Linking science and policy on environmental flows: how science can better meet the needs of policymakers and practitioners

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Abstract

Science has always helped to build decisions not actually make the decisions (Cortner 2000). This paper addresses how decisions on environmental flows should not just be determined directly from scientific data but requires active learning and communication between stakeholders from the inception of an assessment to the implementation. Informed decision making requires that the decision maker understands what the outputs of an environmental flows assessment are and how they can be used to aid in deciding future water allocations. This type of approach to environmental flows assessment is a multi-step process that provides a bridge between the science and policy realms. Cooperative communication coupled with action learning can ensure that the knowledge imparted by scientists to inform decision makers will also be informed by the needs of the decision makers themselves.

Introduction

When planning development on a river, decision making on water allocation can be improved if stakeholders and those responsible have more and better information. This includes information on the water needed to sustain ecosystems that provide essential goods and services to people in the river basin. For example, if a decision maker has information that shows the location of a dam further upstream will help reduce negative impacts downstream, this knowledge can be put on the negotiating table when deciding on dam construction and water allocation. Furthermore, to conduct an adequate cost – benefit analysis that reflects upstream and downstream impacts of infrastructure, knowledge of how impacts vary under different flow regimes is needed. It is easier and less costly to spend time and money upfront determining potential impacts rather than trying later on to fix problems that could have been avoided.

The challenge therefore for scientists is to deliver knowledge to policy and decision makers that is reliable, in a usable format and timely. Only then can knowledge become useful when weighing up decisions. In addition to cost-effectiveness, this demands that attention is given to balancing the need to acknowledge uncertainty with decision-makers' needs for clarity over the different outcomes of alternate development choices. This has meant that while there has been considerable progress in understanding how changes in flow impact ecosystems, there is a growing call for simplified methods that deliver results that better meet the needs of policy-makers and planners.

Simplification carries the danger, however, that key factors affecting how changes in flow impact ecosystems are missed. In such a scenario, new flow allocations might actually lead to further river degradation. Rapid assessment techniques are an option but these do need a comprehensive data set on which to base conclusions. Consequently, at some point detailed studies are needed to have an adequate base of knowledge to draw data from. If environmental flows assessments are decided on inadequate data uncertainty and the likelihood of errors grows, which may lead to questioning of the credibility of the assessment.

Putting the costs of flows assessments into perspective reveals that they are only a fraction of the sum (less than 1%) needed to build a dam or other such water infrastructure developments. Savings can be found in both the long and short term to protect the environment and secure livelihoods that are supported by river flows if an assessment is carried out. Proper planning can save money in the long run that would have been spent of mitigating earlier mistakes. For example, in South Africa there has been a need to build flood retention structures because of poorly planned dams further upstream.

Flows assessments are conducted for a river so the relative cost is even less as the information can be used in planning of all dams that are constructed along the water course. Finally, investments are not limited to data acquisition but can also be used to build capacities of technical experts to do flow assessments and of policy and decision makers to make use of and understand results from assessments.

The challenge for science of better meeting users needs can thus be met in part by care in selecting methods and in carefully determining the intensity of data collection required. However, perhaps the most important step in bridging science and policy is to create opportunities and forums for scientists and end-users from policy and decision arenas to work together on assessments. Communication and application of action learning in environmental flows assessment will support learning by both scientists and policy-makers. This will help policy makers to better handle uncertainty and it will give scientists critical insights into how information is used and therefore what information should be targeted in assessments.

This paper will first examine the role of science in policy making and how decisions can be guided using scientific knowledge. However, science should not be treated as the ultimate answer to complex problems. The discussion of science and its interaction with policy is then more specifically focused around the science of environmental flows. Environmental flows assessments need to be carried out in a way that can deliver information that can actually be used and applied. This can be achieved by scientists and policymakers working together to design assessments and interpret data derived from scientific studies. The Pangani Basin is put forward as a case study where multidisciplinary teams that include decision makers are working together to implement environmental flows in the basin. Finally, the importance of communication and learning between stakeholders including scientists and policymakers is discussed. The conclusion is that communication must lead to a process of mutual learning and trust among all parties (Funtowicz et al. 2003).

The Role of Science in Policy Decisions

"Science alone does not hold the power to achieve the goal of greater sustainability, but scientific knowledge and wisdom are needed to help inform decisions that will enable society to move toward that end" (Lubchenco 1998).

This statement by Jane Lubchenco in the Presidential Address to the American Association for the Advancement of Science in 1997 highlights the importance of science in guiding and informing policy decisions. Nonetheless, there should be an awareness that although science can provide key information and knowledge it does not actually deliver the decisions themselves (Gregory 2006; Cortner 2000). There is often a misconceived notion by society that science will solve all problems from climate change to public health to water management. Yet, research and science is not a panacea for policy decisions, as social and economic problems will continue to persist while the complex relationships underlying these problems are neglected (Stone 2002). For example, science can produce a vaccine against waterborne diseases but they will still persist due to social and economic obstacles, such as limited access to clean water sources and the lack of education on hygiene and sanitation. Scientific expertise is capable of making suggestions on possible solutions based on available information, but cannot directly address social, cultural or economic considerations that must be incorporated into decision making though deliberative, and often political processes (Gregory 2006).

A simple conceptual model of the linkage between science and policy is that first the science is done and then the policy is formulated (Jäger 1998). This linear model assumes that scientific consensus is an essential prior step before policy development and implementation. But the reality is that there is no simple linear model of solving problems using a universal scientific explanation. For example, there is a need to recognize how scientific knowledge is shaped by political and cultural biases (Forsyth 2003). To illustrate this, consider the belief that increasing population and agricultural intensification in the Himalayas is leading to enhanced deforestation, erosion, landslides and lowland sedimentation. However, new research has since shown that much of the erosion is caused by processes other than agriculture – including gullying and the effects of tectonic lift. Forsyth (2003) argued that the projection of the crisis onto the Himalayan region by American researchers reflected their own cultural background of experiencing soil erosion as a major problem in the Dust Bowl, rather than necessarily posing the same threat to hill farmers in Nepal.

This example acknowledges that science in not value free but finds its justifications through prevailing and ingrained social concerns (Funtowicz et al. 1998). Scientific or causal statements underlying assessments of global problems or solutions can reflect the political and social values of societies or networks that created them (Forsyth 2003). Politics, values and ideology are an inevitable part of policy making and are reflected in how funding is allocated, the values of scientists, and the way in which scientific results are used to justify political decisions (Stone 2002). Scientific research can legitimize the aims of those who commissioned or funded it, and at the same time the scientists or research group gains policy credibility and some authority (Stone 2002). Therefore, the science which is produced in the first place is always indirectly linked to a political agenda. Science is political because it is infused in values and scientists are members of policy communities that react to norms and conventions, as well as political incentives (Cortner 2000).

Acknowledgement that science and policy are inextricably linked is a step towards harnessing science so that it can be used to enhance and inform the social processes of problem resolution rather than simply providing a definitive solution or technological implementation (Funtowicz et al. 1998). This means including participation and mutual learning among key stakeholders when making decisions, so that there is a clearer understanding of what science can provide in regards to technical knowledge, and what information policy makers actually need to make informed decisions. There is a push for the inclusion of policy makers in the design and use of assessments and assessment tools. There is also the call for the inclusion of diverse stakeholders, including the lay public, in the assessment process. As science is often driven by social issues, then place-specific knowledge and the resources of local communities are complements to knowledge derived from scientific practice (Funtowicz et al. 1998).

The old conception of scientific communication as a one-way flow of information from experts to the public has to be replaced by a notion of partnership through reciprocal learning among those involved in the process (Funtowicz et al. 1998). The general public is increasingly encouraged to use their discrimination on scientific questions, just as on all others of public concern. This can raise difficulties because public opinion can be formed through a variety of outlets such as media, pressure groups, and local discussions. Consequently, quality assurance processes are needed for science and policy that are based on wide societal and ethical reflections.

We know that if quality assurance in scientific research is inadequate then the foundations of the message may be flawed. However, it is not only inaccurate information or analysis that can be dangerous, but also the lack of involvement of other stakeholders in drawing conclusions from research can lead to adverse impacts (Crewe and Young 2002). For example, if water allocation amounts are determined using insufficient information then the likelihood of errors grows, which may cause the credibility of an assessment to be questioned. The decision to release water from a dam without adequate data on the downstream effects can threaten native aquatic species and can either artificially enhance or degrade riparian soils and vegetation. In addition, erosion and sedimentation can lead to hydrologic, ecological, and economic impacts that effect local livelihoods and well-being. Understanding such impacts benefits from the participation and the contribution of knowledge by diverse stakeholders. Moreover, making choices over the trade-offs between such impacts demands that technical knowledge is placed alongside wider social, cultural, ethical and political considerations in deliberations over decisions.

Environmental Flows Science and Policy

An environmental flow can be defined as “the water regime within a river, wetland or coastal zone to maintain ecosystems and their benefits where there are competing water uses and where flows are regulated” (Dyson et al. 2003). The concept of environmental flows aims at a natural flow regime, which does not necessarily mean a larger volume of water is available after an intervention (Meijer 2007). The level of health at which a river is maintained depends on the judgments from society, which can vary between countries and regions.

Since the emergence of environmental flows science, various methods have been developed to assess environmental flow requirements. As the science has evolved so have the various methods, which amount to more than 200 (Meijer 2007). Environmental flows methods can be grouped into four categories: ‘hydrological’, ‘hydraulic rating’, ‘habitat simulation’ and ‘holistic’ methods (Tharme 2003). Reviews of various methods have been conducted by a variety of authors including Karim et al. 1995; Jowett 1997; Dunbar et al. 1998; King et al. 1999; Tharme 2003; Acreman and Dunbar, 2004. The reviews indicate that there is not one method that can be applied to all situations, rather the method used depends on various factors such as the availability of data for the studied river, location and extent of the study area, time and financial constraints or the level of confidence required in the final output (Meijer 2007).

Nonetheless, only a few environmental flow assessment methods include the evaluation of livelihoods and social well-being in relation to river flow regimes. These include the Building Block Method, DRIFT (Downstream Response to Imposed Flow Transformation) and the Managed Floods Approach (Meijer 2007). These methods are classified as holistic and require considerable multidisciplinary expertise and input. Holistic methodologies are frameworks that incorporate hydrological, hydraulic and habitat simulation models, and sometimes socio-economic aspects of environmental flows (Korsgaard 2006). A successful decision making process for determining environmental flows needs to include representatives of different interest groups as well as scientists and experts (Dyson et al. 2003). Such integrated environment flows assessments are multi-step processes that provide a bridge between the science and policy realms.

Although these integrated processes are providing an initial link between science and policy, the question remains why environmental flows science is not leading to more implementation. Is this because the methods and outputs are too complicated or perhaps not relevant? If so, what can assessments do differently to help decision makers implement water allocation regimes that include environmental flows?

The environmental flows concept is driven by science and provides information on the amount of water that needs to be allocated to the environment to maintain a healthy ecosystem. Inputs and recommendations are made by scientists, but science is not necessarily equipping policymakers to make decisions about implementation. The information provided by scientists is often too complicated and there is a danger that policymakers will come to disregard environmental flows science. However, simpler environmental flows assessment methods will not necessarily provide clearer information to policy makers. Rather the process by which the assessment is undertaken is the key to moving towards implementation. The involvement of decision makers such as river basin managers and government officials in each step of the process ensures they have a good grasp of why the assessment is important and what the data means thereby increasing the likelihood of implementing environmental flows when deciding on water allocation. In other words, the type of method used is not so much the issue, but instead it is the process of assessment and the involvement and communication with stakeholders that is important. Direct contact between technical staff and involved decision makers, local people and interest groups is the best pathway to translating information into understandable concepts and building trust (Dyson et al. 2003).

Decisions should be made on the basis of values and tradeoffs of stakeholders rather than only through technical debates. In addition, science remains a useful source of knowledge but environmental flows scientists need to be aware that decision makers also use other information. Thus, assessments need to be done hand in hand with decision makers. “Scientists must learn as well as teach; policy makers must specify their needs and accept uncertainty as well” (Funtowicz et al. 1998).

Bridging Science and Policy: The Case of the Pangani Basin

Background on the Pangani Basin

The Pangani River Basin (PRB) covers an area of 43,650 km^2, with a 5% of this area in Kenya and the remainder in Tanzania in the administrative regions of Arusha, Manyara, Kilimanjaro and Tanga (Figure 1). The administrative Pangani Basin has an estimated population of about 3.4 million; with about 2.6 million within the Pangani River Basin. Population density is highest in the northern and eastern highlands, and is relatively sparse throughout most of the rest of the basin area. Eighty percent of the population relies either directly or indirectly on agriculture for their livelihoods. The PRB is also an area where there is large concentration of pastoral communities, who are nomadic and depends on livestock for their livelihoods. The increased competition for land and water resources means that the pastoralists are forced to move constantly in search of water and pasture. They are the poorest, most excluded and marginalized people in Tanzania. The population of PRB continues to grow faster than its urban and industrial economics, with more people relying on agriculture for survival every year. Consequently, there is increasing competition and conflicts over land and water resources. Furthermore, due to the diversity of interests within the basin and as there are gaps in water governance this also creates various degrees of conflicts over the use of water resources.

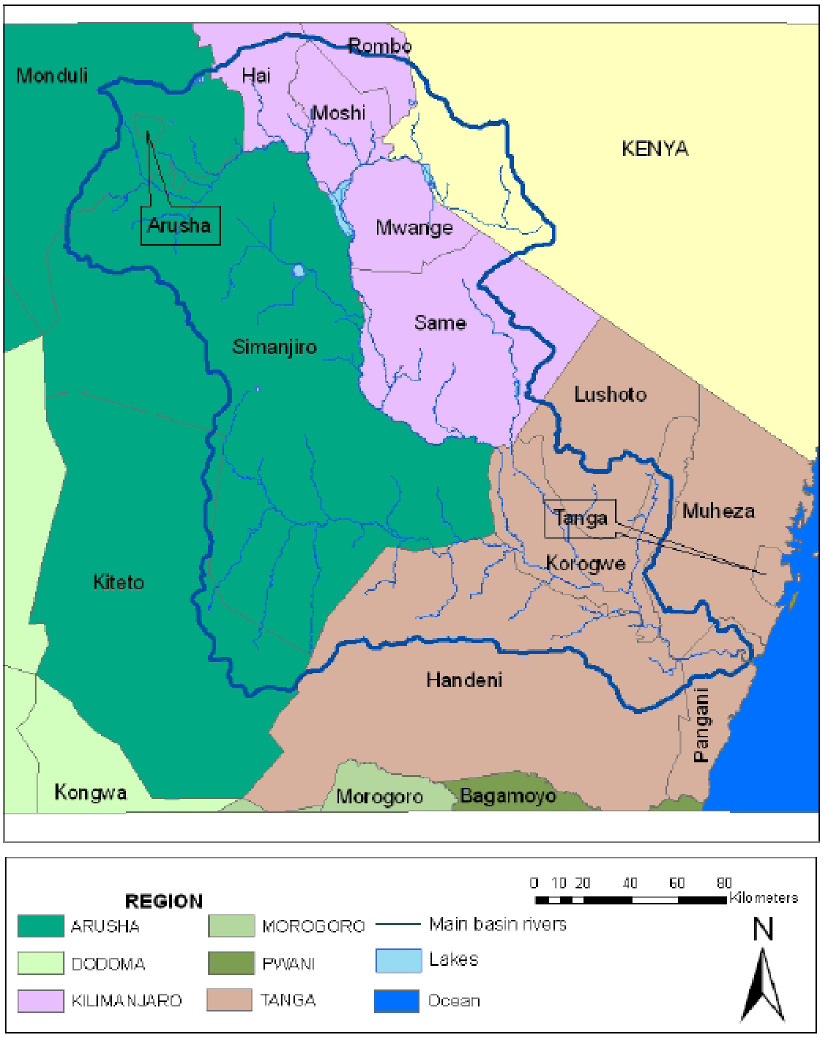

Fig. 1. The Pangani River Basin in relation to administrative boundaries in north-eastern Tanzania.

The Ministry of Water in Tanzania launched a new national water policy in 2002 (NAWAPO 2002). Within NAWAPO 2002 water for basin human needs is given the highest priority for water allocation, followed by water for maintenance of ecosystems. Environmental flow assessments are required for Tanzanian rivers to implement the Water Policy (Acreman et al. 2005). However, Tanzania has little experience and capacity in conducting such flow assessments. The IUCN Water and Nature Initiative (WANI) are using demonstration basins, such as the Pangani Basin in Tanzania, to show how implementing the policy can produce tangible results.

In the case of the Pangani Basin an environmental flow assessment has been undertaken as part of the Pangani Basin Management Project. The objectives of the flow assessment were to provide technical information to water managers on the water allocations necessary to maintain environmental goods and services. Secondly, the aim was to build the capacity of research communities, water managers and decision makers within Tanzania to implement flow assessment programmes. The process included gathering and analyzing technical information on hydrology, water quality, river and estuary ecology, and socio-economics while at the same time people learned the intention of the policy, and what it meant in practice. The participants in the environmental flows assessment process learned what the information meant and how it could be used. This was all done in conjunction with setting up governance arrangements in the basin which can further use the information to make water management decisions.

Policy – Enabling change and mobilizing action

The Tanzania National Water Policy (NAWAPO) was followed by the formulation of the National Water Sector Development Strategy (NWSDS) to implement the policy. Emphasis is on IWRM, which is also reflected in the Water Sector Development Programme (WSDP) 2006-2025 which was launched in March 2007 during World Water Week. The WSDP provides a strategic background for the implementation of plans and interventions for the achievement of national targets, and calls for development partners to actively engage and support the water policy/strategy. Implementation of the WSDP is contingent on the water law, as it is hard (but not impossible) to implement policy comfortably without law and guidelines. To ensure that polices do not conflict there is funding available for policy harmonization for all water related sectors under the WSDP.

The NAWAPO directs that water resources management in Tanzania should be organized around participatory and representative forums, starting from the national level to basin and sub-basin level. The policy identifies five levels of basin management – the nation, the basin, the catchment, the district and the community or water association level. The institutional framework for water resources aims to integrate sectors at different levels, and this is formalized in the new water law. At the national level, the irrigation, tourism, agriculture, etc sectors interact through the national water board. At the Basin level there are integrated boards (such as the Pangani Basin Water Board) with different water users and sectors. At the catchment level, the aim is to have a catchment council that will provide integrated planning. District councils will participate fully in basin boards and catchment councils. Districts are also responsible for planning and development of water resources. The community level and Water Users Associations (WUAs) are responsible for local-level management of allocated water resources (IUCN Eastern Africa Programme 2003).

Practice – Realities on the ground

The building blocks are in place and the institutional framework is being developed to ensure that there is a participatory and inclusive process of making decisions over water allocation in Tanzania. Putting policy into practice requires understanding of the barriers to change in water management. In the Pangani Basin this includes conflicts over water resources between different sectors (i.e. agriculturalists, pastoralists and hydropower) and between upstream and downstream users. Poverty is also a critical concern as people have competing priorities to survive. Economic drivers can also be a barrier to change as there is growing demand for hydropower and large scale irrigation as development is pushed forward. Finally, there has been a lack of capacity at the technical, institutional and community levels to work together to implement environmental flows.

Pangani - Flows Assessment

Through the Pangani Basin Management Project some of these barriers are being addressed. As mentioned above, part of the project was to undertake a comprehensive environmental flows assessment with the aim of supporting eventual implementation. A situation analysis of the Pangani Basin, commissioned by IUCN in 2003, was undertaken to understand water management issues in the basin. Also in 2003, IUCN in partnership with the Tanzania Ministry of Water and the World Bank, convened a training workshop entitled, *Building Capacity to Implement an Environmental Flow Programme in Tanzania.* Awareness of the different environmental flows assessment methodologies and techniques was raised during this workshop and important networking contacts with international practitioners were established. During the following 18 months, IUCN worked with the Basin Water Office, the Ministry of Water and the international practitioners to custom-design a flow assessment methodology for Pangani Basin.

As a result of the training workshop and subsequent exchange visits, IUCN, the Ministry of Water and the international practitioners designed a project that would focus both on building capacity within Tanzania to do environmental flow assessments as well as generating technical information to support water management. The project is currently ongoing and has gathered and exchanged information that captures the relationships between water flows, and social, economic and environmental aspects. A tool (to be used in a modified version of DRIFT) has been developed to model these relationships and evaluate the social, economic and environmental implications of specific water allocation scenarios.

As part of the Flow Assessment Component of the Pangani River Basin Management Project a State of the Basin Report was produced in 2007. The report collected and synthesized present knowledge on the Pangani River systems and its users to help promote an integrated approach to future water-allocation decisions.

The next steps involve developing scenarios that will be tested using the modified DRIFT model for the Pangani Basin. Participants in the flow assessment will identify conceptual relationships and compile data to be input into the scenario-evaluation tool. Projected impacts of changes in flow for each scenario will then be compared. Outputs from the scenario workshop will be used to help decision makers determine strategies for water allocation in the Pangani Basin.

Pangani – Implementing Change

The knowledge gathered from the Pangani River Basin Management Project has a multitude of applications if it is used within activities that develop and strengthen partnerships, work towards conflict resolution and governance arrangements. For example, the development of sub-catchment councils will provide a platform that can support representation of all stakeholders in an area so that they can voice their interests and concerns over water allocation, while at the same time learning about the needs of other constituents. The need for such multistakeholder platforms was identified as a gap in the water policy; therefore these types of institutions will be included in the new water legislation.

Another example is that the capacity building component and specifically the exchange between multi-disciplinary teams of international experts whom are mentoring Tanzanian experts through the flow assessment process has resulted in an increased appreciation for flow assessments among the technicians involved. The aim was for the Tanzanian team to serve as a national-level resource for conducting flow assessments in other basins and indeed, some of the Tanzanian technicians are already involved in similar work in other basins.

The process underway in the Pangani Basin demonstrates a holistic approach to bringing science into decision making by creating a space for dialogue, empowerment through capacity building and encouragement of action learning. Communication and learning has been an integral part of the process.

Communication and Learning

In Chapter 35 of Agenda 21 it is noted that "often there is a communications gap between scientists, policy makers and the public at large…". An integral component of bridging this gap is through proactive communication and learning. Lubchenco (1998) called upon the scientific community to formulate a new social contract for science, such that scientists should "communicate their knowledge and understanding widely in order to inform decisions of individuals and institutions; and expertise good judgment, wisdom and humility." Not only should there be close dialogue and ongoing communication between scientists and decision makers, processes must also have the full participation of those with local knowledge (Funtowicz et al. 1998). Research is more likely to contribute to evidence based policy making if the outputs are based on local involvement (Crewe and Young, 2002). In addition, credible evidence should be communicated via the most appropriate communicators, channels, style, format and timing.

Marketing specialists have realized that communication must be seen as a social process where attitudes and/or behaviour is changed through social relationships (Crewe and Young 2002). In other words, simply delivering knowledge as though policy makers are a blank slate does not work, it is more effective to mainstream learning from the assessment process and involve end users (policy makers). For example, the process being undertaken in the Pangani Basin to assess and implement environmental flows has been a relatively open and communicative exercise. The intent is to get participants to work together to determine what questions need to be asked, what data needs to be collected, and what data is not necessary. The environmental flows assessment can then be tailored to what people need as well as promoting a joint understanding of why the assessment is necessary and how the results can inform decisions on water allocation.

One of the main challenges of an integrated environmental flows assessment is ensuring that the key stakeholders take part. Careful identification and selection of stakeholders is a critical step (Laban and Moriarty 2005). For example, to effectively scale up innovation in the water sector the government needs to be a key partner. Despite perceived difficulties of working with government agencies in some countries and regions, these agencies are the ones that are in a position to scale up innovations and support their future sustainability.

Several methods can be used to promote communication and joint learning among the selected stakeholders. One method that will be discussed is action learning, which is a process of solving actual problems in collaboration between researchers and practitioners, in addition to being able to bring in more generic and widely applicable lessons.

Action learning

Action learning can be undertaken by groups of individuals, larger organizations or institutions, assisted or guided by professional researchers, with the aim of improving strategies, practices, and knowledge of the environments within which science such as environmental flows science are implemented. Locally relevant innovations and ideas are developed and then generic lessons are used in the scaling up process.

Action learning is developed through a cyclical approach, where lessons learned and knowledge generated can be fed back into the environmental flows assessment and implementation process so as to strengthen further actions. This aims to prevent repetition of past mistakes and build on learning as it happens. Figure 2 illustrates how information is inserted into the learning cycle to develop and adapt innovations in a flexible and context-specific way. Action learning is thus a very dynamic, on-going process as action often cannot wait a long time for research outputs and dissemination.

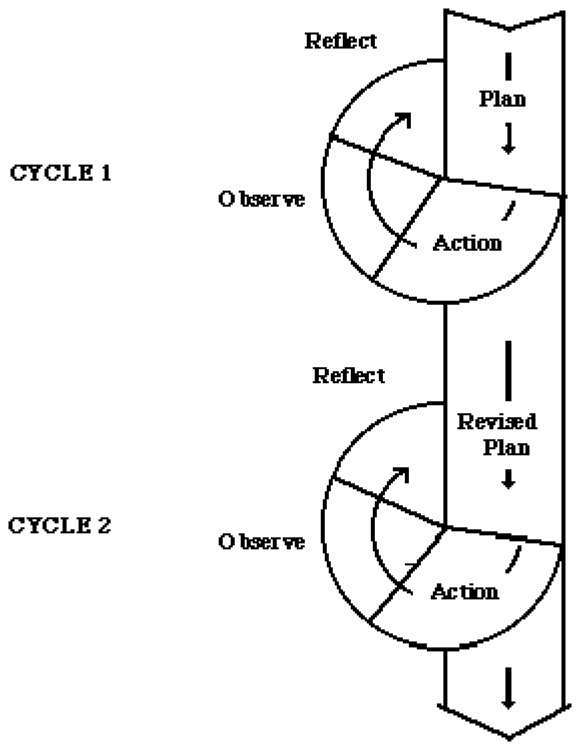

Fig. 2 Simple Action Research Model (MacIssac 1995; cited in Smits et al. 2007).

To ensure sustainability, all stakeholders should be involved in action learning. This creates ownership of both the problems and solutions that are developed. For example, the process of undertaking a comprehensive environmental flows assessment in the Pangani Basin involved key stakeholders from the inception. This allowed people to adjust the learning agenda to the changing context in the Pangani. Only through open discussion were participants able to begin to understand each others priorities and main concerns. The scientists needed to be aware of areas where managers require help (Dyson et al. 2003) and adjust their research to meet these needs. Equally, managers had to be willing to guide researchers on their needs and use the results from the flows assessment (Dyson et al. 2003).

Conclusions

Science will not provide the answers to decisions about environmental management, it can only inform decision makers of the options. When applying these options it is important to remember that science is based upon sets of assumptions about the external world that are social in origin (Irwin 1995). Technological solutions addressing issues such as water allocations will make little difference if not embedded into the social and political fabric. Obstacles, such as the credibility of government statements and social conflict over water resources, can be partially overcome by recognizing and involving key stakeholders in the process of determining how and why water is allocated.

An environmental flow is the water within a river, wetland or coastal zone that is required to maintain ecosystems and their goods and services, when there are competing water allocation demands. Environmental flows assessments are used to determine the amount of water that is needed to maintain a healthy ecosystem. The output from the assessment can be used by decision makers to make informed decisions on water allocation. These assessments should include input from a variety of stakeholders from the inception phase to implementation. This allows the scientists undertaking the assessment to understand what type of information is needed by water managers and decision makers. It also provides an opportunity for the managers and decision makers to understand how the assessment is carried out and what impacts their decisions will have on the watershed.

The process of assessing environmental flows in the Pangani Basin reflects the priorities and values of the Tanzania water policy. The assessment acknowledged that successful management of the Pangani Basin's water resources needed to integrate all environmental, economic and social demands, and trade their various costs and benefits against each other. The resulting integrated environmental flows assessment is now recognized as a useful tool to inform such decision-making. It identifies the needs of each water user, including the environment, evaluates its economic value to both the basin and the nation, and through scenario evaluation balances this against the future availability of water.

Bridging the gap between scientists and policy makers in the Pangani and beyond requires communication that also encourages stakeholders to actively learn from one another. There needs to be a good working relationship between managers and scientists. They have different roles and all are essential if good science is to transform into good management (Dyson et al., 2003).

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