Sharing benefits through knowledge management: A knowledge-based approach to integrated trans-boundary river basin management

Jeremy Aarons
Faculty of Information Technology and Monash Sustainability Institute
Monash University, Australia
Email: jeremy.aarons@monash.edu

Henry Linger
Faculty of Information Technology
Monash University, Australia
Email: henry.linger@monash.edu

Paul McShane
Monash Sustainability Institute
Monash University, Australia
Email: paul.mcshane@monash.edu

Abstract

Where river basins are shared between competing nations, how do we build cooperative and collaborative management approaches based on sound evidence so that the benefits that come from those water resources can be shared equitably? In this paper we approach this question from an Information Systems (IS) perspective, adopting a knowledge based view on the information challenges associated with benefit sharing in trans-boundary river basins. Utilising the task-based knowledge management (TbKM) approach adapted to the context of integrated water resource management (IWRM) and guided by key literature on IWRM and benefit sharing we present a knowledge management (KM) framework for supporting effective decision making amongst key stakeholders engaged in river basin management.

Keywords

Task-based knowledge management, knowledge work, collaboration, benefit sharing, integrated water resource management

INTRODUCTION

Trans-boundary river basins cross international and internal state borders traversing social, political and economic divides. About 40 percent of the world's population relies on freshwater resources shared between two or more nations, with more than 260 major international trans-boundary river basins having been identified (Gleick 2012:1-3). The health of these shared waters is fundamental for human well-being and prosperity and for the health and sustainability of the natural environments that depend on them. Maintaining these water resources requires effective and well-coordinated management of trans-boundary water basins, involving cooperation and collaboration between all parties responsible for and reliant on their water resources.

Trans-boundary waterways have traditionally been viewed as a source of conflict, a point of tension upon which rival parties compete for access and use of this most precious of resources. With added pressures of increasing world population, increasing energy demand, and changes in water availability due to the impacts of climate change, water is viewed as a potential trigger point for significant international conflict (Pearce 2006). Further to this industrial development, land clearing and other human activities have degraded water quality in many waterways. Similarly, encroachment of saline water given climate change can affect water for human wellbeing.

However in recent years the focus on international river basins has switched from conflict to cooperation, with a new emphasis on developing collaborative approaches to river basin management through cooperation and coordination between riparian states with shared water resources. Key to this has been a focus on 'benefit sharing' from the shared water resource, which is defined as "the process where riparians cooperate in optimising and equitably dividing the goods, products and services connected directly or indirectly to the watercourse, or arising from the use of its waters" (SADC 2010:1). Examples of benefit sharing approaches include shared investment and ownership of infrastructure such as dams and hydro power facilities (economic

benefits), cooperation to improve watercourse flow and ecosystem function (environmental benefits), and within-basin trade and agricultural agreements to support livelihoods and address poverty (social and political benefits) (SADC 2010).

Focusing on cooperation and benefit sharing, rather than attempting to manage and resolve conflict, has meant that multilateral negotiations have shifted away from emphasising diplomatic approaches such as treaties and formal agreements. Instead there has been a focus on regional governance arrangements, data and information sharing, and coordinated activity between riparian states. This aligns to the reality that river basins do not follow state borders. Through this approach considerable progress has been made towards developing trans-boundary integrated water resource management (IWRM) in a number of major international river basins (GWP 2000). IWRM is defined as "a process which promotes the coordinated development and management of water, land and related resources in order to maximise economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems." (GWP 2013:6). A notable example is the well-developed approach to managing the Danube River in central Europe, involving coordination between the many riparian states mediated by a transnational body responsible for an integrated, basin-wide framework for protecting and enhancing the river basin (ICPDR 2009). Considerable progress has also been made in the Mekong River system through the work of the Mekong River Commission (MRC 2006, 2011a) and participant riparian states. There are also some well-established coordinated management approaches in regions with significant political tensions such as the Jordan River (Phillips 2006; Gleick 2012) and the upper Nile (Phillips 2006).

However, despite the ongoing development and success of coordinated collaborative IWRM in a number of water basins, there are still considerable gaps in both our theoretical and practical understanding of these approaches. In particular, for the purposes of this paper, there is currently a lack of detailed theoretical discussion from an information systems (IS) perspective on key issues underlying such approaches such as knowledge sharing, collaboration, and informational governance and infrastructure. These have important practical implications regarding the development of collaborative approaches to river basin management: for example, for supporting knowledge and information sharing between key players, for the development of collaborative data and information systems, and for the development of support tools such as decision-support and monitoring and evaluation systems.

To address this gap, this paper presents a conceptual study which aims to provide an IS framework for building the information requirements and supporting the knowledge sharing/transfer/brokering needs to enable trans-boundary benefit-sharing approaches to IWRM. This work is designed to be applied and tested within a specific context, being the first stage of a larger project engaged in developing a knowledge management framework to support new collaborative benefit sharing approaches in river basins in the Hindu-Kush Himalaya (HKH) region. It is guided by an assessment of the specific requirements relating to the HKH region, an area which so far has experienced limited progress in implementing IWRM, and has been developed with input from experts based in the region. This paper concludes with a brief discussion on how the conceptual approach developed here will be applied and tested in a number of catchments in this region.

The approach developed here adopts a *knowledge-based* perspective on the information challenges associated with benefit sharing in trans-boundary river basins, utilising the task-based knowledge management (TbKM) approach from Burstein and Linger (2003, 2011) adapted to the context of IWRM. This approach is guided by key literature on IWRM and benefit sharing which outlines the principles underlying such approaches, reviews current efforts and provides recommendations on how to improve implementation in new contexts. In doing so this literature also clarifies the gaps in current understanding, showing how IS research and application can make a significant contribution to current and future efforts in water resource management. This background and context is discussed in the next section below.

BACKGROUND: LESSONS LEARNT FROM CURRENT EFFORTS IN BENEFIT SHARING

Our multi-disciplinary analysis brings together insights from water management and policy studies and incorporates them into an IS approach. The key peer-reviewed literature provides an analysis of the factors that enable or constrain benefit sharing approaches in shared river basins, looking at broad social, political and economic factors (Sadoff and Grey 2002, 2005; Dombrowsky 2007, 2009). This work emphasises the idea that benefit sharing comes in a number of forms and occurs across a "cooperation continuum" (Sadoff and Grey 2005). That is, an appropriate approach for a given river basin context depends crucially on local factors, most importantly the level of political dispute or cooperation between riparian states. The cooperation continuum ranges from significant dispute between parties at one extreme to closely integrated relations at the other. Where a particular river basin sits in this continuum determines what forms of cooperation are possible and hence which forms of benefit sharing mechanism are appropriate.

The most up-to-date and comprehensive accounts of trans-boundary water resource management and benefit sharing appear in 'grey' rather than peer reviewed literature. In particular Phillips *et al* (2006), Qaddumi (2008), SADC (2010), MRC (2011b), and GWP (2013) provide a thorough overview of the current state of play in IWRM as well as summarise the key lessons learnt from current efforts. These conclusions lay the basis for and guide the approach developed here.

Phillips *et al* (2006) reviews current efforts at benefit sharing in international river basins, and summarises the keys requirements for enabling effective benefit sharing. These are essentially political and strategic factors aimed at building strategic long-term commitment: elevating the acknowledged importance of trans-boundary waters; developing a broad holistic vision; building long-term commitment to a consensus-based approach by external parties involving true collaboration; and securing top-level commitment amongst governments and key stakeholders (Phillips *et al* 2006:181-2).

Other overviews emphasise factors which are more relevant to an IS perspective. Qaddumi (2008) in particular emphasises the importance of focusing on technical cooperation on information sharing as a starting point for building benefit sharing approaches:

> "It is clearly impossible to speak of 'benefit sharing' or 'water sharing' when riparians cannot agree on the data on which the analyses are to be based. *The first stage, thus, should begin at a very elemental level, with technical cooperation on data and information sharing* [emphasis added]. This should include not only hydrological information, but also the national social, economic and environmental information that are necessary inputs into the determination of benefit sharing formulae. Such activities represent little risk, but still help to develop a common factual basis and the beginnings of trust." (Qaddumi, 2008)

This point is also echoed in more recent reports including SADC (2010), MRC (2011b), and GWP (2013). Based on these overviews and analyses, the main lessons learnt from current IWRM efforts can be summarised as follows:

- There are no generic solutions to IWRM and no preferred approaches to benefit sharing. For each context the approach must be developed from the 'bottom-up' and be tailored to the specific geographic, political and socio-economic context of the water basin in question. In some cases where significant conflict or lack of trust exists benefit sharing approaches may not be appropriate or even possible (Phillips *et al* 2006).

- The key players are a complex network of stakeholders acting at multiple levels of organisation (ranging from major government decision makers down to community-level participation) and representing a range of potentially competing interests. This point is most clearly made by Qaddumi (2008) who states "The major stakeholders are not 'countries', 'states' or 'riparians', as abstract wholes, but various national government bodies and sectoral bureaucracies, regional and local governments, civil society, individual water users, influential individuals, and others. The perceptions and motivations of all of these groups must be understood and reflected in any cooperative arrangement that is to be viable in the long run."

- Enabling cooperation between these key stakeholders is of primary importance, particularly in regards to data and information sharing which should form the starting point for developing collaborative approaches to water basin management. Focusing on data and information sharing as a starting point in negotiations can provide the basis for developing a shared 'knowledgebase', leading to a shared understanding of the issues amongst stakeholders. This can provide a means to reduce conflict via common understanding and an agreed recognition of mutual benefits.

- Long term solutions require a strategic collaborative approach with high level commitment and widespread agreement amongst key stakeholders. This requires a clear, transparent and agreed process with well-defined goals and targets, incorporating an adaptive approach with mechanisms for monitoring, evaluation and review and continuous improvement.

KNOWLEDGE-BASED APPROACH TO BENEFIT SHARING

IWRM and benefit sharing as *knowledge work*

In contrast to the key literature described above, which tends to come from a physical science (water resource management) or socio-political (water-policy) perspective, we approach the challenges of trans-boundary benefit sharing from an IS perspective by applying a knowledge-based view.

Our starting point for adopting an IS perspective on IWRM and benefit sharing is recognising that developing IWRM and benefit sharing approaches essentially involves complex forms of *knowledge work* (Blackler 1995;

Alvesson 2004). This knowledge work requires complex evidence-based decision making (Majone 1989; Head 2009) involving the analysis and synthesis of many forms of data/information/knowledge, including factual, theoretical, technical, and practical knowledge as well as intuition and practical wisdom (Schwartz 2011). It is often characterised as collaborative knowledge work (Iivari and Linger 1999) performed by multiple actors, often with different values and goals and generally with different and potentially conflicting sources of data and information used as a basis for decision making. It occurs *within* organisational boundaries, such as in organisations responsible for water policy or management (to establish water policy or management arrangements) and within bodies engaged in specific activities (e.g. development of infrastructure by a hydro-power company). It also occurs *across* organisational boundaries, such as in establishing international agreements on water resources or bi/multi-lateral treaties for waterway management, and *beyond* organisational boundaries such as when policy/programs are developed as a result of broad stakeholder engagement across multiple levels of activity (Linger et al 2013).

As such, the challenges here are broader in scope that those generally addressed by adopting a knowledge-based view (Grant 2002; Spender 1996; Eisenhardt and Santos 2002). The forms of knowledge work extend across and beyond the boundaries of a single organisation to encompass multiple groups operating at different levels of authority and decision making capability: from top-level governments and government agencies, through a range of key stakeholder groups with a direct interest in water resource management, down to the community and individual level of those directly reliant on water resources.

By adopting a *knowledge-based* view in this context we recognise the key role that knowledge resources and knowledge-related processes and systems play in developing effective approaches to IWRM (as emphasised in the key IWRM and benefit sharing literature discussed above). The approach here can thus be viewed as a form of knowledge management (KM), where KM is understood in a broad sense as *a systematic approach to collecting, sharing and integrating knowledge to inform policy and support decision making*. We recognise this definition may differ from KM as it is sometimes conceived (e.g. more narrowly as data or information management) and that the term 'knowledge management' is potentially confusing due to its slippery fad-like nature (Wilson 2002). However we believe the term KM is well-suited for describing this approach, particularly as it is consistent with the Standards Australia (2005) definition of KM as a "trans-disciplinary approach to improving organisational outcomes and learning, through maximising the use of knowledge".

The Task-based knowledge management (TbKM) approach

The approach adopted here is based on a practice-based approach to KM known as task-based knowledge management (TbKM) (Burstein and Linger 2003, 2011). This work builds on recent iterations of TbKM that extend its scope to apply to the context of natural resource management and sustainable development (Linger et al 2013). For the purposes of this paper TbKM is applied as a knowledge-based approach that focuses on the *informational* dimension of water resource management: in this case the TbKM architecture is applied to the context of trans-boundary IWRM and benefit sharing. The purpose is to use the solid theoretical foundation underlying TbKM to develop a platform for building an effective information infrastructure to support cooperation, collaboration and coordination for benefit sharing in trans-boundary river basins.

The TbKM approach is based on the idea that KM is primarily about developing strategic approaches for supporting knowledge workers in performing complex knowledge work tasks. This task-focused view of TbKM is geared at analysing and improving the systems in which complex decision-making is carried out by key decision makers, who can be viewed as constituting communities of practice operating within and across institutional boundaries (Burstein and Linger 2011).

The key insight of TbKM is that knowledge work involves two dimensions: one is related to the structural setting in which the work is performed and the other is related to the function of the work. Firstly knowledge work tasks occur within specific organisational, technological and informational settings which define what are termed the "structural dimensions" in which task performance occurs. Within this structural setting knowledge work has certain functional requirements that comprise the "functional dimensions", defined by the knowledge-related process required to successfully perform the work: generalizable as remembering, sense-making and learning. Based on this distinction the TbKM approach is founded on a knowledge architecture that maps out and integrates the structural and functional dimensions of complex knowledge work tasks (Figure 1).
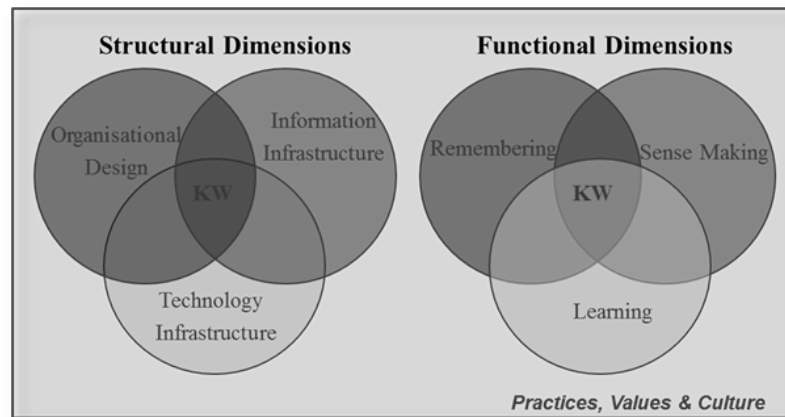
Figure 1: Architecture for implementing Task-based Knowledge Management

In a given context the TbKM approach is applied by mapping out and integrating the structural and functional dimensions of key knowledge work tasks. This provides a systems-level model of how the tasks are performed.

How the structural and functional dimensions of knowledge work relate and how they can be brought together in an integrated framework is explored in the next section, where we describe how the TbKM approach is applied to IWRM and benefit sharing.

Applying TbKM to river basin management – a KM framework for benefit sharing

The first step in applying TbKM to trans-boundary river basin management is to identify the key knowledge work tasks and then to map out the relevant structural and functional elements that relate to those tasks.

Here the key knowledge work tasks involve the development and implementation of IWRM policy and benefit sharing approaches. Broadly speaking these tasks can be considered as forms of 'policy work', a term that encompasses both the development and implementation of government policy more generally (Linger et al 2013).

The TbKM architecture maps onto the IWRM policy work context in the form of a 'systems' model of the decision-making space, here termed a 'KM framework for policy work' (Figure 2).
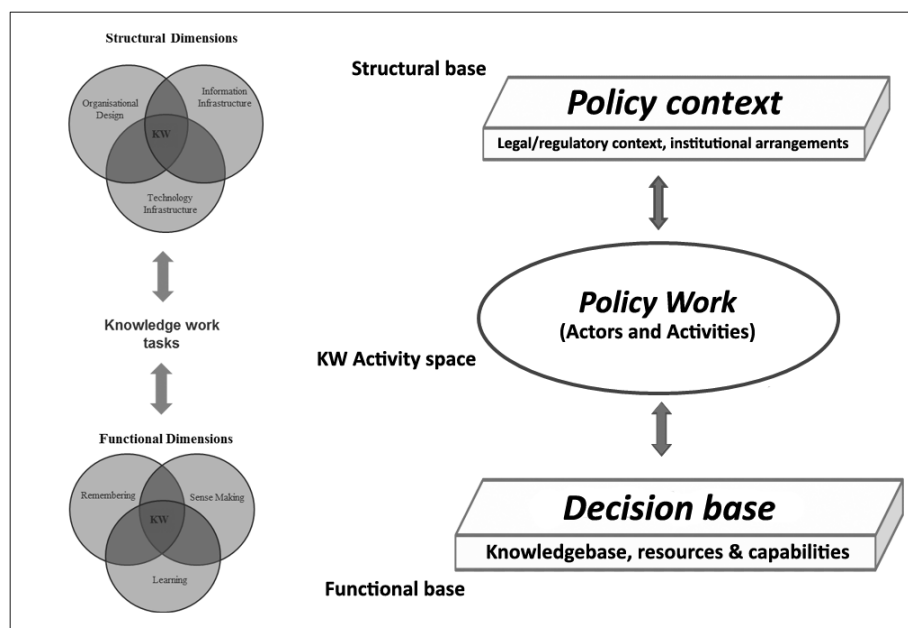

Figure 2: TbKM architecture and KM framework for policy work

We term this model a 'KM framework' as it provides a clear structure within which one can map out the factors that enable and constrain decision making amongst a network of decision makers engaged in specific knowledge work tasks. It thus enables a systematic approach to supporting decision making and as such is an effective approach to KM (as defined here).

The KM framework provides a systems-level view of the key elements that constitute the environment in which the relevant decision makers work - the 'decision-making space'. It includes three main components that bring together the structural and functional dimensions of TbKM and explicitly link them to decision makers and their tasks:

1. The **policy context**, which encapsulates the key *structural* dimensions of the policy work (i.e. the *structural base*). This includes the legal, regulatory and policy settings that relate to how governments and organisations operate and set the frameworks for communication, coordination and collaboration between key players.

2. The **decision base**, which provides the foundation for the *functional* dimensions of policy work (i.e. the *functional base*). This is made up of fundamental knowledge assets (data, information and knowledge), as well as technical tools and techniques that can be used to support effective evidence-based decision making.

3. The network of **actors and activities,** which is the *knowledge work (KW) activity space*. This is made up of the decision makers and their tasks and represents the performance of their knowledge work. It includes the key groups of stakeholders responsive to the policy work context and the linkages and flows of information between them and the relationships between their activities.

The three components are then linked together: (i) mapping the linkages between the actors/activities and the policy context (defining the structural setting that constrains/enables decision making); and (ii) mapping the linkages between the actors/activities and the decision base (defining the functional setting that supports evidence-based decision making). Mapping these components and then investigating the linkages between them allows us to clearly situate specific forms of policy work within the TbKM architecture.

Applying this general approach to the problem domain of trans-boundary river basin management yields a KM framework for benefit sharing as follows.

Firstly, the *structural base* includes key components of the legal and regulatory context governing river basin management and how individual legal/regulatory instruments relate to (constrain or enable) decision making bodies. This incorporates national and international policy relating to river basin and water resource management (e.g. United Nations conventions and resolutions, international and bi/multi-partisan treaties and agreements, and national, regional and local policy frameworks). It also includes governance arrangements that apply to water policy development and implementation, such as trans-boundary governance bodies (e.g. the Mekong River Commission). It also includes institutional arrangements and policy mechanisms that play a role in water related policy and decision-making (e.g. the various impact assessment processes that are often legislated steps in policy/program development: Environmental Impact Assessment (EIA); Social Impact Assessment (SIA) and Cumulative Impact Assessment (CIA)).

Next, the *functional base* is derived by mapping the available data, information and knowledge resources that form inputs into decision making processes. This includes the base data sets and information resources (e.g. water flow data, hydrological models, regional climate models, land use patterns, agriculture). It also includes other relevant forms of knowledge such local technical expertise, community knowledge and traditional wisdom. The functional base also includes details on where data/information is held and by whom and how it is accessed/transferred by and between the key decision makers and those who inform them as participants in the decision making process (e.g. scientists, consultants, NGOs, community advocates).

Finally the KM framework includes the *KW activity space*, which maps out the network of key actors and activities related to trans-boundary IWRM. This includes a mapping of key decision-making bodies responsive to river basin management, including information on their relative influence in decision-making processes. Following Qaddumi (2008) the key stakeholders for IWRM include primary decision-makers (e.g. governments and government agencies), key organisations and interest groups (e.g. industry, NGOs, water user groups), multi-disciplinary experts (social and physical science, engineering, economics, law) as well as local, traditional and community-based participants. These are actors at multiple levels of decision making, with different and potentially conflicting interests, values and goals. Mapping out the KW activity space can clarify where these interests, values and goals may intersect (enabling cooperation and collaboration) or where they may conflict (and form barriers to cooperation). The KW activity space also documents the knowledge flows and engagement pathways between these actors and includes identification of barriers to information exchange.

The KM framework is rounded out by linking KW activity space (the actors and activities involved in knowledge work) to the structural base (policy context) and functional base (decision base).

Linking to the structural base involves mapping the links between stakeholders and the various legal/regulatory instruments and mechanisms that are relevant to them (with respect to river basin management). For example, governments and government agencies will be linked to specific international agreements such as the United Nations Convention on the Law of the Non-Navigational Uses of International Watercourses 1997 (UN 2005) or (for the Indus River basin) the Indus Waters Treaty 1960. Linkages to specific processes or tools are also included, for example the roles agencies or authorities play in EIA or SIA processes should be clearly represented.

Linking to the functional base involves connecting the various components of the decision base to: (i) the stakeholder(s) who generate/own/control those knowledge resources; and (ii) the stakeholders who access and apply those knowledge resources for their purposes. For example, agencies that gather and curate key data sets will be clearly identified, as will the extent to which other stakeholders are able to access those data sets and the processes that facilitate such access. Usage of different forms of knowledge are also clarified by this mapping, for example the use of different theoretical disciplines such as river science (e.g. hydrological modelling), climate science (e.g. climate change scenarios; rainfall projections; glacial runoff modelling), economics (e.g. valuation mechanisms; market-based approaches) as well as local and traditional knowledge (e.g. traditional irrigation and agricultural systems; local adaptation strategies). Integrating and applying these different forms of knowledge bring a range of different challenges, including dealing with inconsistency, uncertainty, knowledge gaps, ethical issues (e.g. economic versus environmental trade-offs) and political issues. The KM framework cannot directly resolve all these problems, but it can provide a clearer and richer understanding these issues by making the implicit (or unknown) more explicit.

Applying the KM framework

The KM framework is a broad systems-level conceptual model of the *decision-making space* within which key decisions relating to river basin management are made.

In developing this framework we recognise that there are no generic (one-size-fits-all) solutions to IWRM – this approach does not intend to be generic in that sense. However it is intended as a general template that can serve as the basis for developing a customised, context-specific approach for a particular region. As a template itself this approach is also inherently flexible, and it is designed to be modified to adapt to a particular context or setting.

When applied to a specific river basin context the KM framework can serve a number of functions:

1. **To improve understanding**: The systems-level framework can provide richer understanding of the knowledge work tasks, by making explicit the context in which the tasks are performed and the process and knowledge requirements needed to support the task.

2. **To identify current problems**: The framework can be explored to identify causal processes that are contributing to current problems, such as locating significant barriers that prevent successful task performance or gaps in systems, processes or knowledge that make effective task performance more difficult.

3. **To design interventions to address problems**: The framework can guide the design and implementation of interventions to address identified problems based on the causal understanding of such problems, selecting and customising interventions to address problem causes. It can also be used to model a range of different scenarios to investigate the impact of specific interventions and to select interventions with preferred outcomes.

4. **To develop a strategic vision for improved task performance**: The KM framework structure can also be used to articulate the goals of intervention by representing the desired endpoint of such work: an improved decision-making system that enables effective trans-boundary IWRM with benefit sharing outcomes.

These last two functions are closely related: a clearly articulated strategic vision can help guide the design and application of interventions to improve the current way the system operates and shift it closer to the strategic goal.

The KM framework can thus act as a tool to help identify the structure and design of effective interventions to achieve desired outcomes. For example, where the structural base (policy context) provides weak support for good decision-making the KM framework may indicate clear opportunities for strengthening the policy context to improve the situation. This could involve, for example, establishing new or strengthening existing trans-boundary

governance arrangements, including high-level leadership and coordination, regional cooperation and an improved overarching legal and regulatory environment. Developing this would involve undertaking an analysis of current governance arrangements, exploring the possibility of a basin-wide governance system, and developing means for strengthening diplomatic relations between riparian states.

There may also be a clear opportunity to improve the functional base, by strengthening, integrating and providing wider access to the decision base. For IWRM this may involve the development of a unified data system (knowledgebase), establishing data sharing arrangements between key stakeholders, and developing targeted decision-support and new integrated tools and technologies (e.g. GIS; flood warning systems). Building this understanding into the KM framework requires undertaking data/information audits across the range of key stakeholders, investigating establishing a basin-wide data governance system and coordination process between key stakeholders, and establishing a platform for data integration into an accessible knowledgebase. Note that the task of developing and enhancing a knowledgebase involves both functional and some structural elements as featured in the TbKM architecture, in particular data/information infrastructure and data governance. This is to be expected as information system development essentially involves both structural and functional components – this is in fact one of the key insights of TbKM.

Finally, the KM framework may demonstrate clear opportunities for supporting and improving the KW activity space, by revealing pathways for enabling more effective communication, collaboration and coordination between stakeholders. For example there may be a lack of formal coordinating bodies and forums entailing a priority need for such entities, or there could be a need to strengthen informal networks and communities of practice. There may be a current lack of communication avenues and access to education and training, entailing the need for capacity building amongst key stakeholders. Another possibility could be the need to develop bottom-up participatory processes for community involvement in policy and program development, linking local and community level stakeholders with decision makers directly engaged in policy development.

In summary, the approach described here recognises the importance of 'evidence-based' assessment: building a benefit sharing framework from the bottom-up based on best available knowledge generated and utilised by the complex network of relevant stakeholders. Achieving this involves establishing cooperation and coordination on data and information sharing, including the establishment of knowledge networks and trans-boundary capacity building. The aim in applying this approach is to build collaborative frameworks for benefit sharing based on co-operation, negotiation and mutual agreement, incorporating shared information infrastructure (e.g. data systems, GIS, decision support tools, warning systems) and systems for monitoring, evaluation, review and improvement.

CONCLUSION

The KM framework described in this paper is designed to provide a systematic and structured approach to building the information requirements to enable trans-boundary benefit-sharing approaches to IWRM, by providing a framework for building the appropriate governance arrangements, policy settings and data/information infrastructure. This approach is built on the solid theoretical base of IS, as instantiated in our TbKM approach, and incorporates both theoretical insights from water resource disciplines and practical insights from the latest reviews of current efforts in trans-boundary river basin management. Our claim is that it can provide a powerful means for unlocking benefit sharing through its knowledge-based approach.

Clearly the research discussed here is conducted primarily as a conceptual study, and further work is required to apply and test this approach in specific river basins. This will occur as the next phase of this research, by using this approach to develop KM frameworks for three river basins in the Hindu-Kush Himalaya (HKH) region. These three river basins are the Koshi (shared by Nepal and India), the Teesta (India and Bangladesh) and the Indus (Pakistan and India). These three river basins range across quite different geographical and political landscapes and each case brings with it a different set of complexities. All are at relatively early stages in developing benefit sharing approaches, although some are far more advanced than others in developing shared information systems and in generating trust between the relevant governments and other key stakeholders. Together they will provide a good test of the flexibility, adaptability and applicability of the KM framework approach described here.

However despite the current lack of further empirical support for this approach (over and above the empirical studies that have informed it) it is clear that this work is valuable in its own right in a number of ways. Firstly, this approach is novel as it addresses the challenges of IWRM and benefit sharing through the theoretical lens of IS, something that (as far as these authors are aware) has not been attempted before. Secondly this approach has theoretical value in its own right in the way it adapts and extends the TbKM approach into new domains. Finally, by laying the platform for a new knowledge-based approach to IWRM this research has the potential to bring new and powerful means for achieving benefit sharing outcomes in trans-boundary river basins.

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