Obstacles to the Implementation of Environmental Flows

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Abstract

In 1998 the South African National Water Act formally introduced the requirement for the management of the so called "Ecological Reserve", which is defined as *"..the quantity and quality of water required….to protect aquatic ecosystems in order to secure ecologically sustainable development and use of the relevant water resource.* This more or less equates to the terms "environmental flow allocation" and "instream flow requirements" as used internationally but gives emphasis to the quality aspects as well.

The fact that South Africa had put the concept of environmental flow requirements into its legislation sparked the recognition and interest of ecologists, water managers and regulators alike, and significantly contributed to the South African Water Act becoming a "text book" Act for countries striving to achieve the same.

The design of the procedures to measure the Ecological Reserve has been the subject of ongoing research mixed with an urgent need to carry out the assessments in the field so that water managers could get on with the job of implementing the legislation. A range of models have been produced, from computerized desk-top models to complex multi-party, expert driven models that are expensive and time consuming to run. Yet, there is a growing concern that the en-

thusiasm to provide for the needs of environmental water requirements in South Africa is starting to wane. Water managers are not only having to deal with the enormous responsibility of implementation where there is sometimes a fierce competition for a scarce resource, but these same managers are being confronted by an increasingly complex set of protocols which are being promoted by the scientific community which itself does not have much confidence in the products. Coupled with that is the very often high costs associated with assessment.

It has become clear that it is now necessary, after more than a decade of development in the environmental flows approach, that there is a pause for consideration of progress in terms of the following aspects:

- are the protocols indeed measuring the environmental requirement
- are the products being picked up and used by management, and
- in relation to both of the above questions, if not, why not?

This paper will consider the above issues not only from a South African experience but also in relation to the international scene. It will consider the procedures used to determine environmental flows and whether these are indeed suitable for implementation. It will also view the problem from the management perspective and will present some possible solutions. The overall objective of the paper is to probe into what is becoming an impasse between the scientific and management fraternities and to provide pointers for a way out.

Introduction

As water resources word wide have become increasingly subject to various forms of use and abuse, it has become apparent that a certain quantity and quality of water needs to remain within river and wetland systems in order to maintain the ecosystems which are responsible for so many benefits to society. This quantity has become recognized as the "environmental flow requirement" of an aquatic system which in some cases is also integrated with the requirement for water of a certain quality. In South Africa, both of these together are described as the Ecological Reserve which is defined as *"..the quantity and quality of water required.…to protect aquatic ecosystems in order to secure ecologically sustainable development and use of the relevant water resource* (DWAF, 1998).

The recognition of this need for environmental flows (reviewed in Dyson *et al* 2003) was followed by a flurry of research by the scientific community to provide the methods that would estimate the volumes and timing of flow, and to a lesser extent the quality of the water, that would serve to satisfy the needs of the river ecosystem. In a relatively short space of time, several hundred methods were developed (already over 200 in 2003 - Tharme, 2003). There are several reviews that describe some of these methods (Arthington *et al*, 1998; Dyson *et al*, 2003).

Uptake of these methods by water resource managers has been an altogether different affair. While there has been some acceptance of the principles of environmental flows (Dyson *et al*, 2003) and even institutionalization of many of the methods of assessment, the implementation of these methods to the benefit of river ecosystems and thus ultimately society, has been somewhat hesitant. In South Africa where much of the thinking around environmental flows was developed, a large number of assessments have been completed (900 assessments done to date, Grobler, *pers com*) and yet implementation has lagged behind and indeed not a single assessment has been implemented in its entirety (Weston *pers com*). Reasons for this include a combination of legal risk, levels of

uncertainty, distrust of the outcomes, lack of understanding of those responsible for water management, cost of assessment as well as cost of implementation.

It has become increasingly clear in the South African situation, and this may be reflects in other countries, that there are considerable threats to the successful implementation of environmental flows. Preliminary exploration of whether this is indeed an issue was carried out via an international environmental flows email network hosted by the IUCN. Some interesting comment from several important role players includes:

…..there is a danger of an EWR whitewash being a reality….The time is right for communication science to come into the picture. (Neil van Wyk, Chief Engineer Department of Water Affairs and Forestry, South Africa).

…..it is becoming increasingly apparent that decision-makers are viewing the concept of environmental flows as an impediment to development. The fact that the processes are complex and the outcomes not as precise as decision-makers would like them to be, exacerbates the problem. This poses a risk to the viability of the concept of environmental flow…(Anthony Turton, Strategic Research Leadership: Water Resource Competency Area, CSIR, South Africa).

…..the process is so complex that even the implementing agency does not understand what the results mean…(Ralph Heath, Golder Associates Africa).

… The challenge is not whether these requirements are correct to the nth degree but how do we get government and implementers to actually release the proposed volumes for e-flows? There is a very complex set of hard-core engineering barriers propagated by technocratic institutions….that are slowing this process down…(Ele Jan, Saafconsult, BV/HJP International, Pakistan).

….Around the world, we are beginning to see resistance to environmental flow assessments that are viewed as being too expensive, time-consuming, and complicated. Too often, prescriptions have been developed in a manner that is very difficult for water managers to implement. (Brian Richter, Director, Nature Conservancy USA).

There are clearly several issues around environmental flows and their implementation that need to be addressed. The time is right, after over a

decade of intensive method development, for a re-assessment of how the science of environmental flows can actually fit into water resource management and ultimately serve to protect the river ecosystems on which society depends.

Discussion

Methods of assessment and implementation

The various methods of assessment have been extensively reviewed by Tharme (2003) and Dyson *et al*, (2003). These methods may be categorized in various ways each of which has its own merits. The approach of Taylor (2005) was to categorize the methods into historical/hydrological flow methods, desktop methods and holistic methods. Hydrological flow methods include those where the hydrological record is used to model a reduced flow in the river which is anticipated to be acceptable to the environment. Desktop methods take this further by incorporating ecological information at a conceptual and general level. Holistic methods are the most detailed, including wide ranging site specific ecological and maybe even social information. As one alternative, this information may be interpreted in a bottom up approach which requires the construction of a flow regime based on first principles, the expected needs of biota etc to meet a predefined objective condition. Examples of this approach include the BBM method (and its derivatives) used in South Africa (King *et al*, 2000) as well as the Water Framework Directive of the EU (European Commission, 2000). Holistic methods may also be top-down in nature, constructed via a scenario process where environmental flow requirements are defined by the degree that the natural flows can be modified to fit with different water management options. An example of this is the DRIFT method (King *et al*, 2003) used in the Lesotho Highlands (LHDA, 2003).

The plethora of methods that have become available is not necessarily a good sign for the newly developing science as it suggests that a model which most people would find acceptable has not yet been found. A number of questions need to be asked in relation to all of these methods so that there can be a separation of those which are effective from those which incorporate alternative agendas:

- Are they as simple as is necessary to do the job?
- Do they produce redundant data and information?
- Do they hide the consequences of weak and unreliable data?

- Are they accessible to practitioners who need to understand them for the sake of the river ecosystems and society?
- Do they actually do what they set out to do, i.e. lead to protection of the aquatic ecosystem?
- Do the methods embrace non-ecological factors such as the valuation of goods and services and the needs of stakeholders?

Procedures for implementation have been less well described possibly as this was anticipated to be a simple process of manipulating flows in regulated systems in order to provide the flow regime defined by the method of assessment. Instead it is emerging that the implementation of environmental flows may be every bit as challenging as their determination.

In those cases where implementation has been attempted it has been found that the process is challenging, with that in the Lesotho Highlands in Southern Africa possibly the most significant example (Dickens *et al*, 2007). Converting a detailed documentation of the historical hydrology of a river and the resulting reduced flow recommendations into an actual flow based on the prevailing conditions in the river is fraught with difficulties. Ideally this would require an accurate prediction of immanent flow conditions with a commensurate adjustment of managed flows. Such flow predictions are becoming a possibility based on detailed rainfall forecasts coupled to modeled run-off as is currently being done for the Orange River basin by the University of kwaZulu-Natal in South Africa (Schulze *pers com*) but this approach will have its attendant risks. Alternatives to this operate at a much coarser level as is done in the Lesotho Highlands where conditions over the previous year are used to categorize whether the river is in a wet or dry cycle, which is carried forward to direct the flow releases over the next quarter. This system unfortunately fails to anticipate the sometimes very dramatic changes in rainfall trend that occur when the region moves from drought to wet conditions or *visa versa* with the result that inappropriate flows may be released in the absence of a more adaptive management strategy (Dickens *et al*, 2007).

An often-touted guide for deciding on releases of water from a dam is that the inflow to the impoundment should guide the release. If this inflow-outflow system is followed closely, then it should be possible to release a managed flood at the same time that there is a natural flood entering the impoundment or that the system enters drought conditions at the same time when the inflow to the impoundment indicates that this is the situation. Following such as system possibly negates some of the need for the process to be driven by hydrological models although the situation in non-dammed rivers requires other options. Where management is flexible,

the inflow-outflow system is possible but it requires a rapid decision making process stripped of bureaucratic obstacles. In the case of the Lesotho Highlands scheme the decision process to release water may take several weeks leading to the bizarre situation of "blue sky floods" (Dickens *et al*, 2007) which introduces risks to the ecosystem as such conditions are likely to be outside of the evolutionary adaptations of the biota, and it also poses risks to a rural community who are making use of the river downstream.

Forms of implementation can be categorized broadly into two main types, that which is rule based and that which is subject to adaptive management principles (see Table 1).

Table 1. Forms of implementation of environmental flows

Rule based with minimal opportunity to change.	**Adaptive**
Driven by characteristics of the hydrological regime, often via the output of models that separate the day to day realities from the founding principles.	Guided by characteristics of the hydrological regime designed to meet environmental requirements. Continual and fluid interaction between the realities of the day and indicators of a responding environment and management requirements.
Clearly defined flow volumes and regimes.	Flow regimes defined but adaptable to improve performance.
Fixed targets for biophysical variables.	Defined objectives for biophysical variables with continual evaluation of changes to the ecosystem as indicated by many or key variables the relevance of which may be changing over time.
Biophysical indicators of success.	Indicators of success a combination of biophysical indicators coupled with value addition to society.

The first form of implementation (Table 1) has been termed "rule based" which suggests that a number of pre-set rules would define the required flow in a river. These rules would be linked to relatively fixed criteria for the assessment of both the quantity and quality of the water in the river and also the response targets which would include physical aspects such as the geomorphology and also biological variables such as fish, invertebrates etc. There is a very strong tendency, with this approach, to view the objectives of flow management and the indicators of performance

in strongly quantitative terms where resource values would be fixed into management rules. While this may be an appealing option, this tendency may be at the root of the difficulties experienced with implementation. Not only does this approach make high demands on the science that is required to provide this information, thus the ongoing debates about the appropriateness of the various assessment methods, but it also makes the assumption that the biophysical information used to inform the process is based on ecological "truths" (Breen *pers com*). There is a tendency for these ecological "truths" to take on an absoluteness which suites the command and control style of management but is completely at odds with the at times tenuous information that went into the production of these "truths". It is very clear that the state of the science that links river flow, water quality and the response of both physical and biological variables, is not yet at a stage when there can be a high level of confidence in reducing these relationships to inflexible rules. It is also increasingly apparent that this is not necessary.

What are the alternatives if the science is not able to provide the absolute "truths" that would suite a command and control style of management? Clearly a start is to completely alter the approach and indeed the way of thinking that is required to introduce a system that is more sensitive to the situation. An analogous situation can be seen in the change that has taken place in the education of children over the years. It could be said that the "old style" of education was that the teacher knows what the child needs, which is after all encompassed in the school syllabus, and proceeds to deliver this with the demand that the child reflects the intended learning. This was found to be successful in some cases, but less so in others. The "new style" of education also has a syllabus which defines what a child needs to know, but the teacher (or educator - *defn. to draw out of*) is continually receptive to the needs of each child and moulds the learning into a form which is most effective. The end result is that each child comes to know the syllabus as best they may. So, what qualities distinguish a teacher who best educates a child? Likely qualities include being adaptive, of being open to the changing needs of each child and situation, of being a good listener, of being caring and guiding each child towards the objectives of the syllabus.

How does this apply to the implementation of environmental flows? It is suggested that the same qualities apply, that the implementer is adaptive, is open and sensitive to the changing needs of the river and society, is continually in touch with the way that the river is responding and is in a position to change operations in order to guide the river ecosystem towards the objectives set by society. To some extent this type of approach is encapsulated in the philosophy of Strategic Adaptive Management (Rogers *et al*,

2000). They give notice that this will require a new way of thinking, that it will require continual iterations and that it will not suite the current way that regulators like to work through the development of fixed measurements of performance. They also introduce the need for the environmental flow to interact with the needs of society. After all, the development of environmental flow science, as expressed in the South African Water Act (DWAF, 1998), is to *protect aquatic ecosystems in order to secure ecologically sustainable development and use of the relevant water resource*. The latter portion of this requirement is frequently omitted in environmental flow thinking.

Linking methods of assessment with policy implementation

The concept of environmental flows has been widely accepted by resource managers across the world and in many countries has been built into legislation. Some examples of partial uptake by legislators date back many years (such as management of flows to protect fishing activities) but South Africa was at the forefront of introducing a more holistic concept through the definition and inclusion of the Ecological Reserve into its Water Act in 1998 (DWAF, 1998). Since then several other countries have followed suite (Dyson *et al*, 2003) yet it remains a concern that so few have effectively implemented the broad suite of environmental flows. That done by the Lesotho Highlands Development Authority (LHDA, 2003) is possibly the most comprehensive and has now been implemented for nearly five years. A number of lessons from this implementation have been learned and were the outcomes of possibly the first audit of a major implementation of environmental flows (Dickens *et al*. 2007).

The slow uptake of environmental flows by policy makers but more so by regulators and resource managers suggests that although there is a perception of an acceptance of the methods, in reality this acceptance is not sufficiently strong to ensure active implementation. A number of obstacles to implementation may be speculated:

- the legal risks associated with the allocation of licenses to use water,
- the threat of objections from stakeholders when water is "reassigned" to the environment,
- the probability that water resource managers and other stakeholders may have a limited ecological understanding and thus acceptance of the need for environmental flows,

- the reliance on specialist input to assess and implement the environmental flows especially when these skills need to be brought in from outside of the regulatory authority,
- doubts about the reliability and authenticity of environmental flow assessments, particularly if supported by errant case studies,
- the complex nature of some models dampens the ability to make decisions,
- the costs of the assessment of environmental flows (~US$1 million for a comprehensive assessment in South Africa – Weston *pers com*) which poses a threat especially when the need for this expense is not fully accepted by those who manage the purse-strings,
- the perceived loss of water for productive use,
- the challenge of implementing environmental flows in non-regulated rivers,
- the challenge of linking non-flow related issues (e.g. pollution, land degradation) that will be having an impact on the health of the aquatic ecosystem and which may undo any attempts to maintain the condition of a system through flow management,
- the challenge of linking flows with social needs. A technical and non-anthropocentric approach to environmental flows is unlikely to gain acceptance from society especially as Van Wyk *et al* (2006) noted "the Reserve is often equated with sustaining the ecosystem at the cost of benefit to society."

Possibly the greatest obstacle to implementation is reflected in the need to bring together two different management perspectives. On the one hand, water resource managers tend to approach their task from a quantitative perspective, preferring absolute and inflexible programmes for implementation with fixed targets for success. These fixed targets are often built into license conditions and are thus exposed to tight regulation. On the other hand there is the need to manage the natural ecosystem which requires flexibility and a willingness to adapt to changing circumstances. Bringing these two together, particularly where there are competing demands on a water resource, will require creativity and a willingness to try a new approach. While this is embodied in the science of adaptive management (Pahl-Wostl, 2007), the sensitive and potentially rapid adaptation that is required to manage environmental flows will put this philosophy to the test.

The obstacles to this adaptive approach could be:

- The perceived need of water resource managers to tightly control the use of the water resource.
- Extended decision-making procedures in organizations responsible for management.
- The complexity of some assessment methods reduces the ability of managers to be flexible.
- Dam infrastructure which may not permit variable water releases.

Conclusion

It is clear that, despite the scientific excitement about this new science of environmental flows, the uptake by policy makers and implementers has been less enthusiastic. Possibly this points to an over-zealousness on the part of scientists who may have developed the procedures to a level beyond the needs of management? Possibly it points to a failure to communicate effectively with implementers and stakeholders? The net result of this is a looming impasse between the scientific fraternity and implementers or resource managers.

What has been suggested in this paper is that there is a need to approach the implementation of environmental flows from the perspective of the stakeholder and of the ecosystem and to acknowledge that both of these will be moving perspectives and will require the manager to be adaptive. While the phrase "adaptive management" may be a term that many feel that they have practiced for years, it is likely that this is not the case and that there is an urgent need to embrace this new type of thinking. Rogers *et al* (2000) note that "Adaptive Resource Management is an approach to management that acknowledges that because nature is in a continual state of flux and our understanding of ecosystem functioning is poor, dealing with uncertainty from an imperfect knowledge base is central to effective management. The original intent of adaptive management was therefore that it be an inductive process utilising well planned interventions in nature to test hypotheses of ecosystem response to management and thus lean-by-doing (Walters and Holling 1990)". It is suggested that this description does not fit many water managers.

In conclusion, it is recommended that the environmental flow fraternity, together with the associated water resource managers and appropriate stakeholders, need to carefully review the status of both the science and management of environmental flows.

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