Educational Strategies: An Integrative Approach to Water Relations

Pieter van der Zaag, Universities Partnership for Transboundary Waters, and UNESCO-IHE Institute for Water Education
Lynette de Silva, Universities Partnership for Transboundary Waters, and Oregon State University

Abstract

The importance of symmetric access to information in the context of asymmetric hydro-graphic and political relations between countries, highlights the opportunities offered by modern techniques and approaches towards water management. Also of importance is the training of a new generation of water experts. These approaches are exactly what the Universities Partnership for Transboundary Waters (UPTW), From Potential Conflict to Cooperation Potential (PCCP), and the UNESCO-IHE Institute for Water Education have to offer. What is exciting about these approaches is that when combined, they are symbiotic, providing an integrative approach to water conflict management, and opportunities to more comprehensively explore the complex dynamics of conflict and cooperation over international freshwater resources. Through this means we increase the likelihood of finding strategies to anticipate, address, and mediate between competing water users. Technology has also afforded the ability to exchange information more efficiently, allowing us to readily foster a global water governance network and culture. These approaches will be explored using the Incomati River and Columbia River Basins, as case studies.

Introduction

With this paper we make the case that education and capacity strengthening is an important dimension in promoting transboundary water management. It is obvious that education on its own can never fundamentally change the existing status quo, and transform asymmetric power relations into more balanced relationships. However, we argue that water managers and water diplomats that have had a greater exposure to alternative view points and perspectives and to practical approaches and techniques, are more likely to make transboundary water management more effective. This is even more likely when all the riparian parties have sufficiently equipped technical and diplomatic staff.

We acknowledge that in most river basins large asymmetries exist between riparian countries in terms of hydraulic position (upstream or downstream) and in terms of economic, military, knowledge resources, and that transboundary water management always has a strong power dimension. However, power asymmetry does not automatically and in all contexts create an obstacle to peaceful sharing of a common resource (see e.g. Baland and Platteau, 1999).

We concur with Zeitoun, Mirumachi and Warner (this conference session) that a very effective way of exerting power is to have the power over ideas, and by doing so have control of the issues that are being considered and the issues and alternatives that remain hidden, unexplored and avoided. This in fact provides the strongest justification for relevance of capacity building and education on transboundary water management.

Education exposes trainees to (a) different perspectives to analyse transboundary dynamics and strategies that may help to better understand the mechanisms with which the status quo is reproduced and stabilised, and also possible ways to get or trigger positive change (e.g. towards greater equity); and (b) approaches, techniques, tools and measures that can, under specific circumstances, help to enhance and strengthen cooperation (think of issue linking, benefit sharing, water resources modelling etc.), but that each also have its particular limitations or pre-conditions. With such an exposure it will be more difficult for certain parties to "hide" or avoid certain possible alternative solutions.

We concur with Zeitoun et al. (this conference session) that certain forms of cooperation are a veil of maintaining an unjust status quo. Indeed, education and capacity building in itself and on its own are not likely to fundamentally and quickly change the power structure. One could, however, argue that empowering actors with new analytical and technical tools, especially from relatively powerless riparian countries, is unlikely to strengthen and sustain such an unjust status quo. It is more likely that they will question it and try to transform it.

Incomati River Basin in Southern Africa

The Incomati River, a relatively small river located in southern Africa and shared by South Africa, Swaziland and Mozambique, provides some relevant illustrations of the role of technical knowledge on transboundary water management. It should be noted that in this river system South Africa is the strongest party, in terms of economic power and also, partially, in terms of geographical location.

Four illustrations from the Incomati River Basin

The first illustration we give is the role of new data sources (data derived from satellite images) in promoting transboundary cooperation. The second illustration refers to the importance of negotiating parties having the technical capacity to develop alternative water allocation models, especially the parties that are considered less powerful. The third illustration is an alternative strategy that is frequently promoted in transboundary water management, namely benefit sharing rather than water sharing. Benefit sharing is not without it challenges, it is knowledge-intensive and requires expertise of a high level. And, the fourth illustration shows the usefulness of organising education and training on a regional basis, not only because it is more efficient if knowledge resources are scarce and unevenly distributed within a region (Opschoor, 2006), but also as a strategy that promotes a common understanding of what the real water-related issues are, resulting in future water specialists speaking a common (water) language, that enhances mutual respect, and that can be considered an investment in future peace.

(1) The opportunity posed by new data sources

Efficient management and use of water resources is a prime concern all over the world. When there is water scarcity this creates an environment of tension and conflict, while excess water can cause flooding and became a threat to citizens. A student from Mozambique investigated the possibility of the use of remote sensing to assess water storage in three reservoirs in the Komati Catchment, located in upstream South Africa (Magaia and Van der Zaag, 2006). The Komati Catchment is an important tributary of the Incomati River Basin. Water use and needs, as well as quantified maximum development levels are stated in the Tripartite IncoMaputo Agreement signed in Johannesburg in 2002. All three riparian countries need to implement a monitoring system and method to evaluate the agreement.

The main input from remote sensing was the delineation of the reservoir area and estimation of water storage in the reservoir using the relation water surface area-water stage and water volume. Four ERS (radar) images and 2 LandSat ETM images were used (for an example of ERS and LandSat images, see Figure 1). The surface areas that were obtained from ground data and that from remote sensing were compared. The study found that with remote sensing techniques the stored water volume could be estimated with an accuracy between 20-30%.

We may conclude that for countries that depend on releases from upstream reservoirs located in another country, remote sensing can be an alternative and independent source of data. The availability of remotely sensed images (optical and radar) has “democratised” access to crucial data (although most images are not available free of charge), allowing countries to access images that reveal the extent of water surfaces, and even water levels of lakes and reservoirs.

It may be hypothesised that the mere availability of remotely sensed data, as well as the technical capacity to interpret them, may induce parties to exchange the real data, and thus function as a trust building tool between them. For this to materialise, however, (a) these techniques need to be further tested (see also Sawunyama et al., 2005; Annor et al., 2009), and (b) riparian countries should have the knowledge and capacity to master these techniques.

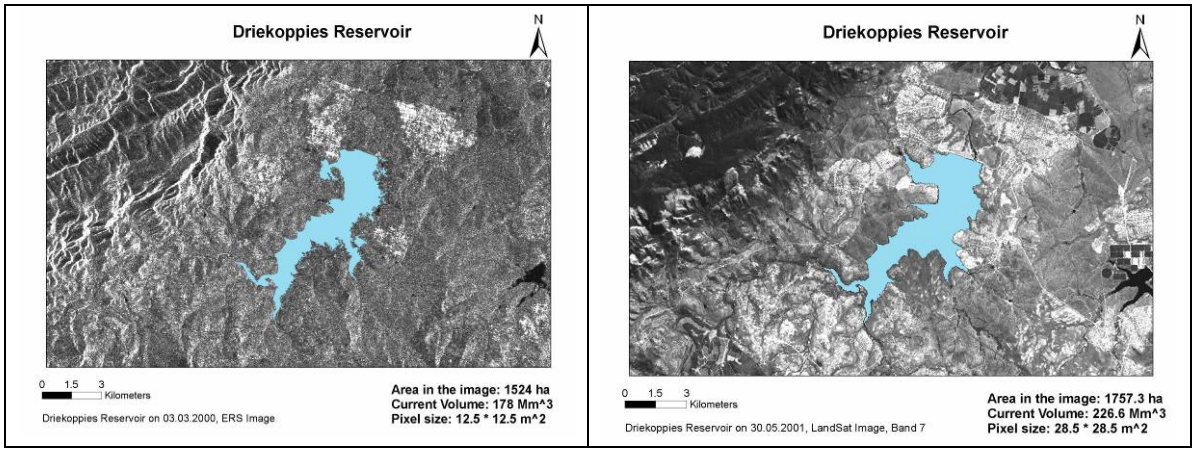

Figure 1. Driekoppies Reservoir in ERS and LandSat images
(source: Magaia and Van der Zaag 2006)

(2) Developing alternative models enhances

The Tripartite IncoMaputo Agreement of 2002 is unique in that it specifies in detail maximum water development levels and abstractions from the Incomati and Maputo Rivers by each of the three riparian countries. The negotiations leading to the Agreement largely focused on the correct interpretation of the available water resources. This requires a good understanding of the water system, and of system analysis models for water planning and allocation. The Water Resources Yield Model (WRYM) was especially developed for the Joint Inkomati Basin Study by private consultants in collaboration with the South African Department of Water Affairs and Forestry. The model was subsequently used during the negotiations on the Incomati and Maputo Basins. Mozambique and Swaziland did not have direct access to the WRYM model, but they could submit preferred scenarios to the South African experts, who would then run the scenarios and return the model results. There were continuous discussions about the model performance and the Swazi and Mozambican delegations were increasingly distressed about the fact that the model was developed and managed by South African experts, while South Africa was obviously one of the interested parties in the process (Juizo and Liden, 2008). The model results were thus viewed with suspicion by the other two countries. The incapacity of Swazis and Mozambicans to use the model themselves and test it in order to become confident in its performance, clearly affected the speed of the negotiation process.

Master students from, among others, the departments of water of Swaziland and Mozambique co-developed an alternative, much simpler, although still quite complex, water resources model. Various water sharing scenarios were analysed using that model (Sengo et al. 2005; Nkomo and Van der Zaag, 2004). Although, we do not have evidence that this alternative model has been used in subsequent negotiations, but the point is that for transboundary water management some redundancy in the models used may be prudent, due to the inevitable complexities and uncertainties, which are likely to lead to distrust and controversies about model outcomes. The capacity to compare and debate the outcomes of alternative and competing water resources models can in our view only enhance the quality of the decision process, and more readily lead to converging understanding.

(3) Benefit sharing is knowledge intensive

Sadoff and Grey (2002) suggest that when riparian countries negotiate the equitable and reasonable utilisation of a transboundary river basin, they should not solely focus on the allocation of water, they should also focus on the equitable sharing of the benefits derived from the water. This idea of benefit sharing rather than water sharing has become very fashionable. Benefit sharing is a concept with appeal. But there are also some limitations, among them the following (Van der Zaag, 2007; see also Dombrowsky, 2009):

1. Benefit sharing presupposes a consensus over basic entitlements, which is likely to have been a major obstacle in the first instance.
2. Benefit sharing arrangements should encompass all the benefits and all the costs across the entre basin. The costs of large water schemes are often belittled or remain hidden.
3. The sharing concept seems to suggest that all benefits (and costs) are quantifiable and commensurable. It is for example, not trivial to compare the costs of loss of recession agriculture with the gains of irrigation.
4. For benefit sharing to be fair requires an effective system of redistribution of the benefits over those who bear the costs. Not trivial either!

The point is that benefit sharing arrangements are knowledge intensive, as it requires both an adequate understanding of the available water resources (and their reliabilities) and water needs, as well as an understanding of all the costs and benefits. Maguga Dam in Swaziland (on the Incomati River) is a typical benefit sharing venture. The dam is located inside Swaziland, but approximately 60% of it was financed and is now owned by South Africa. Box 1 gives an excerpt of the benefit sharing agreement. Note that the full agreement is much more complex, whereby also different levels of assurance of supply are defined and "commensurated" (see Swaziland and South Africa, 1992). It may be concluded that without well-trained water experts and diplomats, it will be difficult to develop benefit sharing arrangements that share the costs and benefits fairly.

Box 1: Summary of a benefit sharing arrangement between South Africa and Swaziland on the Komati River.
Source: Treaty on the development and utilisation of the water resources of the Komati River Basin between Swaziland and South Africa, signed on 13 March 1992; Annex 2 (Apportionment of capital cost)

Total Cost of Driekoppies Dam	T_D	=	R 104.7	million
Total Cost of Maguga Dam	TM	=	R 138.3	million
Hence: Total Cost	T	=	R 243.0	million
South Africa: incremental water allocation per year	i_r	=	111.0	cubic hectometres
Swaziland: incremental water allocation per year	i_s	=	72.6	cubic hectometres
Hence: Total incremental water allocation per year	i_t	=	183.6	cubic hectometres

The Basic Cost is apportioned to Swaziland and South Africa in proportion to the mean basic water shortages experienced by each of the respective states in 1981, i.e. 0.11 and 0.89 respectively. The Basic Cost shall be fixed as 0.599 times the Total Cost. The Incremental Cost is apportioned to Swaziland and South Africa in proportion to the incremental water allocations expressed as equivalent High Assurance water.

Hence Swaziland's share of the Total Cost expressed as proportion of the cost of Maguga Dam is given by:

$$S_s = \frac{T}{T_M} \times (0.599 \times 0.11 + 0.401 \times \frac{i_s}{i_t})$$

$$= \frac{243.0}{138.3} \times (0.06589 + 0.401 \times \frac{72.6}{183.6})$$

$$= 0.39438$$

Accordingly South Africa's share of the Total Cost of Maguga Dam ($1-S_s$) is 0.60562.

(4) The relevance of a regional approach to water education

The above illustrations demonstrate that water management requires expertise of a high level. Those involved in transboundary water management need a balanced mix of analytical and process-oriented knowledge and skills. Water education typically requires a broad curriculum. In this section we focus on the experience with postgraduate training in integrated water resources management (IWRM) in Southern Africa, WaterNet.

Given the broadness of the required curriculum, there is hardly any individual university that has the combination of expertise required to offer such a Masters in Water Resources Management. It is therefore nearly inevitable that a consortium of universities jointly offers such a Masters programme – this will allow the best expertise in all the specific fields to be brought in. This is a very efficient way of pooling and sharing expert knowledge.

Connecting institutions on a regional basis makes sense not only in that it allows to pool resources, but also because water has a transboundary dimension. Through connecting universities regionally, knowledge capacities are being spread and shared, which will contribute to equity and is more cost-effective than doing this at national level (Opschoor, 2006). Furthermore, the educational process of students from different countries sitting in the same class, learning the same concepts will enhance respect and mutual understanding. Moving these students around in the region further exposes them to a regional perspective. All this is thought to facilitate future cooperation on water and provides an investment in future peace.

WaterNet conducts a combination of activities that reinforce each other: the regional Masters programme allows for comprehensive short professional courses; the research activities provide thesis research projects for Master students, generating new insights that are fed back in the curriculum, as well as research papers that are presented during annual meetings. These symposia provide a platform where researchers, professionals and policy makers meet and exchange ideas (see Figure 2). Taken together, WaterNet has promoted the professional interaction at the regional, transboundary level. Several of the publications referred to in this paper are results of a WaterNet related activity.

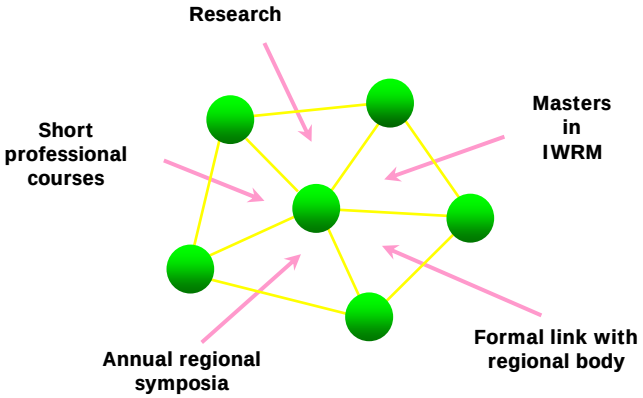

Figure 2: Regional capacity building in water resources management

Columbia River Basin in North America

The Columbia River Basin is approximately the size of France, and is the fourth largest river in the US. Fifteen percent of the basin is in Canada, in the Canadian province of British Columbia; and the remainder of it is in seven US States, Washington, Oregon, Idaho, Montana, Nevada, Wyoming, and Utah. In fact, 33% of the Columbia River water flows from Canada into the US. Management of the river is influenced by the 1964 Columbia River Treaty between the US and Canada, providing benefits to the US and Canada in the form of hydropower and flood control. Furthermore, both the US and Canada have the option to terminate or make changes to the treaty after 60 years (2024), but must give 10 years advance written notice in order to do so (USACE & BPA, 2009).

With 2014 fast approaching, the Columbia River Basin is at a critical juncture, not only because of the possibility of renegotiation of the treaty, but also because over the next decade, several contributing factors could trigger rapid change and social and economic instability in the basin (Everard, 2004), placing greater demands on competing water interests. These contributing factors include climate change, continued regional population growth, a threatened and deteriorating ecosystem, demand for non-fossil fuel energy, and deteriorating infrastructure.

Given these challenges a group of faculty formed the Universities Consortium for Columbia Basin Governance (Consortium) to determine how they might contribute in addressing basin-scale issues. The consortium comprises the University of British Columbia, Washington State University, University of Idaho, University of Montana and Oregon State University. What makes this group of universities unique is that they are all designated as “Land Grant Universities,” tasked with the special responsibility of providing applied, practical education and practical information to assist in natural resources management.

A fundamental premise of the Consortium partners is that the process of water governance can be improved by research that is informed by stakeholder input. Under the auspices of the renegotiation of the treaty, there is a mechanism, and an existing framework, along with a built-in timetable to help drive the process.

This newly formed Consortium has recently proposed, “to build a collaborative group that will develop innovative, interdisciplinary approaches to guide decision making under uncertainty using water governance in the Columbia River Basin as our decision making arena” (Santelmann, 2009). Several tools are proposed to improve decision making processes to better understand complex adaptive systems, economic and hydrologic scenarios, and policy and governance outcomes. Also included is a task to integrate research and education; discussion here is limited to this task.

Three illustrations from the Columbia River Basin

The first illustration focuses on school age children, and ways we can engage them in the challenges we face on the global, regional and local scales, using creative mechanisms to meld art with science into the school curriculum. The second example focuses on undergraduate students, providing them with an opportunity to develop international agreements for environmental and water issues through practicing the art of negotiating. And, the third demonstrates how graduate students might earn university credit while applying learnt water governance skills.

(1) Enhancing water education for school age children

The consortium proposes to develop water-related educational programs that integrate art with science. The approach involves partnering with national branches of organizations such as Project WET (Water Education for Teachers), a non-profit program for teachers and young people; regional library systems; and teacher-training programs offered by children's museums, such as the Oregon Museum of Science and Industry (OMSI), to reach children, parents, educators and the community with water education. Santelmann et al. (2009) proposed this approach primarily geared as a means to both educate and engage young people by providing broader opportunity through which they can learn, communicate, and express themselves. It is being designed to become a means to give voice to children basin-wide, including those from urban and tribal schools.

This kind of educational approach would allow children to participate in a more innovative school curriculum, while learning about global and local environmental concerns, water governance and water conflict management. The education modules will include basic instruction about the science behind the environmental issues, followed by training teachers to help students express their understanding and vision of environmental choices and the outcomes of those choices. Among some of the multimedia and arts approaches that Santelmann et al. (2009) suggest are films, visual arts, dance and music. It is hoped that school-age children will see the impact they can have within their region, and help build community and create a basin-wide cultural awareness of the issues.

(2) Building negotiation skills

To explore the complexities and dynamics of developing international agreements for environmental and water issues, undergraduates can be introduced to the process of negotiating, through preparing for and conducting mock negotiations (Jordan et al., 1998). These mock negotiations provide a mechanism to emphasize the need to understand differences among parties, particularly, states and nations with regard to interests, culture, perspectives and values.

Each Consortium institute would have five students take on the role of different stakeholders in the mock negotiation. In preparation students would be expected to do pre-negotiation research. Professional negotiators would be invited to act as coaches at the mock negotiation; and actual basin stakeholders would be invited to provide strategic consultations (Santelmann et al., 2009).

This kind of reflective tool can provide students with first-hand experiences with the negotiation processes; it can be used for discussion purposes and feedback after the mock negotiations; and can be used by teachers to identify strengths and weaknesses in the curriculum.

Various scenarios could be readily explored, and possible outcomes could add a human component to decision making models being developed by the Consortium, thereby informing the process. This exercise was utilized in 1998, by one of the Consortium faculty, while acting as a co-principle investigator at the University of Alabama, on a project centered around the water dispute involving the Alabama-Coosa-Tallapoosa and Apalachicola-Chattahoochee-Flint

(ACT/ACF) River Basins of Alabama, Florida and Georgia (Santelmann et al. 2009; Jordan et al. 1998).

(3) Integrating theory with practice

Graduate programs such as Oregon State University's Certificate in Water Conflict Management and Transformation explicitly integrates human, policy and scientific dimensions of water resources within the framework of governance and sustainability. And its capstone course entitled, "Water Governance and Conflict Management" coupled with an intersession capstone internship, provides an opportunity to gain hands-on experience (de Silva, 2008). This internship is designed to provide students with an opportunity to work with a mentor on water-related issues, applying learnt water governance skills to watershed councils, local government agencies within ones community, and other water-related programs and initiatives.

Through this course, students earn college credits at an internship site of their choosing, that has been approved by the instructor. This provides a platform for hands-on learning in a safe environment under the tutelage of a mentor, while exploring and gaining understanding of everyday challenges that often must be balanced to meet the needs of the community. The course also includes writing assignments. In all, the internship provides a mechanism for moving students to a more professional role in the workforce by melding theory with practice.

Conclusion

Transforming asymmetric power relations into more balanced relationships is a daunting task. And in fact, there may be no quick solutions to change the power structure. But by empowering actors and providing less powerful countries with additional resources, such as more training and new analytical and technical tools, important questions and concerns may be part of the discussions and negotiations.

Universities can play a vital role in bridging the divide among riparian nations by providing education and training, outreach and information resources, and coordinated applied research. To address these needs universities and institutions are going beyond the traditional physical systems approach to water resources management training and are finding innovation and integrative approaches to water relations. The approach is to cross-disciplinary fields; to break down barriers; to prepare students to successfully work and communicate in a multi-disciplinary, multi-cultural environment.

In fact, universities are gearing these educational strategies towards, not only technical and diplomatic staff or even trainees and graduates, but the next generation, school age children. Thereby investing in the future by building community and creating a basin-wide cultural awareness.

So whether integrative approaches to water relations are built through tapping into regional approaches to water education, accessing new data sources and models, benefit sharing, building negotiations skills, or integrating theory with practice, these varied approaches will broaden ones perspectives. Furthermore, it is hoped that this kind of approach will afford the opportunity to assess water governance and conflict management at several geographic and temporal scales to hopefully better anticipate, address, and mediate between competing water users and riparian nations.

References

Annor, F.O., N. van de Giesen, J. Liebe, P. van de Zaag, A. Tilmant and S.N. Odai, 2009. Delineation of small reservoirs using radar imagery in a semi-arid environment: a case

study in the Upper East Region of Ghana. *Physics and Chemistry of the Earth* 33: 309-315

Baland J.-M., Platteau J.-P., 1999. The ambiguous impact of inequality on local resource management. *World Development* 27(5): 773-788.

de Silva, L., 2008. Press Release: The Certificate in Water Conflict Management and Transformation. ADDRESS: http://www.transboundarywaters.orst.edu/training/certificate.html [Accessed 28 July, 2009].

Dombrowsky, I., 20009. Revisiting the potential for benefit sharing in the management of trans-boundary rivers. *Water Policy* 11: 125-140

Everard, M., 2004. Investing in sustainable catchments, Sci. Total Environ. 2004 May 25; 324 (1-3): pages 1-24.

Jordan, J.L., A. Wolf, C.H. Bryan, and D. Lee, 1998. Using 'Mock Negotiations' to Teach Conflict Resolution: An Interstate-Interdisciplinary Approach to Water Allocation Problems. Proceedings of the UCOWR Annual Meeting, pp. 62-84.

Juízo, D., Lidén, R., 2008. Modeling for transboundary water resources planning and allocation, *Hydrology and Earth System Sciences Discussions* 5 (1), pp. 475-509

Magaia, E. J., and P. van der Zaag, 2006. Remote sensing and GIS for reservoir water assessment in the Incomati basin. Paper presented at the 7th WaterNet/Warfsa/GWP-SA Symposium on “Mainstreaming IWRM in the Development Process”. Lilongwe, 1-3 November.

Nkomo, S. and P. van der Zaag, 2004. Equitable water allocation in a heavily committed international catchment area: the case of the Komati Catchment. *Physics and Chemistry of the Earth* 29: 1309-1317.

Opschoor JB. 2006. Tertiary capacity development and societal development: reflections in relation to OECD/World Bank ‘Cross Border Higher Education for Development’ draft. World Bank/OECD/Nuffic Seminar, 14-16 September; Nuffic, The Hague.

Sawunyama, T., Senzanje, A., Mhizha, A., 2006. Estimation of small reservoir storage capacities in Limpopo River Basin using geographical information systems (GIS) and remotely sensed surface areas: Case of Mzingwane catchment. *Physics and Chemistry of the Earth*, 31 (15-16), pp. 935-943.

Santelmann, S.V., A. Wolf, S. Capalbo, W. Jaeger, K. Vaché, R.K. Paisley, F. Fiedler, B. Cosens, E. Weber, M. McKinney, 2009. Water Governance in the Face of Uncertainty. Proposal submitted to National Science Foundation, July 2009.

Sengo, D.J., A. Kachapila, P. van der Zaag, M. Mul and S. Nkomo, 2005. Valuing environmental water pulses into the Incomati estuary: key to achieving equitable and sustainable utilisation of transboundary waters. *Physics and Chemistry of the Earth* 30: 648-657.

U.S. Army Corps of Engineers, and Bonneville Power Administration, 2009. ADDRESS: Columbia River Treaty History and 2014/2024 Review. http://www.bpa.gov/Corporate/pubs/Columbia_River_Treaty_Review_-_Feb_2009.pdf [Accessed 28 July 2008].

Van der Zaag, P., 2007. Asymmetry and equity in water resources management; critical governance issues for Southern Africa. *Water Resources Management* 21 (12): 1993-2004