Can science influence policy? The inclusion of estuaries in the South African water law

Jill H Slinger and H Vreugdenhil

Delft University of Technology, Jaffalaan 5, 2628 BX Delft, Netherlands.
tel: +31-15-2788067. j.h.slinger@tudelft.nl

Abstract

Is the existence of appropriate scientific knowledge sufficient to ensure the transition to improved management of freshwater resources? The remarkable inclusion of estuaries in the new South African water law in 1998 is examined in the light of this question. We demonstrate that the requisite scientific knowledge was present, but not integrated, ten years prior to the changes in the water law. It was formalized in a manner accessible to water managers five to seven years thereafter, yet was utilized only in an ad hoc fashion. By combining information from the scientific literature on the knowledge generation process and comparing this with the perceptions of participants, we establish that the cohesive nature of the scientific group and the role of individuals in building bridges and transferring knowledge cannot be underestimated when science influences policy.

1. Introduction

Many are the debates revolving around the influence of science on policy (Wildavsky, 1979; Weiss 1979; Bobrow & Dryzek, 1987; Funtowicz & Ravetz, 1990; Ravetz, 1997), yet few are the studies examining the mechanisms of knowledge transfer at work during successful scientific interventions. In this paper we focus on the role that scientific knowledge plays in

the formulation of new legislation; the path of the knowledge development itself and the interaction with water and research managers active in the arenas of water policy in South Africa in the period 1986 to 1998. We also examine the effects of this legislation on the operational management of water resources and estuaries, in particular, in the period thereafter. It is noteworthy that whereas at the outset estuaries were regarded as elements of the marine system, in the new freshwater legislation they are regarded as elements of the continuum of a river from its source to its sink, the sea. This fundamental shift in their legal status reflects a change in perspective on the role of freshwater in determining the character and functioning of estuarine systems. How did this perspective alter and what influence did scientific knowledge development exert on this process?

In examining the role that science and scientists played in influencing estuarine policy in South Africa, we identify various phases in the policy process. We differ from other authors in that we include the idea generation or germination phase and do not begin only from its initial manifestation in institutional transformation. Indeed, we explore the transfer of knowledge from the conception, through the scientific incubation and development, the messy birth process with its initial critical examination, to the careful testing and then the adoption by the policy agency. The final phases of operationalization and successful implementation receive attention, but do not form the primary focus of the paper.

We are able to demonstrate that whereas knowledge development is a necessary condition for the transition represented by the inclusion of estuaries in the South African fresh water law, it is by no means a sufficient condition. Instead, a network understanding of the science—driven knowledge transfer process and an understanding of the societal –institutional context are suggested as complimentary sources to explain this remarkable phenomenon.

2. Method

An historical exposition of the development of knowledge of the role of freshwater in South African estuaries was undertaken based on literature surveys of both refereed scientific publications and those in the grey literature. The synthesis of knowledge and its formalization in simulation models, expert systems and categorizations were examined as indicators of the development of a common knowledge base. The process of knowledge transfer was explored using documents such as workshop proceedings, conference proceedings and the minutes of the steering committee meet-

ings of relevant research projects. Where no such documentation was accessible, we present the views of the primary author who herself participated in the knowledge transfer process from 1986 to 1998. The validity of the subjective insights of the primary author were checked in interviews conducted with key research managers, policy agency representatives and scientists involved in estuarine science and its application in the period 1986 to 2006. The information obtained in the interviews was used to verify the interpretation placed on the preceding information sources. Where there was a divergence in viewpoints, these are reported faithfully hereafter.

The reflective insights on the process of knowledge development and transfer obtained via the interviews lead to new insights on the roles of individuals, social networks and the socio-political context in determining the influence of knowledge of the estuarine scientists on South African water policy.

3. Results

3.1 The development of knowledge of the role of freshwater in South African estuaries

Estuaries have long been regarded as the margins of the marine system. Their definition as "a semi-enclosed coastal body of water which has a free connection to the open sea and within which sea water is measurably diluted with fresh water derived from land drainage" (Cameron & Pritchard, 1963) emphasizes this. However, although the critical role of freshwater in determining the hydrodynamic character of an estuary was recognized from the outset (Dyer, 1973), the connection between this and the unique biotic assemblage of individual South African estuaries was only studied in the 1980's and beyond. Early, authoritative texts (Begg, 1978; Heydorn and Tinley, 1980; Day, 1981) emphasize estuaries as elements of the coast and explore regional differences and similarities in the habitats they provide for estuarine flora and fauna.

Concurrently, coastal engineers attempted to explain the intermittent closure and opening of the mouths of many South African estuaries (CSIR, 1980) using the sediment transport formulae of Ackers and White (1973), Bruun and Gerritsen (1960) and the observations of O'Brein (1969).

In the early eighties, the focus shifted to the detailed study of individual estuarine systems. The mouths and adjacent berms of certain estuaries

were surveyed annually for the Department of Environmental Affairs and synopses of available information on the estuaries of the Cape region were prepared by the Estuarine and Coastal Research Unit of the CSIR. Surveys of individual estuaries were undertaken regularly to supplement the available information and enable these synopses to be completed. However, many of these surveys did not extend to the head of the estuaries, but focussed on the marine-dominated region near the mouth. Consequently, detailed knowledge of individual systems consisted primarily in knowledge of the marine and brackish ecosystem components. Little was known of the dynamics and features of the upper, freshwater-dominated reaches of South African estuaries.

In 1986, hydrologists from the Department of Water Affairs published a report on the freshwater requirements of estuaries and lakes (Jezewski & Roberts, 1986). They wished to establish the volume of freshwater on an annual basis that could not be stored in an upstream impoundment for use, but would need to be released to an estuary to ensure that the mouth condition before and after construction remained similar. They deemed the annual average evaporation from the surface and the volume of water of a flood with a return period of 1 in 2 years adequate as annual freshwater input to an estuary.

The publication of this report, the subsequent low freshwater inflows to estuaries where dams already existed, and the anticipation of such problems in estuaries where upstream impoundments were planned, led to ongoing disquiet amongst estuarine scientists (Allanson, 1992). This was marked by several notable publications on the effects of freshwater deprivation on estuaries (Reddering, 1988; Whitfield & Bruton, 1989). Indeed, detailed studies conducted in the late eighties and early nineties led to a growth of understanding of the hydrodynamic and biotic responses to alterations in freshwater flow on estuaries (Slinger *et al*.,1994; Whitfield & Wooldridge 1994). These concerns were clarified when a Water Research Commission research project focused on determining the freshwater requirements of estuarine fauna in the Cape coastal region experienced difficulties developing a uniform methodology. Within six months, a workshop to which all estuarine scientists were invited, was hosted by the Water Research Commission (WRC Workshop Proceedings, 1992). A research proposal aimed at informing the existing decision making procedures of water managers regarding the freshwater requirements of estuaries was formulated at this workshop.

The Co-ordinated Research Programme on Decision Support for the Conservation and Management of Estuaries (WRC Contract number 577, 1992) received funding in 1993 and the first efforts to jointly codify the knowledge of South African estuarine scientists and engineers in a format

suitable for use by water managers was initiated. The formalization of the effects of reduced freshwater flows on the hydrodynamics, water quality and on floral and faunal indicator species was undertaken initially by linking five existing mathematical models (Breen & Slinger, 1995). The integrated predictive capability was later expanded to include a sixth model and to accommodate a formal procedure for accessing the expert knowledge of biologists and including this routinely in predictions of the effects of changes in freshwater inflows to estuaries (Slinger, 1996). As such, this sub-project was able to demonstrate that the predictive capability applied to estuaries that were permanently or intermittently open and extended over both the short and long term. In addition, an updated synopsis of available information and an importance rating system aimed at assessing the relative significance of individual estuaries within bio-geographic regions and nationally was developed and tested in another sub-project (Whitfield, 2000). By July 1995, the estuarine scientific community had demonstrated that the estimation of the freshwater requirements of estuaries in South Africa according to Jezewski and Roberts (1986) were woefully inadequate and had developed procedures for predicting the consequences of altering freshwater flows to estuaries.

Concurrently, river scientists and hydraulic engineers had developed and were testing the building block methodology for determining the freshwater requirements of rivers (King & Tharme, 1994; King & Louw 1998; Tharme *et al.* 1998). Estimations of the freshwater requirements at the meeting point between river and estuary frequently differed substantially with the estuarine scientists often estimating far higher volumes than riverine scientists. Late in 1995, a workshop was convened by the Department of Water Affairs in which key estuarine scientists were requested to explain and justify their views to some of the key river scientists and water managers (Whitfield & O'Keeffe, 1995). Following this workshop, in which the river scientists accepted that the differences in the biophysical environment of estuaries and rivers led to the need for different approaches, the Department of Water Affairs and Forestry went on to request estuarine scientists to conduct studies on the freshwater requirements of estuaries on an ad hoc basis.

In 1996, with a new Minister of Water Affairs at the helm, this hot coal could no longer be ignored. Members of the estuarine scientific community were approached for assistance in drafting the new South African Water Bill and estuaries were to be included as integral components of a river basin. This represented a major departure from tradition in that the Water Act had remained unchanged from 1966. Initially, the contributions of the estuarine scientists were limited to the provision of descriptions of the methods then followed for assessing the freshwater requirements of an es-

tuary. The Jezewski and Roberts (1986) estimates were finally accepted as inadequate and were to be replaced by new procedures. By the promulgation of the South African Water Act in 1998 (DWAF, 1998), a number of estuarine scientists were hard at work specifying the procedure for determining the ecological reserve for estuaries. This is the term given to the amount and distribution of water required to keep an estuary in an agreed dynamic state (termed management category). So, this trajectory of knowledge development culminated in the inclusion of estuaries in the South African Water Act (DWAF, 1998).

Several studies on the freshwater requirements of estuaries have been undertaken in the period from 1998 to 2006, following the recommended procedures (e.g. Breede Estuary, Mtavuna Estuary). This has led to minor refinements and adaptations, but little change in freshwater release policies implemented by the Department of Water Affairs and Forestry in practice. Internationally, South African scientists had received acknowledgement of their contributions to estuarine science and have participated in special issues of journals on this topic (Montagna et al, 2002).

3.2 Reflections on the knowledge development trajectory by participants

In the interviews conducted in March and April 2006, the respondents were requested to reflect upon their involvement and that of others in the process of knowledge development on the role of freshwater in estuaries. Only those scientists and engineers who were involved in the process from 1989 or earlier, even consider the germination phase to be important. Those who became involved later tend to consider the enactment of the law and the current implementation phase as most relevant to knowledge development. Indeed the water managers interviewed, considered the starting point of the process to lie in the period from 1996 to 1998 when the Department of Water Affairs first tentatively acknowledged the need to consult learned societies and individual experts in drawing up the new water act. This is especially surprising since some of the people interviewed were present at workshops where the freshwater requirements of estuaries were discussed as limitations to dam capacity in river basin studies convened in 1988 and 1989. The research manager on the other hand concurred with the view presented in this paper.

Concurrently with the initiation of the Co-ordinated Research Programme on Decision Support for the Conservation and Management of Estuaries (WRC Contract number 577, 1992), the Consortium for Estuarine Research and Management (CERM) was formed. This is an open alliance

of estuarine scientists, managers and coastal practitioners interested in the conservation and management of estuaries. The research manager and all scientists interviewed named the formation and regular annual to bi-annual meetings of this alliance as a major reason for the success in building a common knowledge basis. CERM provided the forum for disseminating new knowledge and receiving informed and directed comments. Consequently, the sharing of knowledge was enhanced and the quality of communication regarding the available knowledge improved. It is the opinion of the primary author, that personal communication between key scientists and high level managers within the Department of Water Affairs and Forestry were also instrumental in increasing the profile of CERM and enhancing the conviction that the opinions of this group of people could not long be ignored. Only, the research manager considers the influence of key individuals to have been relevant in the final acceptance of the knowledge held by the CERM members.

While the scientists interviewed considered the validity of their knowledge and argumentation to have eventually won the day in persuading the Department of Water Affairs and Forestry of the role of freshwater in estuaries and the need to include estuaries in the water law, both the water managers and the research manager stated in their interviews that it was the influence of two agents who were primarily responsible for this. These agents were members of the scientific community, but are not regarded as key scientists by the scientists themselves. One was employed by another government department and the other was elected to act as a representative of a learned society in dealing with DWAF. Their key roles are underacknowledged by the scientific community.

No one mentioned the change of the socio-institutional setting in South Africa from a politically oppressive, paternalistic, strongly hierarchical and technocratic regime (Rossouw & Wiseman, 2004) to a new democratic government as contributing to the willingness of the Department of Water Affairs and Forestry to adopt scientific knowledge and change the water law in the period from 1996 to 1998. This is clearly a major background driver.

With regard to the initial implementation phase, the efforts of a number of scientists in developing the procedures for implementation was recognized by all. All but one of the scientists interviewed expressed themselves satisfied with the process and the quality of the outcomes of the procedures for the ecological reserve determination. One scientist expressed doubts about the adequacy of the information base and about the tardiness of the Department of Water Affairs and Forestry in implementing the recommendations. In contrast, the water managers were concerned about the high costs, time consuming nature of the studies and the delay in

receiving answers. They expressed concerns that these operational limitations to the process of setting an ecological reserve, could undermine the acceptance of the final result both within the Department of Water Affairs and Forestry and by the affected citizens.

The research manager expressed deep concern regarding the human capacity to conduct such studies both now and in the future. This is stretched to the limit at present and there is no pool of young estuarine scientists in training. In his opinion, this is the most significant threat to the continued use of existing knowledge and the development of new knowledge on the role of freshwater in estuaries.

4. Concluding remarks

The historical analysis revealed that Jezewski and Roberts (1986) did not do justice to the available information, which already indicated (albeit in a non-integrated way) that their recommendations on the requirements of estuaries for freshwater were inadequate. We have demonstrate that the requisite scientific knowledge was present, but not integrated, ten years prior to the changes in the water law. However, it was only formalized in a manner accessible to water managers five to seven years thereafter. Still it was only utilized in an ad hoc fashion.

The supplementary information obtained from the interviews with individuals who participated in the knowledge generation process, indicated that there were additional factors that needed to be present before the appropriate knowledge could be adopted. We have established that the formation of the Consortium for Estuarine Research and Management played a role. This cohesive group developed and agreed upon methods for the determination of the freshwater requirements of estuaries. Key scientists promoted these methods amongst higher management echelons of the relevant government departments and individuals crossed institutional boundaries in translating and transferring this knowledge. Clearly, appropriate knowledge is necessary for adaptive policy processes to occur, but the roles of such groups and individuals cannot be ignored.

Similarly, the socio-institutional setting in which such knowledge transfer occurs deserves further attention.

Acknowledgements

This research was conducted under the auspices of the Multi-Actor Systems Research Programme of the Delft University of Technology.

Grateful thanks are extended to the South African research managers, scientists, and water managers who participated in the interviews. In addition, the long term commitment of the Water Research Commission to estuarine research deserves special mention.

References

Ackers P and White W R (1973). Sediment transport: New approach and analysis. Proc. ASCE, Journal of Hydraulics Division HY11.

Allanson B R (1992). A summary of the findings of a number of workshops held at the July 1992 conference in Cape Town. South African Journal of Acquatic Sciences 18 (1/2); 112-115.

Begg G M (1978). *The Estuaries of Natal*. Vol 41, Natal Town and Regional Planning Commission, Pietermaritzburg, South Africa. 657pp.

Bobrow D B and Dryzek J S (1987). *Policy Analysis by Design*. Pittsburgh, University of Pittsburgh Press.

Breen C M and Slinger J H (1995). Integrated research into estuarine management. *Water Science and Technology* **32**(5-6), p 79-86.

Bruun P and Gerritsen F (1960). Stability of coastal inlets. North Holland Publishing Company, Amsterdam.

Cameron W M and Pritchard D W (1963). Estuaries. In: *The Sea*, Vol 2, (ed.) M N Hill. Wiley, New York. 306-324.

CSIR (1980). Effect of the proposed Hangklip Dam on Palmiet River Mouth. CSIR Report C/SEA 8048, Stellenbosch, South Africa. 26pp.

Day J H (1981). *Estuarine Ecology with particular reference to southern Africa*. Balkema, Cape Town, South Africa. 411pp.

DWA&F (1998). Water Act No. 36 of 1998. Department of Water Affairs and Forestry, Pretoria, South Africa.

Dyer K R (1973). *Estuaries: A Physical Introduction*. John Wiley & Sons, London, UK. 140pp.

Funtowicz S and Ravetz J R (1990): *Uncertainty and Quality in Science for Policy*, Kluwer, Dordrecht

Heydorn A E F and Tinley K L (1980). Estuaries of the Cape Part I. Synopsis of the Cape Coast. Natural Features, Dynamics and Utilization. CSIR Research Report 380, Stellenbosch, South Africa. 97p.

Jezewski W A & Roberts C P R (1986). Estuarine and lake freshwater requirements. Department of Water Affairs Technical Report TR129, Pretoria, South Africa. 22 pp.

King J M and Tharme R E (1994). Assessment of the instream flow incremental methodology and initial development of alternative instream flow methodologies for South Africa. WRC Report No. 295/1/94. Water Research Commission, Pretoria. South Africa. 590pp

King J., Louw D. (1998). Instream flow assessments for regulated rivers in South Africa using the Building Block Methodology " *Aquatic Ecosystem Health and Management* **1**(2): 109-124(16).

Montagna P A, Alber M, Doering P and Connor M S (2002). Freshwater Inflow, Science and Policy, Management. Editorial. *Estuaries* **25**(6B). Special Issue on the Freshwater Requirements of Estuaries.

O'Brien M P (1969). Equilibrium flow areas of inlets on sound coasts. Proc. ASCE, Journal of the Waterways and Harbors Division, 95, WW1.

Ravetz, J. R. (1997). ULYSSES Working paper, Darmstadt University of Technology.

Reddering J S V (1988). Prediction of the effects of reduced River discharge on the estuaries of the south-eastern Cape Province, South Africa. *South African Journal of Science* **84**, 726-730.

Rossouw N and wiseman K (2004). Learning from the implementation of environmental public policy instruments after the first ten years of democracy in South Africa. *Impact Assessment and Project Appraisal*, **22**(20): 131-140.

Slinger J H, Taljaard S & Largier J L (1994). Changes in estuarine water quality in response to a freshwater flow event. In: *Changes in Fluxes in Estuaries. Implications from Science to Management.* (ed) K R Dyer & R J Orth: 51-56.

Slinger J H (1996). Decision support for the Conservation and Management of Estuaries. Final report of the Predictive Capability Sub-Project of the Coordinated Research Programme. WRC Report No. 577/2/00. Water Research Commission, Pretoria, South Africa. 136 pp.

Tharme R E, King.J, Louw D (1998). Development of the Building Block Methodology for Instream Flow Assessments, and Supporting Research Water Research Commission, Pretoria, South Africa.

Weiss, C. (1979). The Many Meanings of Research Utilization *Public Administration Review* **39**(5): 426-431.

Whitfield A K and Bruton M N (1989). Some biological implications of reduced fresh water inflow into eastern Cape estuaries: a preliminary assessment. *South African Journal of Science* **85**, 691-694.

Whitfield A K and Wooldridge T H (1994). Changes in freshwater supplies to southern African estuaries: some theoretical and practical considerations. In: *Changes in Fluxes in Estuaries. Implications from Science to Management*. (ed) K R Dyer & R J Orth: 41-50

Whitfield A K and O'Keeffe J (1995). Proceedings of the workshop on Methods for the assessment of the freshwater requirements of estuaries and rivers. October 1995. Grahamstown, South Africa.

Whitfield A K (2000). Available scientific information on individual South African estuarine systems. WRC Report 577/3/00. Water Research Commission, Pretoria, South Africa. 217pp.

Wildavsky A (1979). *Speaking Truth to Power: The Art and Craft of Policy Analysis*. Little, Brown.

WRC Workshop Proceedings (1992). Water Research Commission Workshop. 3 November 1992, Port Alfred

WRC Contract number 577 (1993). A co-ordinated research programme on decision support for the conservation and management of estuaries. Consortium for Estuarine Research and Management. Water Research Commission, Pretoria, South Africa.