote collaboration, and encourage regional and international cooperation.

Integrated Flood Management

Traditionally, flood management focused on draining floodwater as quickly as possible or storing it temporarily, in addition to separating the river from populations through structural measures, such as dams and levees; all with not thought to the consequences of upstream and downstream flood risks. Specifically, actions to manage flooding consisted of local flood prevention schemes involving concrete and other engineered defences such as dams, dykes and weirs that had little regard for health of the surrounding catchment. However, engineered solutions can have negative effects on water quality and quantity as natural water flow is disrupted. In many regions of the world including Europe and South Asia, the biodiversity of freshwater has suffered due to major physical changes in the rivers, lakes, and wetlands from flood management practices including straightening of rivers, dredging of rivers, and construction of levees. Flood plains provide key ecosystem services including water retention and prevention of soil erosion. Intact floodplains play an important role in alleviating floods by storing water and releasing it slowly back into streams and rivers. Man-made flood defences can also increase the vulnerability of communities to other man-made or natural disasters such as earthquakes.

In Integrated Flood Management land and water resources in river basins are developed in order to maximize the efficient use of floodplains and to minimize loss of life and damage to property. Integrated Flood Management is also about working with nature and improving the ecosystem and its services such as restoring rivers natural ability to store and slow down floodwaters. This can be achieved through restoring natural features of river basins including flood plains and wetlands. For example, wetlands provide a buffer from flooding as they can store water in their soil or retain it as surface water slowing down the rate of flooding (European Commission 2011).

Integrated Flood Risk Management

Flood risk management requires the coordination of numerous activities including planning of development, land management, flood warning, community involvement, and physical structures to increase resilience of communities and reduce flood risk. Because actions in one part of a river can have consequences elsewhere, flood management is most effective when it is carried out in an integrated

and coordinated way throughout the river basin. In Integrated Flood Risk Management resilience is the capacity of individuals, communities, and societies to survive, adapt, and grow in the face of shocks. In the context of climate change, resilience is not only about reducing the risk of disaster but also about ensuring "failure" does not result in catastrophic consequences to life and infrastructure. Adaptive management is an important concept in building resilience (Royal Society 2014). According to the Intergovernmental Panel on Climate Change, adaptive management is a process of iteratively planning, implementing, and modifying strategies for managing natural resources in the face of uncertainty and change (IPCC 2014). Adaptive management involves adjusting approaches in response to observations of their effect and changes in the system brought on by resulting feedback effects. Resilience building is an ongoing process involving new use of information and evaluation of existing measures to regularly update resilience planning and decision making. In the context of managing climate change, extreme weather events, including flooding, adaptive management involves identifying and prioritizing the risks and opportunities associated with extreme weather, implementing measures to address them, establish monitoring arrangements and regularly assess the effectiveness of interventions, and evaluate the process and adjust measures as a result. However, full knowledge of the risks and consequences of extreme weather events are often partial and incomplete, for instance it is almost impossible to predict future flooding events with precision and accuracy. By recognizing this uncertainty, an adaptive management approach enables decisions to be made and actions to be taken in the absence of complete information. The result is policies that embed flexibility. Acting under uncertainty and accepting some risk of failure are frequently necessary in pursuing opportunities to increase resilience. With climate change the risk of inaction is the greatest risk (Royal Society 2014).

The Intergovernmental Panel on Climate Change defines risks as the potential for consequences where something of value is at stake and where the outcome is uncertain. Risk is often represented as a probability of a hazardous event occurring. A common way of estimating risk is to measure the exposure (presence of people, livelihoods, species or ecosystems, environmental functions, services, and resources, infrastructure or economic, social or cultural assets in places and settings that could be adversely affected) and vulnerability (propensity or predisposition to be adversely affected, including sensitivity or susceptibility to harm and lack of capacity to cope and adapt) of people, combined with the severity and likelihood of a hazard, where hazard is defined as a physical event that may cause loss of life, injury, or other health impacts as well as damage to property, infrastructure, livelihoods, service provision, ecosystems, and environmental services. As such, reducing risk (the combination of hazard, exposure, and vulnerability) is a core component of enhancing resilience. With a focus on flooding, flood risk is determined by the occurrence of flooding which may impact exposed populations and assets (e.g. houses located near flood plains) while vulnerability is the characteristic of the population or asset making it particularly susceptible to damaging effects e.g. fragility of housing constructing, poorly planned development, poverty, environmental degradation, and climate change (Royal Society 2014).

Integrated Flood Risk Management in Europe

The European Commission's Communication on '*The Post 2015 Hyogo Framework for Action: Managing Risks to achieve Resilience*' states that current policy responses are insufficient in effectively addressing existing risks of natural disasters including flooding as the effects of the changing climate and continued environmental degradation will lead to more intense and frequent flooding, and climate change is a threat multiplier for instability, conflict, and state fragility leading to migration and displacement, weak governance, and geo-political instability (European Commission 2014). Conflicts and fragility also further affect the vulnerability to disasters. Economies are globalised and increasingly structured around complex global supply chains which are vulnerable to flood risks: The 2011 Floods in Thailand lead to an economic shock that rippled out to economies and businesses on the other side of the world.

In Europe there is a long tradition of cooperation and vast experience and knowledge of managing transboundary rivers in a sustainable manner, necessary as 60% of the EU's territory lies in transboundary river basins. In 2000, the EU's Water Framework Directive (WFD) established a legal basis to protect and restore clean water across Europe and ensure its long-term, sustainable use. The WFD called for all Member States to establish River Basin Management Plans (RBMPs) by 2009 with the aim of achieving good status in river basins by 2015, or by 2027 at the latest. The WFD states that waters in the Community are under increasing pressure from the continuous growth in demand for sufficient quantities of good quality water for all purposes. To reduce this pressure, the WFD states that common principles are needed in order to coordinate Member States' efforts to improve the protection of Community waters in terms of quantity and quality, to promote sustainable water use, to contribute to the control of transboundary water problems, to protect aquatic ecosystems, and terrestrial ecosystems and wetlands directly depending on them, and to safeguard and develop the potential uses of Community waters. The purpose of the WFD is to establish a framework for the protection of inland surface waters, transitional waters, coastal waters, and groundwater which: prevents further deterioration and protects and enhances the status of aquatic ecosystems and, with regard to their water needs, terrestrial ecosystems and wetlands directly depending on the aquatic ecosystems; promotes sustainable water use based on a long-term protection of available water resources; ensures the progressive reduction of pollution of groundwater and prevents its further pollution; and contributes to mitigating the effects of floods as well as droughts (European Commission 2000).

In 2007, the EU Flood Directive entered into force requiring Member States to assess if all water courses and coast lines are at risk from flooding, to map the flood extent and humans and assets at risk in these areas and to take adequate and coordinated measures to reduce this flood risk. The aim of the Flood Directive is to reduce the adverse consequences to human health, economic activity, the environment, and cultural heritage associated with floods (European Commission

2007). The Flood Directive required that by 2011 each Member State of the EU had identified areas subject to potential significant flood risks, and has these flood hazard and flood risks mapped by 2013, from which Flood Risk Management Plans (FRMP) must be developed by the end of 2015, subject to review every six years afterwards.

While the Flood Directive provides Member States with the decision-making ability on the types of measures used in managing floods, the objective of the Directive is to promote cooperation in the development and implementation of transboundary FRMPs. This comes under the Flood Directive's principle of solidarity in that flood protection measures should not compromise the ability of other, upstream or downstream, regions or Member States to achieve the level of protection the regions/Member States themselves consider to be appropriate. Regarding the types of measures taken to protect lives and infrastructure from floods, the Flood Directive recommends that taking both structural and non-structural measures reduces the likelihood of flood and/or the impact of floods in a specific location.

Overall, enhancing the EU's resilience to natural hazards as well as its capacity to anticipate, prepare, and respond to risks, especially transboundary risks, is also one of the objectives of the Europe 2020 strategy: competitiveness and sustainability depend on effective disaster risk management which helps avoid losses and strengthens resilience to increasing global shocks and threats (European Commission 2014).

Case Study: Integrated Flood Risk Management in the Rhine River basin

In the Rhine River basin, one of the causes of increased flood threats is that more than 85% of the former natural flood plains of the Rhine have been cut off as a result of straightening, correction, and embankment. This development has been in tandem with rapid sealing of soil and soil compaction, which accelerates flood waves. At the same time, population density has increased with intensive land use in natural floodplains, increasing the vulnerability of people and infrastructure to flooding. However, it has not been possible to stop this development.

In 1998, the International Commission for the Protection of the Rhine (ICPR) implemented the Action Plan on Floods, which aims to protect humans and their assets against floods while improving the ecology of the Rhine and its flood plains (ICPR 2003). Specifically, the Action Plan aims to reduce flood damage risks to humans and infrastructure by 25% by 2020. In 2001, the ICPR adopted Rhine 2020, the Program on the Sustainable Development of the Rhine that seeks to improve the Rhine ecosystem. The Action Plan on Floods was incorporated into Rhine 2020 with one of the goals being the improvement of flood prevention and protection. Specifically, Rhine 2020 aims to reduce, in the lowlands of the Rhine, risks of flood damage by 25% by 2020 compared with 1995 and reduce, downstream of Baden-Baden, extreme flood peaks by up to 70 cm compared with 1995 levels. Regarding structural goals along the Rhine River and in the Rhine basin, the Rhine 2020 strategy aims to increase water retention facilities and maintain and strengthen dikes. Non-structural goals include increasing

water retention along the Rhine by reactivating inundation areas, improving the flood warning systems, while in the Rhine basin non-structural goals include increasing water retention in the basin by re-naturing streams, reactivating inundation areas, initiating afforestation projects, and reducing the amount of sealed surfaces (ICPR 2001).

Case Study: Integrated Flood Risk Management in the Danube River Basin

In the Danube River basin, it is projected from hydrological and climatic modeling that both the probability and the extent of extreme rain events during winter is expected to increase with climate change. To increase resilience to flooding, the International Commission for the Protection of the Danube River (ICPDR) in 2002, the Action Programme for Sustainable Flood Prevention in the Danube River Basin (Action Programme) with the overall goal of achieving a long-term, sustainable approach for managing the risks of floods to protect human life and property, while encouraging conservation and improvement of water-related ecosystems (ICPDR 2004).

The five main principles of the Action Programme are (1) a shift is required from defensive action against hazards to management of the risk and living with floods. In managing these risks, human interference in the processes of nature should be reversed, compensated for, and in the future prevented; (2) flood strategy should include the entire Danube basin area and promote the coordinated development, management, and conservation of water, land and related resources with the development of basin and sub-basin-wide flood action plans based on an integrated approach taking into account the Water Framework Directive; (3) joint action of government, municipalities, and stakeholders toward developing flood risk management strategies that involve timely and reliable flood risk warning and forecasting systems, ongoing training and raising public awareness about flooding, and the need to co-exist with these phenomena; (4) reduction of flood risks via restoring of river's natural wetlands and floodplains to alleviate flooding risks, structural measures (defence structures) to protect human health and safety and of goods and property mainly in urban areas, and reduction of hazards, for instance, human use of floodplains should be adapted to existing hazards and measures taken to reduce the risk of flooding; and (5) solidarity is essential in managing flood risks as one region should not pass on water management problems to another region.

Discussion

From the two case studies of the Rhine and Danube, there is a need to simultaneously reduce flooding risks to life and economic assets while restoring natural ecosystems. Specifically, flood managers can maintain and strengthen flood stop banks while increasing artificial water storage areas, while environmentally,

flood managers can restore waterways to natural conditions by reducing sealed surfaces which enhance the health of aquatic ecosystems, reactivate natural floodplains and restore these floodplains to natural conditions through afforestation projects with trees slowing down floodwaters and forests overall absorbing excess floodwater. In addition, solidarity is required in managing transboundary flood risks as negative actions from one region can adversely impact another region which in turn impacts regional stability.

The EU can contribute to other river basin management organisations, with the scientific and political aspects of the EU Flood Directive and best practices of integrated flood risk management to ensure flood risks in South Asia are managed in a transboundary, integrated manner. Scientifically, the Flood Directive emphasizes the need to assess all waterways for flood risks and map the extent that human life and economic assets are exposed to flood risks. Politically, the Flood Directive ensures cooperation on managing flood risks by requiring the implementation of transboundary flood risk management plans. The benefits of exporting this model to the region is to reduce loss of life and economic output from flood risks, ensure natural ecosystems remain healthy and increase the resilience of the populations to flood risks which overall reduces geo-political instability in the region. In addition, Europe can export this model to the wider Asia-Pacific region to promote cooperative rule-based regional integration (ASEM 2014). The EU can promote and support the scientific and political aspects of the integrated flood risk model to the South Asia region on several levels: at the EU to South Asia State level, through regional-to-regional dialogues or between EU Member States and South Asia States.

The benefits of adapting the application of European transboundary integrated flood risk management models to the South Asia region are that politically, integrated flood risk management plans reduce instability from floods at both the intra- and inter-state levels as the majority of the region's river basins cross political boundaries. At the intra-state level, conflict from one political administration creating enhanced flood risks to downstream areas is reduced. At the inter-state level, integrated flood risk management plans reduce the potential for tension and even conflict over flooding risks between nation states that share transboundary water resources. In particular, integrated flood risk management plans promote cooperation in managing flood risks which in turn avoid upstream states releasing floodwater suddenly, impacting hydropower, agricultural, or industrial infrastructure or upstream states failing to provide early warning to downstream states of predicted flood events, etc. However, there are political costs of implementing the European integrated flood risk management model in South Asia. For instance, many underprivileged people would be under risk of being displaced from floodplains to make way for afforestation projects. With property rights not being as strong in South Asia as they are in Europe, and the region having numerous ethnic minorities, this kind of situation like displacement of people could lead to ethnic tensions and even conflict.

There are many potential economic and social benefits of adapting the European integrated flood risk management model to the South Asia region. Economically, water is a vital resource in the production of economic goods and services. In South Asia,

many industrial sectors, including the food, pharmaceutical, and textile manufacturers, rely on large volumes of water for production of food, medicines and clothing, and therefore are exposed to the risk of floods which damage critical infrastructure and contain excessive amounts of chemicals and sediments making water unsuitable for industrial use. As such, floods have the ability to impact revenue generation of businesses. At the aggregate level, floods can impact exports of goods and services, which in turn affect overall employment and income levels. Meanwhile, water is essential in the production of energy and floods can damage energy infrastructure further reducing economic output. Therefore, the implementation of integrated flood risk management models that incorporate both structural and non-structural means enhances the resilience of economies in the region to flood risks. However, it is very costly, financially to implement integrated flood risk management plans as it involves mapping and analysing of areas at risk of flooding, high-maintenance costs of developing structural measures such as dikes, high costs of restoring waterways, and floodplains to their natural states and compensation costs of relocating people away from areas of high flood risks. With the region developing, the national governments are likely to continue to seek support in implementing these projects.

Conclusions

The South Asia region is one of the most vulnerable regions to climate change flood events. According to the Asia Development Bank, India along with Bangladesh, Nepal, Sri Lanka, Bhutan, and the Maldives would lose almost 10% of its gross domestic product by 2100 if no action is taken on climate change. This could endanger stability and security in the region, potentially having a direct impact on European interests as well as international peace and security. To reduce the vulnerability of people, infrastructure and economies in the region from flooding risks European best practices in integrated flood risk management can be implemented. From the two case studies of the Rhine and Danube, there is a need to simultaneously reduce flooding risks to life and economic assets while restoring natural ecosystems. In addition, solidarity is required in managing transboundary flood risks as negative actions from one region can adversely impact another region which in turn impacts regional stability.

Bibliography

ADB. 2014. "Assessing the Costs of Climate Change and Adaptation in South Asia." http://www.adb.org/publications/assessing-costs-climate-change-and-adaptation-south-asia

ASEM. 2014. "3rd ASEM Sustainable Development Dialogue: Water Management—Fostering Prosperity and Stability Through Interregional Cooperation." http://www.

aseminfoboard.org/events/3rd-asem-sustainable-development-dialogue-water-management-%E2%80%93-fostering-prosperity-and

European Commission. 2000 "The EU Water Framework Directive." http://www.ec.europa.eu/environment/water/water-framework/index_en.html

European Commission. 2007. "The EU Flood Directive." http://www.ec.europa.eu/environment/water/flood_risk/

European Commission. 2011. "Towards Better Environmental Options for Flood Risk Management." http://www.ec.europa.eu/environment/water/flood_risk/better_options.htm

European Commission. 2014. "Communication on The Post 2015 Hyogo Framework for Action: Managing Risks to Achieve Resilience." http://www.ipex.eu/IPEXL-WEB/dossier/document/COM20140216.do

Flood List. 2013. "June 2013 Flood Summary." http://www.floodlist.com/summary/june-2013-floods

ICPDR. 2004. "Flood Action Programme." http://www.icpdr.org/main/activities-projects/flood-action-plans

ICPR. 2001. "Rhine 2020—Programme on the Sustainable Development of the Rhine." http://www.iksr.org/index.php?id=164&L=3&ignoreMobile=1%3Ftx_ttnews%5Btt_id%3D2%96Rnews%5D%3D865

ICPR. 2003. "Upstream Outcome of the Rhine Action Programme." http://www.kvvm.hu/szakmai/budapestinitiative/docs/marc_braun.pdf

IPCC. 2014. "IPCC WGII AR5 Glossary." https://www.ipcc.ch/pdf/assessment-report/ar5/wg2/drafts/fd/WGIIAR5-Glossary_FGD.pdf

Royal Society. 2014. "Resilience to Extreme Weather." https://www.royalsociety.org/policy/projects/resilience-extreme-weather/

The Independent. 2014. "Frequency of Severe Flooding across Europe to Double by 2050." http://www.independent.co.uk/environment/climate-change/frequency-of-severe-flooding-across-europe-to-double-by-2050-9163852.html

Water Industry (Law) Reforms: The Adoption of Australian Drinking Water Guidelines in Western Australia — From Targets to Aspirations

Neil Coles[A1]

The past two decades have overseen a dramatic shift in the way Australians view water resources, their value, and the way in which it is allocated and managed. Water law and regulatory reforms within government and industry at National and State levels have resulted in unprecedented changes in the way governments, councils, and corporate bodies are structured to manage it. Although Western Australia has been at the forefront of the planning and regulatory reforms required to manage two decades of declining rainfall and expanding population, much of the reform is driven by the National agenda. Modifications in water policy, water industry re-structure, and water supply and drinking water quality guidelines were introduced with this reform agenda. This paper evaluates the changes in the water industry, and in the way in which water resources are managed and water is licensed and regulated to deliver quality drinking water through the framework of the Australian Drinking Water Guidelines in Western Australia.

***Keywords**: water resources, water law, regulatory reform, licensing, governance*

1 - Introduction

Water resources in Australia, their long-term security, and sustainability have taken increasing importance over the last two decades as climate change has impacted on the durability, delivery, and quality (Khan and Hanjra 2008). Climate has always been a determining factor in Australian water management and planning, and impacts significantly on water allocation for human, industry and environmental uses. Drinking water, its availability and quality, is inextricably linked with these issues and generates significant political debate in Australia at State and National levels. As climatic shifts increased pressures on the availability of water with

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[1] See final page of this article for a key of Abbreviations and Acronyms.

the decade long drought (1999–2009) in 60% of the country, and covering 90% of the population, the Commonwealth and the State Governments would need to become increasingly more proactive. None more so than Western Australia (WA) that has experienced declining rainfall and stream flows into its water supply dams, since 1975 (Department of Water (DoW 2012).

In Australia, water essentially belongs to the Crown, and is invested in the relevant minister in each state or territory (AECOM 2010). Ultimately, therefore the government is responsible for delivering water, the essential ingredient to *life* and *health* (United Nations Committee on Economic 2002) to its people. The Commonwealth of Australian Governments (COAG) reforms were agreed to by all states, territories and the Australian Government in 1994 (COAG 1994) were significant reforms that provided for the separation of land and water title rights, enhancing the State Government's ability to not only manage water as a separate issue, but also as a tradeable commodity. This change is significant in that prior to its introduction the value of the water and access to it was regarded as a "right" that was inextricably linked with the property rights (or in most cases Riparian Rights[1]), with the ability to allocate and trade water previously governed under common law (Fisher 2000). The amount of water that may be taken or used under this process is not precisely measurable (Gardner, Bartlett, and Gray 2009) and that trade and transport from riparian lands is restricted.

The introduction of the COAG reform framework through the National Competition Policy (NCP)[2] resulted in radical restructuring of the water industry in WA, particularly in the areas of water resource allocation, licensing, protection and planning. The Water Reform Framework allowed for significant changes to occur: firstly, the creation of the Water and Rivers Commission (WRC)[3] in 1996, under the WRC Act[4] to establish a Commission with functions relating to water resources, including functions under various written laws, and for connected purpose, clear powers to manage water resources and the environment; secondly, the drafting of express statuary provisions in regard to water resource planning and protection; and

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[1] There is a significant volume of literature devoted to the discussion and doctrines of riparian rights. See mention in Gardner, Bartlett, and Gray (2009, 29). In the main the rights are vested in the access to water, and regarded as incident to owning the riparian land, viewed as a 'natural right' accruing to the landholder. Gardner, A.W., Bartlett, R.H. and Gray, J. 2009. *Water Resources Law* (Chatswood, NSW: LexisNexis Butterworths, 2009).

[2] National Competition Policy refers to a set of policies introduced in Australia in the 1990s with the aim of promoting microeconomic reform. The reforms (based on the Hilmer report) were also used as the basis for the Competition Principles Agreement reached at the 1995 meeting of the COAG. The term 'Hilmer reforms' is now used to refer to processes arising from the inter-governmental Competition Principles Agreement and the associated Competition Policy Reform Act 1995 (Cwlth).

[3] The WRC was later to become the DoW in 2006, under the Water Resources Legislation Amendment Bill 2005.

[4] The WRC was created under the Water and Rivers Commission Act 1995, with 'the Act' being repealed by the *Water Resources Legislation Amendment Act 2007* s.189 (No. 38 of 2007) as at February 1, 2008 (see s.2(2) and *Gazette* January 31, 2008, 251).

thirdly, the introduction of water licences and 'water entitlements' that may be traded separately from rights to the land.

These actions also paved the way to enable the adoption and implementation of the Australian Drinking Water Guideline (ADWG) which to date had largely been implemented as an *ad hoc* approach, since their introduction in 1972 (National Health and Medical Research Council (NHMRC) and Natural Resource Management Ministerial Council (NRMMC), 2003), with different states implementing the recommendations at various stages in their government and regulatory cycles. However the reforms, when combined with a shift or severe decline in rainfall (*i.e.*, *The Millennium Drought*[5] *that occurred in the eastern states and the significant climate shifts in WA*); the drought although catastrophic in many areas, did provide significant motivation and thus opportunities for extensive cooperation in the two decades since the 1994 agreements were signed, and for subsequent legislative and regulatory reforms to be iteratively introduced by successive National and State Governments.

The final areas in drought in Eastern Australia ceasing to be eligible for assistance in early May 2012, and the official end of the drought declared in late in 2012, during this period (1995–2012) the federal government and state governments provided more than $4.5 billion in drought assistance[6]. Thus, providing an indicator of the economic costs (in assistance dollar terms along) without accounting for the forgone production cost, industry rehabilitation or environmental degradation. In response, it is noteworthy that at least five major cities in Australia have now been equipped with desalination capabilities as a hedge against future droughts[7]. A significant capital investment with costs estimated in the region of $10.2 billion (Productivity and Commission 2011) with additional capacity planned for regional centres and larger mining operations.

The addition of desalination operations has to some extent reduced the pressure on rainfall-based supplies (i.e., dams) to the point where in the case of Perth the urban water supplies are now termed as climate independent, using only groundwater and desalination, with only opportunistic use of the existing large storage dams. Thus, providing for greater quality control of water delivered to the consumers.

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[5] The Millennium Drought is defined as covering the period between 1995 and 2009 affecting most of eastern Australia and resulting widespread damage to industry, environment, and significant impairment of existing water sources. The drought contributed to widespread stock losses, dust storms and bushfires. Heberger, M. 2011. Australia's Millennium Drought: Impacts and Responses. In Gleick, P. (Ed.). *The World's Water.* . (Center For Resource Economics, Island Press, 2011).

[6] "Minister Declares End of Drought," *The Age* (*Melbourne*).

[7] There are large desalination plants linked to capital city water supplies that are currently delivering ~1212 ML/d with a further 455 ML/d planned, http://www.en.wikipedia.org/wiki/Seawater_desalination_in_Australia (accessed January 2015).

[8] The Greens Party was founded in Australia four decades ago, based on economic suitability, participatory democracy and social justice. They have increased their role in local and national politics to the point where they are currently (2012) considered as the third force in Australian Politics.

2 - Background

In the early 1990's, given pressure from political (The Greens[8]), population, industry and environmental concerns, the then labour government imitated shifts in Australian national policies in favour of improved environmental and water management. The requirement to deliver recognisable improvements in environmental health, natural resource management, and sustainable industries was lodged firmly in the political landscape. This initiative was preceded by the launch of the Decade of Landcare policy (1989[9]) in Wentworth (NSW) by the then Prime Minister Bob Hawke, as a motivating force to tackle land degradation, using a process that relies heavily on local community groups, within a framework that recognised the responsibilities of the Commonwealth, state and local governments (DAFF 1995).

This new-found enthusiasm for the environment found its way into water resources through the Council of Australian Governments (CoAG) through the introduction of the Inter-Governmental Agreement on the Environment (1992)[10], and the subsequent Strategy for Ecologically Sustainable Development (1992)[11]. The strategy provides broad strategic directions and frameworks for governments to direct policy and decision making, and that was expected to facilitate a coordinated approach to ecologically sustainable development which encourages long-term benefits for Australia over short-term gains[12].

These agreements were followed by initiatives in subsequent years that focused more closely on water and its role in Australian society and its importance to environmental sustainability and industry development. However, the management of water, its regulation and governance becomes a complex task given that there are some 800 agencies across Australia involved in this process in elements of source, supply, consumption, and disposal of water, at the federal, state, regional and local levels (AECOM 2010). To counter this level of complexity and lack of sophistication, the Commonwealth Government, although not having a direct regulatory role in the water industry, acting through the Council of Australian Governments (COAG 1994) initiated and passed strategic legislation and water law reform initiatives.

The 1994 COAG reforms, formalised later under the Inter-governmental Agreement on a National Water Initiative (NWI) 2004[13], were targeted at improving

[9] Decade of Landcare-speech delivered by Prime Minister Bob Hawke at the launch of the Statement on the Environment, Wentworth, July 20, 1989, http://www.bobhawkelandcareaward.com.au/bob-hawke-speech.pdf

[10] Inter-Governmental Agreement on the Environment, 1992, http://www.environment.gov.au/about/esd/publications/igae/index.html

[11] National Strategy for Ecologically Sustainable Development, 1992, http://www.environment.gov.au/about/esd/publications/strategy/index.html

[12] Ibid 1992.

[13] The National Water Commission was created under the *NWC Act 2004 (Cth)* and came into force on December 17, 2004.

the economic efficiency of Australia's water management, while also protecting the water resources and the environment. The initiative builds on the achievements of the 1994 Strategic Framework for the Reform of the Australian Water Industry, the Natural Heritage Trust, and the National Action Plan for Salinity and Water Quality (Shultz, Parker and Bleaker 2004). The National Water Commission (NWC)[14] was then formed to review the progress of the NWI and complete a biennial report on progress. However, prior to 2004 the COAG reforms the only mechanism to manage and implement these reforms was through the National Competition Council (NCC) which audited the performance of the states and their compliance with the NCP reforms[6].

As part of the water reform process, the eastern states and the Federal Government agreed in 2003 (Shultz, Parker, and Bleaker 2004) to undertake the reforms in the Murray Daring Basin (MDB), the Federal Government agreed to provide (with the states) $500 million to restore environmental flows to the MDB, and proposed to give irrigators greater certainty in their rights to water entitlements and to create a market in which those rights could potentially be traded. Under the initiative, the Commonwealth contributed $200M, NSW and Victoria provided $115M each, with SA and ACT contributing $65M and $5M, respectively (Shultz, Parker, and Bleaker 2004).

The initiative included the following statements aimed at providing an approach to improving water resource management and allocation by:

- improving the security of water rights—giving them effectively the same legal status as property rights—by creating a nationally compatible system of water entitlements providing perpetual access to a share of water resources available to irrigators (as opposed to a fixed volume);
- ensuring water is put to best use by creating, and encouraging trading in, a water market encompassing the entirety of the MDB that allows participants to trade water rights both intrastate and interstate;
- restoring over-allocated river systems to environmentally sustainable levels; and
- encouraging water conservation in our cities, including better use of storm water and recycled water (Shultz, Parker, and Bleaker 2004).

As a follow up to the 2004 initiatives on water resource management, in April 2008, the Commonwealth Government established the Water for the Future program in response to the challenge of securing a sustainable water future for Australia. The program's key priorities were:

[14] The National Water Commission was later slated for decommissioning by the Abbott lead Australian Government under the *NWC (Abolition) Bill 2014*.

- taking action on climate change,
- using water wisely,
- securing water supplies,
- supporting healthy rivers (Waterra 2015).

Through this process the Commonwealth Government was also able to provide avenues for funding and support to address the water skills shortage and improving the knowledge of water industry members across Australia, which extend beyond operations and into cross-discipline problem solving, such as integrated water resources management (IWRM).

Australian Drinking Water Guidelines

To support the government initiatives in water reform, the Commonwealth Government turned to the National Health and Medical Research Council (NHMRC) as the source for other key drinking water-related requirements or best practice. These were driven through extensive revision of the ADWGs through the adoption of a water management framework linked to water quality health and safety outcomes. Thereby the AWDGs have become the primary reference on drinking water quality in Australia (NHMRC and NRMMC 2004).

The NHMRC has, since the introduction of the AWDG in 1972, developed guidance and recommended standards on water quality for the Australian water industry (NHMRC and NRMMC 2003). Thus, ensuring that the health of all Australians is not threatened by poor quality drinking water. The strategic intent of the NHMRC is to provide leadership and work with other relevant organisations to improve the health of all Australians by:

- fostering and supporting a high-quality and internationally recognised research base;
- providing evidence-based advice;
- applying research evidence to health issues, thus translating research into better health practice and outcomes; and
- promoting informed debate on health and medical research, health ethics, and related issues (NHMRC and NRMMC 2004).

The Guidelines are developed within the auspices of these key goals, and while not mandatory standards, they provide the basis for determining the quality of water to be supplied to all Australian consumers. In the main, they are invoked by State Governments, the Australian Water Industry, and water management agencies as the authoritative reference on what defines safe, good quality water, how it can be achieved, and how it can be assured (Waterra 2015).

Although the ADWG are developed by the NHMRC, they consult with the NRMMC, and seek to link to aspects of the National Water Quality Management Strategy (NWQMS). The aim of the NWQMS is to achieve sustainable use of the nation's

water resources by protecting and enhancing their quality while maintaining economic and social development (Waterra 2015). The NWQMS consists of three main elements: policies, process, and guidelines that act as support mechanisms for change. Within this enabling framework, the administering and implementation of the revised ADWG can be undertaken provided the appropriate legislative, policy, and licencing reforms in regard to water management and delivery are implemented by each state.

3 - Targets versus aspirations to ensure drinking water quality

A major revision of the ADWGs occurred during December 2004 with, through broad community and industry consultation, a Framework for Management of Drinking Water Quality ('The Framework') was incorporated so as to promote a preventive, risk management approach to water delivery. Working from the premise stated in the original guidelines released in 1972, that is:

> "Water intended primarily for human consumption, either directly, as supplied from the tap, or indirectly, in beverages or foods prepared with water. It should contain no harmful concentrations of chemicals or pathogenic microorganisms, and ideally it should be aesthetically pleasing in regard to appearance, taste and odour." (NHMRC and NRMMC 2003)

The NHMRC has continued to work toward a process in which all those involved in the water industry (including governments and suppliers) to continuously improve their management strategies, water quality, and risk of failure. To this end, the 2004 release of the ADWG signalled a major shift in water management in Australia. The AWDG (NHMRC and NRMMC. 2004) contains a new component, a framework designed to guide the design of a structured and systematic approach to the management of drinking water quality from catchment to consumer, to assure its safety and reliability (Waterra 2015). This shift in the approach taken to water supply assessment and management, with a greater emphasis placed on the effective protection of the water source or catchment to act as a barrier to assist in water quality protection; and preventative risk management systems, included in the Guidelines, to ease the transformation from current practices.

The framework incorporates a preventative risk management approach by including elements of Hazard Analysis Critical Control Point (HACCP), ISO 9001 and AS/NZS 4360[15], but applies them in a drinking water supply context to support consistent and comprehensive implementation by the water industry. The framework is comprised of four major components, that cover 12 elements of the framework, and although listed as discrete components, all the elements are interrelated and each supports the

[15] HACCP is an internationally recognised method of identifying and managing risk adopted under the ISO framework in both Australia and New Zealand.

effectiveness of others. The second of the major components to the framework—system analysis and management relates to the risk management process. It contains the following elements:

- Element 2—Assessment of the drinking water supply system.
- Element 3—Preventative measures for drinking water quality management.
- Element 4—Operational procedures and process control.
- Element 5—Verification of drinking water quality.
- Element 6—Management of incidents and emergencies.

Although being built on HACCP, the framework approach aims to be a fully comprehensive management system, unlike HACCP which was designed to integrate into existing management practices (good manufacturing practices and quality management systems, termed "HACCP Supporting Programs"), thus limiting its scope (Deere et al. 2008). The framework integrates additional (and yet important) factors of commitment, stakeholder involvement, emergency response, employee training, community consultation, and research and development. In that sense both the frameworks (and incidentally the Water Safety Plans) are the equivalent of the Food Safety Plans required for food suppliers which must consist of both HACCP and the Supporting Programs.

Additionally, the revised guidelines moved away from a specific targets approach to water quality, and while maintaining existing standards, recognised that some targets (i.e., zero failures) may be difficult to achieve by the different and varied water suppliers throughout Australia, it provided the framework to enable management system to be adaptive, wherein targets are viewed as an aspiration goals to be iteratively achieved over time. This is another significant shift in that the target values (related to some elements of the framework) are not viewed as hard and fast, but are presented so as to encourage and incentivise the water industry to aspire to deliver on these goals, and could be modified in relation scale, location, source, and cost of supply.

While water management organisations have long recognised the importance of a multiple barrier, risk management approach to protecting drinking water quality from contaminants (Deere et al. 2008), the introduction of the Water Quality Framework for water management set out guidelines, targets, and aspirational goals. The inclusion of the framework as a part of the AWDG, and spurred on by the National Water Reform agenda, resulted in additional efforts to reorganize and manage the delivery of drinking water in WA since 2004.

4 - Water 'Law' Reforms in Western Australia

The water reforms of note in WA over the last 20 years began after the signing of the COAG Agreements in 1994. The creation of entities to manage water supplies and water sources from the existing public utilities (e.g., Public Works Department (PWD), Water Boards[16]) enabled the formation of the Water Corporation to manage urban water supplies and the WRC to manage the state's water resources

were initiated under the Water Corporation Act 1995, and the WRC Act 1995. The WRC was responsible for the management of WA's water resources (Glindemann and Chung 2006). In particular, the Commission's role was to balance the objective of ensuring sustainable water use for current and future users, with the goal of protecting water sources and their dependent ecosystems[17].

These two Acts thus enabled the reforms in water management to be implemented as part of COAG agreements in 1994 with water reforms continuing at a pace over the next decade. This included the development of the Water Source Protection Plans for WA, revised estimates for water sources, in particular Perth's surface and groundwater supplies which were beginning to experience stress from two major drivers: firstly, an expanding population in Perth and the south-west regions and secondly, a significant decline in annual rainfall due to climate change. The Water Services Licensing Act 1995 was also introduced to separate the licensing role from the water provider, with responsibility given to the Minister, and the oversight initially provided by the Economic Regulatory Authority (ERA) with the operational components administered by the WRC.

As the State grappled with its own reform agenda, the Federal Government was pushed ahead with its own reforms, driven largely in part by the continuing drought being experienced in the eastern states of Australia, and the MDB in particular. Thus impacting Australia's major food bowl, export earnings (Heberger 2011), and more directly and perhaps more importantly, on water availability for the six million people within the basin and the major urban centres that draw its water from the river system, as well as the river ecosystems themselves[18]. The national reforms continued with the COAG agreements in 2004 and the creation of the NWC[19], with oversight of the NWI and further supporting the states to complete their obligations under these initiatives. However, the states did not always agree on the nature of the reforms or the compensation offered by the Commonwealth.

In a prelude to later reforms, the WA Government commissioned wide-ranging review of water use and irrigation practices in the state in 2003 (IRSC 2005), and the Water Reform Implementation Committee (WRIC) was established in response; this effectively formed the basis of a new water reform agenda in WA (Glindemann 2006). The WRIC set out a blueprint for the states progressive changes to water management and reform over the next decade including:

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[16] The previous responsibility for managing water was delegated to the Water Board and later the PWD under the *Water Boards Act 1904*.

[17] Since 2003, the Commission's ecosystem responsibilities have been carried out by the Department of Environment, but these were never formally merged with the Department, as the Commission was later to be abolished and replaced with the Department of Water in 2006.

[18] Strudwick, S. (2008). Australia's True Catastrophe Happening Now. March 2008, http://www.murray-river.com.au/petition/drought-tour/ (accessed January 2012).

[19] National Water Commission Act 2004 (Cth) and came into force on December 17, 2004.

- changing the water entitlement system,
- facilitating water trading,
- implementing water metering through a series of reforms,
- recovering water resource management costs,
- land and water planning for the longer-term protection of agricultural land,
- increasing self-management of water resources,
- investment in water use efficiency.

The WRIC noted with the release of the blueprint that additional information and extensive public consultant was required in several areas before it can advise the government. In 2006, with the WRIC recommendations in hand, the political momentum shifted again, with WA Government introducing two new pieces of legislation into the Western Australian parliament, a revision of the Water Services Licensing Act 2005[20] and the Water Resources Legislation Amendment Bill 2005 (the Bill)[21]. The Bill constituted the initial response with the establishment of a new DoW on January 1, 2006, following on from the signing of the NWI on April 6, 2006 and resulted in the abolition of the WRC.

The Bill assigns responsibility to the minister (for Water Resources) for administering the Water Corporation Act 1995, under this arrangement the minister is directly accountable for, approving the Water Corporation's strategic development plan and the Water Corporation's statement of corporate intent; and for making nominations to the board of the Water Corporation. This modification then ensured that the objectives of the Water Corporation are consistent with the Government's agenda on the management of the State's water resources. The Bill gave the Minister responsible for water functions and powers that were previously conferred on the WRC in relation to the management of water resources under the Water Agencies (Powers) Act 1984[22]. Many of the administrative functions of the WRC were thus transferred to the Chief Executive Officer of the DoW (Glindemann and Chung 2006). The reforms instituted as part of the Bill inserted new ministerial powers into the Water Agencies (Powers) Act[23] to enable the Minister to initiate and direct actions into conserving, protecting and managing water resources (Glindemann and Chung 2006).

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[20] The *Water Services Licensing Act 2005* provides the regulatory framework for the water services industry including the licensing of water service providers (potable, non-potable, sewerage, irrigation or drainage) by the ERA.

[21] The Bill is the first step in the WA Government's plan to consolidate 14 water resources acts (including some very old pieces of legislation) into one streamlined Water Act, to be administered primarily by the new DoW.

[22] The Water Agencies (Powers) Act 1984 was amended by the Water Resources Legislation Amendment Act 2007 to enable the changes required to create the requisite ministerial powers, councils and oversight.

[23] Powers granted under amendments made to the Water Agencies (Powers) Act (see Pt. 2, D1, s9 (1-4)) under the Water Resources Legislation Amendment Act 2007 Pt. 6; 38 of 2007; December 21, 2007; February 1, 2008 (see s. 2(2) and Gazette January 31, 2008 p. 251); [as at January 17, 2014].

The Bill provided for the establishment of new bodies and committees under the Water Agencies (Powers) Act, including a Water Resources Council[24]; a Water Resources Ministerial Body[25]; and advisory committees (including the continuation of the Advisory Committee for the Purity of Water (ACPOW)—nominally overseen and chaired by the Department of Health (DoH). In addition, the Bill transferred the functions of the WRC and water catchment management authorities and areas created under the Water Conservation Act (1976) to the Minister, thus making the Minister for Water responsible for the conservation of waters and their associated land (Glindemann and Chung 2006). The COAG (2008)[26] provided further impetus for WA to continue reforms with new legislation introduced within a national urban water reform framework. This legislation was targeted at consolidating existing water legislation and underpins the proposed water reforms, such as the statutory water management plans. This legislation repealed and replaced powers instituted under the Rights in Water and Irrigation Act 1914 and a range of other water-related legislation.

Therefore in WA, the water reform program progressed quickly over the next two years, and was significantly modified to meet the WAs Implementation Plan for the NWI (Reinmuth and Glindemann 2011). Water entitlements and land interests were further separated so that access to land will not be a pre-requisite to holding a water access entitlement, with basic landholder rights relating to taking water for livestock and riparian purposes altered to reflect the requirements of the NWI. The statutory water management plans set out the water entitlements for an area, with these plans will include information on: an area's water resources and environmental water allocations; how risk is to be allocated if the consumptive pool changes; the applicable local water trading rules; how over-allocated systems are to be dealt with and issues specific to that area; with the potential to move to a market-based allocation mechanism once allocation levels exceed 70% of the identified limit (Reinmuth and Glindemann 2011).

Furthermore, the NWC, whose role is to oversee the national water reforms, issued a report in 2011 on the implementation of the NWIs, recommended that all governments should refresh their commitment to water regulatory reform program (Reinmuth and Lynch 2013). Again providing support for new state initiatives at the National level. Significantly, the Productivity Commission in its 2011 (Productivity and

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[24] The Water Resources Council is responsible for providing advice to the Minister on policy and planning issues and is comprised of up to eight members appointed by the Minister who together will have expertise across a wide range of areas including conservation, economic development, community interests, mining and agriculture. The council empowered under amendments to Water Agencies (Powers) Act 1984; through the Water Resources Legislation Amendment Act 2007 Pt. 6; 38 of 2007; December 21, 2007; February 1, 2008 (see s. 2(2) and *Gazette*, January 31, 2008, p. 251).

[25] The Water Resources Ministerial Body is a body corporate that acts as a mechanism through which the Minister will be able to exercise his powers in relation to dealings in land, property, or assets; act as an agent of the Crown and attract Crown immunity; however, the 'Body' itself has no specified functions.

[26] COAG, *Council of Australian Governments' Meeting*, November 29, 2008, Climate Change and Water, http://www.coag.gov.au/coag_meeting_outcomes/2008-11-29/index.cfm (accessed April 20, 2015).

Commission 2011) review noted that efficiency gains may be attributed to improving the performance of institutions in relation to governance, regulation, procurement of supply and pricing, rather than by an attempt to create a competitive water market. However, nationally, the capacity of Australia's water sources and infrastructure to satisfy demand in urban areas has been seriously tested by a number of immediate and longer-term stresses including extended droughts, growing populations, aging infrastructure and climate change (Productivity and Commission 2011). The report concludes that conflicting objectives and unclear roles and responsibilities of institutions in the urban water sector have contributed to an inefficient allocation of water resources and investment, an undue reliance on water restrictions and costly, often poorly targeted conservation programs. In some states there appears to be a lack of transparency about the way government objectives and policies are being applied, with multiple objectives being assigned to their agencies, utilities and regulators, with inadequate guidance being provided on how to make tradeoffs between these objectives (Productivity and Commission 2011).

The Productivity Commissions review went further suggesting that the urban water sector was also characterised by a high degree of political involvement, largely due to public perceptions of water (as different from other utility services). Despite the significant criticisms levelled by the Productivity Commission, water reforms have continued to be at the forefront of government policy in WA, and a large number of reforms have been implemented in the 20 years since the signing of the 1994 COAG agreement. These reforms have occurred in water source protection, environmental health, risk management, water conservation, public awareness, pricing, and licensing. This has enabled WA to progressively improve the management of its water resources. Under the revised licensing conditions[27], linked to the on-going reforms the providers of drinking water, mainly the Water Corporation, Busselton Water, Bunbury Water (and other smaller localised providers) are required to provide an annual water quality report. Although the responsibility for ensuring that drinking quality standards are maintained rests with DoH in WA, the conditions of which are set out in a Memorandum of Understanding (MoU) for drinking water with DoH. This provides for the department to audit the water quality, management, and reporting systems to ensure that they consistently comply with ADWG. Ensuring compliance with the MoU is a pre-requisite for maintaining the corporations (and others suppliers) Operating Licence, issued by the ERA[28]. These on-going monthly summaries are reviewed quarterly by ACPOW and reported to the DoH and the Ministers for Health and Water.

In 2013–2014, the Water Corporation reported that the drinking water supplied was "*of excellent quality and is regularly tested to make sure it remains this way…met 100% of the water quality health standards*." The corporation is one of Australia's

[27] Water Services Licencing Act 1995 Pt2, Pt3 D2, s8(1)a, s12 (1)a,c; Pt3, D4 s31; Pt 3, D9 s46 a,b. [as at December 12, 2005] accessed April 25, 2015.

[28] The ERA is the Economic Regulatory Authority that oversees and enforces the licencing conditions of the water suppliers in WA.

largest water suppliers and delivers more than 370 GL potable drinking water which is sourced from 60 drinking water dams and weirs and 94 bore-fields to over 1 million properties through 34,156 km of water mains[29]. In accordance with the Water Licensing Act, drinking water providers are required to have an extensive drinking water quality monitoring program, independent laboratory testing, and have specific policies in place, for example, a *Drinking Water Quality Policy* and a *Water Source Protection Policy*, which set their commitments in supplying safe, high-quality drinking water, and protecting the water sources with the standards reflecting the AWDG and DoH in compliance with the operating licence, the requirements of the MoU and with regard to the reporting requirements of the NWC.

The release of a discussion paper by WA's DoW in 2013 is yet another step in the WA's gradual shift to integrate the principles of the NWI into State water law and policy. Further changes framed in this paper are aimed at creating a new, streamlined system for allocating and managing water resources and will involve the consolidation and repeal of the various, and, in some cases, outdated enactments that deal with water resource management, including changes to existing licensing regime; a new framework for water access entitlements; over-allocated water resources, and metering requirements (Reinmuth and Lynch 2013). The paper also forecasts potential modifications to the water framework, in areas including environmental water, water quality, domestic/ basic water, and groundwater injections.

5 - Conclusion

Although considerable progress had been made in tackling water reforms, water source protection planning, and environmental allocations at a National level and with implementation through the State's legislative, regulatory, licensing, and policy instruments, much remains to be undertaken and assessed. The impacted values of aesthetics, lifestyle, and foregone revenue owing to climate change, drought, water restrictions, and inappropriate allocations highlighted through the recent productivity commission's 2011 report has spurred the states to continue to reform. The commission also identified further opportunities for efficiency gains in the structural, institutional, regulatory, and other arrangements in the water sector that may directly impact on productivity, direct investment strategies, and water-related industries.

The DoW in WA has recently proposed reforms (Reinmuth and Lynch 2013) that are intended to streamline the existing 'fragmented' framework and to consolidate and modernise water allocation planning, licensing and trading across the State. The Departments' position paper proposes thorough consultation and is focused on providing water users with more options for managing water through a flexible and adaptive framework, while making adequate provision for the protection

[29] Water Corporation Annual Report 2013–2014, http://www.watercorporation.com.au/about-us/our-performance/drinking-water-quality.

of environmental water (or flows). This is aimed at complying with the AWDG, NWI and Australian water futures program, and ensuring that West Australian's are provided with safe reliable and secure drinking water. Although the value of water is becoming more prominent in the consumers' mind, and to the population in general, the links to the ecosystem from which it is obtained and the loss of ecoservices associated with water abstraction are yet to be fully realised within the existing legislative frameworks and business models.

References

AECOM, 2010. Review of Regional Water Quality and Security. Volume 2. Apendices. Oct 25, 2010. Australian Government. Sydeny NSW.

COAG, 1994. Water Reform Framework Agreement—*CoAG Meeting*, February 1994, Communiqué, Attachment A. *In*: -, C. O. A. G. (ed.). Canberra ACT.

COAG, 2008. *Council of Australian Governments' Meeting*, November 29, 2008, Climate Change and Water, http://www.coag.gov.au/coag_meeting_outcomes/2008-11-29/index.cfm (accessed April 20, 2015).

DAFF, 1995. Decade of Landcare Plan—National Overview, *In*: Department of Agriculture, F. A. F. (ed.). Canberra, ACT: Australian Government.

Deere, D., Walling, J., Selvarkumar, A., Whitehill, B. & R., M. 2008. Risk Management. In: *Watershed Management for Drinking Water Protection*. American Water Works Association and Australian Water Association. C. Davis (ed.) AWWA Cat No. 20675. Pg. 128. USA. ISBN: 9781921335037.

DoW, 2012. Perth-Peel Regional Water Plan 2010–2030: Responding to our Drying Climate. Department of Water. Government of Western Australia.65 Pg. Perth WA.

Fisher, D.E. 2000. *Water Law*. North Ryde, Sydney, N.S.W: LBC Information Services

Gardner, A. W., Bartlett, R. H. & Gray, J. 2009. *Water Resources Law*. Chatswood. NSW: Lexis Nexis Butterworths.

Glindemann, R. 2006. Environment and Water Reform In Western Australia *Briefing Note* [Online]. Available: http://www.allens.com.au/pubs/env/foenv28jul06.htm (accessed January 2012).

Glindemann, R. & Chung, V. 2006. *New W.A. Water Legislation* [Online]. Allen Publications. Perth WA. http://www.allens.com.au/pubs/water/fowjun06.htm (accessed

April 22, 2015).

Heberger, M. 2011. Australia's Millennium Drought: Impacts and Responses. *In* Gleick, P. (ed.) *The World's Water Volume 7: The Bicentennial Report on Freshwater Resources.Pg. 95-127. Pacific Institute for Studies in Development Environment and Security*. Center for Resource Economics, Island Press. Washjington D.C. USA..

IRSC. 2005. Irrigation Review—Final Report. Perth, WA: *State Water Strategy.*

Khan, S. & Hanjra, M. A. 2008. Sustainable Land and Water Management Policies and Practices: A Pathway to environmental sustainability in large irrigation systems. *Land Degradation* and *Development* 19: 469–487.

NHMRC and NRMMC. 2003. Water Made Clear: A Consumer Guide to Accompany the Australian Dreinking Water Guildlines 2004 Edition. Pg 30. Australian Government. Canberra. ACT. http://www.nhmrc.gov.au.

NHMRC and NRMMC. 2004. Australian Drinking Water Guidelines (AWDG). Pg 615. Australian Government. Canberra, ACT. http://www.nhmrc.gov.au.

Productivity and Commission. 2011. Australia's Urban Water Sector. Final Inquiry Report. Canberra, ACT.

Reinmuth, J., and Glindemann, R. 2011. *WA's first-in/first-served water policy under review* [Online]. Allen Publications. Available: http://www.allens.com.au/pubs/water/fow27sep11.htm [Accessed April 22 2015].

Reinmuth, J. & Lynch, E. 2013. *Western Australia's New Water Future* [Online]. Allen Publications. http://www.allens.com.au/pubs/water/fow2oct13.htm. (accessed April 22, 2015).

Shultz, C., Parker, J. a Bleaker, A. 2004. *Water Rights Aren't Wrong* [Online]. Allen Publications. http://www.allens.com.au/pubs/env/fowatsep03.htm (accessed January 2013).

United Nations Committee on Economic, C.A.S.R. 2002. General Comment No. 15. In The Right to Water, *(Arts. 11 and 12 of the Covenant)* Ed. U. Nations. Geneva. *E/C.12/2002/11*. available at: http://www.refworld.org/docid/4538838d11.html [accessed 23 June 2015]

WaterRA. 2015. *Water Quality Guidelines. Adelaide SA*. [Online]. http://www.waterra.com.au/research/water-quality-guidelines/ (accessed April 22, 2015).

Abbreviations and Acronyms

ACPOW	Advisory Committee for the Purity of Water
ACT	Australian Capital Territory
ADWG	Australian Drinking Water Guidelines
AS	Australian Standard
CoAG	Commonwealth of Australian Governments
DoH	Department of Health (WA)
DoW	Department of Water (WA)
ERA	Economic Regulatory Authority
GL	Giga Litres
HACCP	Hazard Analysis Critical Control Point
ISO	International Standards Organisation
MDB	Murray Darling Basin
ML	Mega Litres
MoU	Memorandum of Understanding
NCC	National Competition Commission
NCP	National Competition Policy
NHMRC	National Health and Medical Research Council
NRMMC	Natural Resource Management Ministerial Council
NSW	New South Wales
NWI	National Water Initiative
NWC	National Water Commission
NWQMS	National Water Quality Management Strategy
NZS	New Zealand Standard
SA	South Australia
WRC	Water and Rivers Commission
WRIC	Water Reform Implementation Committee
WA	Western Australia

Highlights of Some International Water Meetings in 2014 and 2015

Every year there are numerous important water conferences, workshops and meetings around the world. In this section of New Water Policy and Practice Journal we aim to share inspiration about new water leadership and thinking from recent key water events, such as conferences and workshops. The aim of this section is to provide a mechanism for readers to inform each other about particularly important or invigorating events and we encourage all New Water Policy and Practice Journal readers to send us their ideas and help spread the word about what they found particularly inspiring. Articles should be a maximum of 500 words and written in English.

Below is information on some of the key events of the past year and yet to happen in 2015.[1]

2014

***Water Week – Stockholm**: 31 August – 5 September 2014 Stockholm, Sweden*

The World Water Week in Stockholm, hosted and organised by the Stockholm International Water Institute (SIWI), has been an annual focal point for discussion about the world's water issues since 1991. World Water Week provides a unique forum for the exchange of views, experiences and practices between the scientific, business, policy and civic communities. It focuses on new thinking and positive action toward water-related challenges and their impact on the world's environment, health, climate, economic and poverty reduction agenda.

Each year the World Water Week addresses a particular theme to enable a deeper examination of a specific water-related topic. While not all events during the week relate to the overall theme, the workshops driven by the Scientific Programme Committee and many seminars and side events do focus on various aspects of the theme. In 2014 World Water Week focused on "Energy and Water".

[1] Compiled with the help of one of our Editors, Nehwon Macpherson David

During the Week, several prizes were awarded for excellence in water-related issues. The Stockholm Industry Water Award was awarded to eThekwini Water and Sanitation, serving the Durban metropolitan area, for its transformative and inclusive approach to providing water and sanitation. Hayley Todesco from Canada received the 2014 Stockholm Junior Water Prize for inventing a method that uses sand filters to treat contaminated water and recover water for reuse. The prestigious Stockholm Water Prize was awarded to Professor John Briscoe of South Africa, for his unparalleled contributions to global and local water management, inspired by an unwavering commitment to improving the lives of people on the ground.

Further information is available at: http://www.worldwaterweek.org/

***9th IWA World Water Congress Lisbon 2014**: 21-26 September 2014, Lisbon, Portugal*

The International Water Association's World Water Congress was held in Lisbon from 21 - 26 September 2014. It was the largest water industry event ever held in Portugal with more than 5500 water professionals from 106 countries participating. They could attend 10 keynote speeches, 6 forums, 47 workshops, 90 technical sessions, 850 presentations, 44 business forums and 29 specialist groups meetings and 6 technical tours. The exhibition included 206 companies and organizations.

Further information is available at: http://www.ersar.pt/website_en/ViewContent.aspx?Name=WWC_IWA_Lisbon_2014

1st International Water Regulators' Forum

The Portuguese Water and Waste Services Regulation Authority (ERSAR) coordinated the 1st International Water Regulators Forum as part of the 9th IWA World Water Congress. The 1st International Water Regulators Forum was the first global event bringing together water services regulators to discuss the current status of regulatory frameworks and future trends in their development which will have great impact on water services provision. The Forum established a new set of guiding principles for sound public policies and regulation for water services, imbedded in the 'Lisbon Charter', which were adopted by the International Water Association. According to the IWA, the principles promise to deliver a vital stimulus for the water sector to innovate, and offer a visionary and practical pathway for delivering improved water and sanitation services. Critically, the principles are universal, equally adaptable in any water utility anywhere in the world. The 2nd International Water Regulators Forum will be held in held in London, UK, on 8-9 September 2015.

More information on the Lisbon Charter is available at http://www.iwa-network.org/downloads/1428787191-Lisbon_Regulators_Charter.pdf.

2015

World Water Forum – Korea

The World Water Forum is a large-scale international conference that is held every three years since 1997 in cooperation with the public, private sectors, academia, and industries. It was first launched in an effort to facilitate international discussions on global water challenges. Under the theme of 'Water for Our Future,' the 7th World Water Forum took place in Daegu & Gyeongbuk of Korea. At a time when the UN Millennium Development Goals set in 2000 is due to expire and the Sustainable Development Goals should be established, the 7th World Water Forum aimed at drawing more actions to tackle water challenges.

Some interesting approaches were applied in the planning of this World Water Forum. In a plenary before the Forum, participants were asked to discuss in small groups of 3-4 people how to make the 7th Forum different from previous Fora and what was necessary for successful "implementation." In the discussion, participants suggested that the Forum must cover not only the water field, but also non-water fields such as commerce and trade, energy, and IT. It was also noted that particular effort should also be made to open the door to citizens and non-water experts so that the general public can gain awareness of the importance of water issues in order to more easily modify their behaviors. In addition, it was felt that the Forum should encourage the setting of realistic goals and establish a system to continuously feed back into the implementation process. Rather than one single approach, the Forum should be designed in an interactive and dynamic way, privileging dialogue over presentations. Therefore, the presentation forms, gender composition, and opportunities for experience will need to be diversified and expanded. In particular, expanding participation, monitoring implementation, and organizing an interactive Forum should be reflected in the actual design of the 7th World Water Forum.

We look forward to hearing from readers of New Water Policy and Practice Journal that attended the 7th World Water Forum and how these initiatives were received by the participants.

Further information can be obtained on: http://eng.worldwaterforum7.org/main/

3rd International Conference on Water and Society*: 15-17 June 2015, Coruna, Spain*

Civilizations have over the centuries relied on the availability of clean and inexpensive water supplies. However, as the need for water continues to increase due to the pressure from an increasing global population demanding higher living standards, this can no longer be taken for granted. Agriculture and industry, major users of water, are at the same time those that contribute to its contamination. Water distribution networks

in urban areas, as well as soiled water collection systems, present serious problems in response to a growing population as well as the need to maintain ageing infrastructures. Many technologically feasible solutions, such as desalination or pumping systems are energy demanding but, as energy costs rise, the techniques currently developed may need to be re-assessed. Therefore, this Conference from 15-17 June addressed the interaction between water and energy systems. We look forward to reader's reports on whether the conference achieved its objective of bringing together urban-planners and water professionals from different parts of the world to Coruna, Spain.

Further information can be obtained on: http://www.wessex.ac.uk/15-conferences.html

Still to happen…

***Water Week – Stockholm**: 23-28 August 2015, Stockholm, Sweden*

World Water Week in Stockholm is an annual focal point for discussion about the world's water issues, organised by SIWI. This year is the jubilee year for both World Water Week and the Stockholm Water Prize. The theme is **Water for Development**. Experts, practitioners, decision-makers, business innovators and young professionals from a range of sectors and countries will be in Stockholm to network, exchange ideas, foster new thinking and develop solutions to the most pressing water-related challenges of today.

Further information is available at: http://www.worldwaterweek.org/

***International River Symposium**: 21 – 23 September, Brisbane, Australia*

The International River Symposium is an opportunity to engage with the multitude of businesses and organizations that contribute to and benefit from the wise management of rivers and their catchments. Water has risen high on the business agenda and a decline in freshwater quality and quantity was judged the greatest risk facing the globe at the 2015 World Economic Forum. The contribution that healthy rivers make to our economics and well-being is extraordinary, but often taken for granted. Therefore, the theme for this year's symposium is "Healthy Rivers – Healthy Economics." The 2015 International River Symposium intends to connect businesses that rely on rivers and catchments with community representatives, scientists, policy makers and river professionals to jointly explore the links between river health and economic performance in different contexts globally. The program hopes to feature over 20 keynotes and 10 special sessions covering topical issues. The aim of the symposium is to encourage knowledge sharing and debates, and seek to find collaborative solutions for a better future.

Further information is available at: http://www.riversymposium.com

LuWQ-2015 - 2nd International Interdisciplinary Conference on Land Use and Water Quality: Agricultural Production and Environment*: September 21-24, Vienna*

LuWQ2015 is an international and interdisciplinary conference on the cutting edge of Science, management and policy to minimize effects of agriculture and land use changes on the quality of groundwater and surface waters to be held in Vienna, Austria from 21-24 September 2015. The aims of the conference are to discuss the entire policy cycle for water quality improvement. This cycle includes problem recognition, formulation of technical options, the process of policy development, interaction with policy makers, stakeholders and pressure groups, policy implementation, monitoring and research. The conference hopes to focus on topics such as Agronomy, Agro-economics, Agro-sociology, Water Management, Water Policy, Hydrology, Aquatic Ecosystems, Terrestrial Ecosystems, Unsaturated Zone, Groundwater, Surface Water, Drinking Water, Monitoring, Modelling, Water Quality, Nutrients, Pesticides and other Organic Agro-chemicals, Heavy Metals etc.

Further information is available at : http://web.natur.cuni.cz/luwq2015/, or by contacting Karel Kovar via email: karl.kovar@ppbl.nl