Integration of scientific and technological progress into practical uses in water resources management

Peter Opwanya, Yannick Schuermans, Philippe Quevauviller, Patrick Willems, Guido Vaes

Abstract: This research aimed at examining the integration of scientific and technological progress into practical uses in water resources management and highlighting an existing interface, the WISE-RTD Web Portal that was built to aid the science-policy communication of the European water legislation. It also presents the different possible solutions to address the science-policy and industry communication gaps. Based on the several lessons arising from existing literature, it is noted that challenges to the take up of science in policy stem from the fact that science and policy communities have very different "cultures". Not only do most members understand each other poorly, in general most scientists have little time to engage with policy makers as their career path usually depends instead on research and scientific publications. Similarly, policy officials have little time to engage with scientists or the scientific information is not easily accessible or adapted to the policy implementation jargon. The two communities also often find themselves working to very different timescales, hence face difficulties of matching in-depth research and reporting with the day-to-day needs of policy making/decisions. Difficulties experienced to date stem from the fact that there is no sufficient streamlining of information from the scientific community to policy decision-makers and vice versa. Solutions consist of science-policy interfacing and communication channels. One such channel currently under development is the WISE-RTD Water Knowledge Portal. It is based on an intelligent matching system that maps research results and water technologies to water policies. Other solutions discussed in the paper are the need for scientists & research projects to establish a "Policy Watch" to anticipate policy evidence requirements and greater interaction, discussion and deliberation between researchers and policy makers is called for. It should also be noted that science-policy interfacing is about people; a focus solely on flows of information will not be able to build effective transfer mechanisms without these interactions.

Keywords: Science–policy interface, RTD, Water policy, Water sector, Communication and Dissemination.

Peter OPWANYA
Katholieke Universiteit Leuven - Hydraulics Laboratory,
Kasteelpark Arenberg 40, B-3001 Leuven, Belgium
Tel: +32 16 321774.
Peter.Opwanya@bwk.kuleuven.be

Yannick SCHUERMANS
Katholieke Universiteit Leuven - Hydraulics Laboratory,
Kasteelpark Arenberg 40, B-3001 Leuven, Belgium
yannick_schuermans@hotmail.com

Philippe QUEVAUVILLER
Vrije Universiteit Brussel (VUB), Dept. Hydrology and Hydraulic Engineering, Pleinlaan 2, B-1050 Brussels, Belgium
Tel: +32 2.2963351
philippe.quevauviller@vub.ac.be

Patrick WILLEMS
Katholieke Universiteit Leuven - Hydraulics Laboratory,
Kasteelpark Arenberg 40, B-3001 Leuven, Belgium
Tel.: +32 16 321658; fax: +32 16 321989
Patrick.Willems@bwk.kuleuven.be

Guido VAES
HydroScan NV
Diestsesteenweg 104 A - B-3010 Kessel-lo, Belgium
Tel.: +32 16 24 05 05; Fax: + 32 16 24 05 09
Guido.Vaes@hydroscan.be

Received: 14/03/2013 / Accepted: 24/04/2013
Published online:30/08/2013

Introduction to the Science-Policy Interfacing problem

The integration of research and technological developments (RTD) into practical uses (including infrastructure developments, policy implementation, etc.) is a complex challenge which involves knowledge sharing and exchanges among a wide range of disciplines, sectors and stakeholders. In many instances, the lack of communication and of clear coordination mechanism leads to research outputs not being used or simply known by end-users, and to research needs (identified by end-users) not being communicated to the scientific communities. Since 2000, technical milestones of the Water Framework Directive (WFD) (e.g. characterisation of pressures and impacts, economic analysis, design of monitoring programmes, ecological status…) have called for scientific support, technical knowledge, practical experiences and availability of various tools. In this context, attempts have been made to establish working relationships among research projects and WFD implementers. From the experience gathered over the past years, it appears that the transfer of knowledge resulting from these projects was not satisfactory enough as only a few projects could contribute effectively and timely to WFD policy milestones. This requires new ways for ensuring operational and sustainable exchanges among research and policy-making communities, which cannot be conceived as a 'one shot' event but should rather be developed as a long-term systematic undertaking. The integration of scientific outputs into water policies may be conceived at various levels, e.g. different user communities and policy steps. One of the main identified difficulties for ensuring such integration stems from the fact that there is no sufficient streamlining of information from, for example, the scientific community to policy decision-makers. Neither is there from the latter to

DOI 10.4409/Am-056-13-0049

the former as to formulating their problems to identify scientific ''inputs'' necessary to solve them. The success, for instance, of transferring scientific findings from the research community to operational use by the water managers is still a demanding challenge. Science-policy integration is one of the most complex challenges that scientific and policy-making communities are facing today (Quevauviller et al., 2005). The European Community and developing countries have spent considerable amounts of money funding RTD projects for decades aiming at protecting and managing water and environmental resources for sustainable development. Likewise, many resources are spent in defining and implementing a number of water related policies. Despite the presence of these policies, there still remains a communication gap between policy, research and industry. To improve this situation, an enhanced operational Science-Policy Interfacing (SPI) tool besides other approaches that guides specific user groups to find specific information in a huge body of available knowledge is required.

More specifically, communication channels are required that are two-way effective such that scientists and policy makers can understand each other. A number of strategies often covered by the broad banner of knowledge transfer are used in attempts to bridge the knowledge divide(s) between research, policy formulation, and operations in natural resources management. Although existing strategies may achieve some result, they often fall short of delivering proper alignment and a seamless flow of knowledge between these groups. Success, on the other hand, comes most frequently from fostering an integrated progression from research, to design, adoption and sustainable implementation (Roux, 2001). There are a range of instruments that have been tested but it remains to be concluded which instrument is the best interface. Research on the interfacing instruments and their effectiveness is necessary as it will help to provide insights on bridging the communication gap between scientists, industry and policy makers (Quevauviller, 2010).

Within the research and policy communities for example, there exist excellent communication channels; but across research, policy and industry/users, there still exist communication gaps. The aim of such interfacing mechanism/instruments should be to help Member States (MS) to get a timely access to scientific information supporting Integrated Water Resources Management implementation in general (and in particular the WFD and other relevant directives) and to identify short, medium and long term research needs (Quevauviller, 2010).

In this paper, an examination of some of the key reasons why effective implementation of knowledge transfer remains elusive is provided as well as proving some possible solutions for the SPI problem. Emphasize is put on the need to appreciate both explicit and tacit forms of knowledge, and to shift from a mode of unidirectional transfer, to the co-creation of knowledge. The paper also briefly highlights, as a recently developed SPI tool (as an example of SPI instrument), the WISE-RTD Web Portal (http://wise-rtd.info/en).

Analysis of the Science Policy Integration problem

Different reasons for the SPI problems are quite elaborate. Reports of misunderstandings and friction between ecosystem researchers and managers have been recorded frequently in literature (e.g., Cullen 1990, Aumen and Havens 1997, Baskerville 1997, Norton 1998, Rogers 1998, Walters 1998, Grayson et al. 2000, Cullen et al. 2001, Kinzig 2001). Many reasons for this have been suggested, but the most common theme to emerge is the difference in operational cultures and working philosophies. Many managers hold the view that:

- Scientists do not work at appropriate or useful spatial and temporal time scales;
- Scientists have little regard for application contexts, and are driven only by intellectual curiosity;
- Scientists do not communicate effectively to non-scientists.

Scientists' views of policy makers testify to similar biases in disciplinary and cultural understanding:

- Policy makers have a poor understanding of scientific processes as they are always busy trying to fulfill their political agendas;
- They are caught up in day-to-day operations, and spend little time in intellectual reflection and longer-term Research & Technological Development planning.

These reasons have also been elaborated in Quevauviller et al. (2005) and are discussed further hereafter. Scientists view the end-user in the research project as the client for their research results, but on the ground there is a significant lack of transfer mechanisms that would allow passing the relevant information on to other stakeholders including policy makers and implementers. The latter often do not have sufficient time or capacity to incorporate research results into their activities, or even simple access to specific technical journals and thus relevant information mostly remains within the specialized scientific community. The difference in timing concepts between these communities is an important factor in this; policy-making or implementation (e.g. water management) tends to operate for the short term, while science is generally developed on a long-term basis. Additionally, policy-making tries in most instances to achieve an acceptable compromise and/or applying a rather pragmatic approach (political reasons), whereas the scientific community strives to obtain objective, scientific facts and wants to understand a phenomenon to the greatest possible detail (Willems and de Lange, 2007). One possible solution when dealing with knowledge transfer across the science–policy divide would be to involve other stakeholders, i.e. involve end-users in the knowledge creation process and ensure proper information packaging for policy makers.

Notable is the fact that too often researchers will develop a product and pass the final report, publication, or design on to managers with the expectation that it will be embraced with enthusiasm and implemented immediately. Implementers are presented with a product for which they have little ownership, and which might not suit their particular needs, capabilities, or resource realities. Early and continued interaction with end-users is the surest way to increase compatibility between knowledge innovations and resource management needs (Poff et al., 2003). Prospective users should be involved up front, be encouraged to participate in the new technology's development, and help apply it at a pilot scale before it is finally adopted and rolled out in a wider scale.

Although scientists may be good communicators within their peer groups, they often struggle to translate the scientific message to reach policy makers, and therefore, have little influence on management behaviour. There are various reasons for this: e.g., undue emphasis may be placed on single, lengthy outputs for a homogeneous audience (as seen in research reports or journal publications), and research findings are surrounded with conditions and qualifications (e.g., Cullen 1990, Baskerville 1997, Walters 1998, Saywell

and Cotton 1999, Cullen et al. 2001, Kinzig 2001). Within academia, while many research institutions and universities are increasingly encouraging outreach activities such as working with stakeholders and outreach organizations, overall reward of these kinds of activities still remains low. Managers/policy makers, on the other hand, meet this knowledge "push" strategy with their own set of realities and constraints. They often experience information overload, and perceive scientific messages as promoting a particular viewpoint that is driven by undue self-interest. They cannot trust all information sources equally, and contradictory information makes it even harder for managers to assess the risk of embracing, or ignoring, a particular message (Cullen et al. 2001). To a policy maker, scientific information can be useful, but only if it is packaged to be unambiguous, is not excessively complex, and is compatible with existing planning models (Westley, 1995). It should also be credible with minimal uncertainty.

Recommendations to enhance Science-Policy Interfacing

To address the SPI problem, there is greater need to improve transfer and usability of research outputs through organisation of "Water Science meets Policy" events, either at thematic level (ad hoc basis linked to relevant projects and Common Implementation Strategy (CIS) Working Groups), or as Science-Policy Interfacing quarterly/yearly events involving project coordinators, stakeholders, experts, policy-makers from EU MS, and officials from EU institutions (in particular EC General Directorates and European Parliament). This would ensure a dynamic interface to identify research needs and boost usability of available (or to be produced) results to support the implementation of the WFD and other directives within the CIS framework.

The other possible ways forward towards addressing science-policy and industry gap could include: strengthening the "translation" of research results and aligning research more closely with policy needs. In general, most research results are published in academic papers, journals and books, few of which are read by policy makers. The language is often technical, full of jargon and the findings are not presented in ways that make clear the policy implications to non-specialists. Intermediaries in the form of "Knowledge brokers" and/or translators are therefore needed to 'translate' research output into inputs that may be used by policy makers.

Additionally, scientific results that could potentially be used in the policy making and implementing process should be better disseminated (not only in scientific journals but also in a way that is 'readable' by policy makers) e.g. through "science-policy briefs". The "Science for Environment Policy" news alert should be promoted; this is designed to help the busy policy-maker keep up-to-date with the latest environment research findings. The use of social media can also influence the science-policy dialogue including organizing summer schools for the dissemination of policy and/or science needs.

Early and continued involvement of all stakeholders including civil society/end users at all stages of the project cycle and organizing science-policy panel workshops where they discuss needs from both sides is another way of bridging the science-policy gap. Face to face discussions are seen to be effective and efficient forms of interfacing. A case in point is the Centre for Science and Policy at Cambridge University which runs a programme enabling policy officials to meet researchers where they present their scientific knowledge needs. It should also be noted that science-policy interfacing is about people; a focus solely on flows of information will not be able to build effective transfer mechanisms without these interactions.

Since policy cycles are generally iterative in nature, accessing the right information at the right time in the cycle is critical. To ensure that research results are available when policy-makers need them, scientists and research projects need to establish a "Policy Watch" to anticipate policy evidence requirements. Linked to this, research aiming to support policies should develop a work plan mixing good science and demonstration of its applicability through testing against policy deliverables/milestones.

There is also need to embed "policy dimension" in existing academic curricula and professional training as a long term solution and this will eventually lead to a young generation of "new species/facilitators" who understand the importance of science-policy interface. It is noted that the availability of policy officials with a scientific background is likely to strengthen the potential effectiveness of the science-policy interface. As an example, in the U.S, Government scientists participate in expert-level exchanges with staff of Resources for the Future as well as in research projects. This emphasizes the need to support science students to think about policy issues and to draw them into policy work early enough.

To further facilitate the up-take of scientific research by policy makers, it is also recommended that EU funded research projects should now focus more on policy support than just academic research. Scientists should carry research based on policy and community identified needs not just to satisfy curiosity and future EU or any other Government funding should be based on these criteria. The CIS-SPI Expert group for example ought to take stoke of available research results relevant to CIS research and implementation needs and research gaps. This will ensure that research gaps are known and possibly taken up in research programming activities and that new knowledge generated from these projects actually goes back to inform policy work. This is also in line with the EC's Green Paper (E.C., 2011).

Important to note also is that in trying to shrink the gap between science, industry and policy, it is paramount to consider the aspects of "demonstration", i.e. specific activities aiming at demonstrating the applicability of research outputs in supporting policies. The WISE-RTD Web Portal discussed in section 4 is doing this as well through linkages with case studies and experiences. It is indeed only with practical examples that implementers may believe in the usefulness of new methods or solutions derived from research. For example, there is a clear need to establish science-policy interfacing functions at MS level (environment ministries or agencies) that would enable to improve the transfer and the implementation of research results. Some MS have already recognized this need, e.g. the "Evidence Department" at DEFRA (UK), the ONEMA (FR), etc. There is a need to develop a common world view through close and continual engagement of all actors.

There exist potential areas for further research and the following is recommended; while each policy area, e.g. water, is interfacing with scientific evidence, there is a lack of cross-cutting work to share common areas of knowledge, expertise and evidence and to explore long-term partnerships. The challenge over the next few years will

 DOI 10.4409/Am-056-13-0049

be to establish operational links and develop one portal for environmental reporting ensuring an efficient dissemination and use of research results among the different sectors (air, soil, agriculture, water, climate change, etc), actors and stakeholders. This will create a streamlined reporting. Moreover, resources can be concentrated on developing jointly standardized procedures and tools for all the partners involved in the above sectors. These standards may be further used as a technical basis for environmental regulations.

WISE-RTD as a promising example of SPI instrument

One promising example of science-policy interfacing instrument is the WISE RTD Water Knowledge Portal (http://wise-rtd.info/en), initiated within Harmoni-CA. One of the objectives of Harmoni-CA was the creation of a forum for communication, information exchange and harmonization of information communication and technology (ICT) tools for integrated river basin management and the implementation of the WFD. Harmoni-CA was initiated in a joint initiative with DG Environment and DG Research of the European Commission (Harmoni-CA, 2003). The interfacing instrument aimed to enhance the accessibility of results of RTD projects to a range of stakeholders, including policy implementers, industry, NGOs, etc., and to technically support the interfacing (Willems and de Lange, 2007). It became one of the cornerstones; RTD projects focussed part of the Water Information System for Europe (WISE):water.europa.eu. After Harmoni-CA, two other EU projects SPI-Water and STEP-WISE continued the development of WISE-RTD. The SPI-Water project worked out a number of concrete actions to bridge gaps in communication by developing and implementing a 'science-policy interface', enhancing the use of RTD results in the WFD implementation (Vaes et al., 2009). In the STEP-WISE project, the WISE-RTD portal that initially was only linked to the WFD policy, was expanded to include more EU water related directives as well as the US Clean Water Act (CWA). As an example of the SPI instruments, the WISE-RTD portal has been implemented to serve as a dissemination tool, linking diverse EC Directives' policy aspects to RTD results, obtained within the scope of the EC's Framework Programmes and LIFE demonstration projects, thus bridging the science-policy gap in information exchange. It is a web-based interface which has been in use since 2007 with the ultimate focus being on the 'water' sector.

As discussed in section 3, one should also realize that the development of an operational science-policy interface will only be possible through interactions and guidance of a dedicated group mixing policy people, scientists and stakeholders. Within the research and policy communities for example, there exist excellent communication channels; but across research, policy and industry/users, there still exist communication gaps (see also Fig. 1). A critical issue is who drives the agenda for what knowledge is produced. To clarify who the decision maker is (society, government and science or all) when it comes to science-policy interfacing, it is important to note in this paper that ownership of the problem of creating science/knowledge that is usable rests both on scientific organizations and those organizations that might benefit from the knowledge produced. It is however, obvious that society and government often tend to appropriate science in order that their decisions are considered reliable and valid. A model that combines "science push" from the scientific community and "demand pull" from society and government, in a co-production of knowledge, where the research agenda is shaped in an iterative manner between knowledge producers and users is recommended. Involvement of all stakeholders (science, government and society) in knowledge co-production is called for. It must be emphasized that the three angles of the triangle have an influence on each other and should effectively be interacting with each other through their interfaces. Good communication and dissemination ought to be ensured. This is demonstrated by the WISE-RTD portal which aims to facilitate dissemination and communication aiding interfacing for all these users.

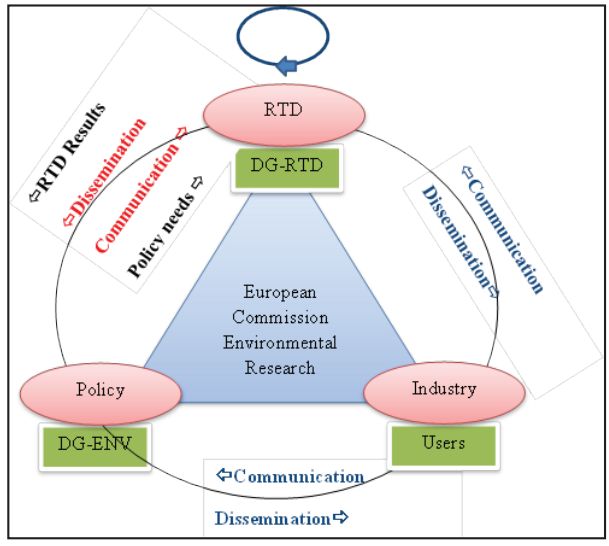

Fig. 1: *Dissemination and Communication through the WISE-RTD Portal.*

It is important to mention that the first aim of the science-policy interfacing instrument is the interfacing between results of RTD projects, relevant for water policy implementation tasks, and the needs of end users, mainly policy developers and implementers, such as water managers, but also other related stakeholders including industry, NGOs, etc. The WISE–RTD Water Knowledge Portal works in such a way that through an intelligent matching system, research results and water technologies are mapped to water policies. Each of the policy implementation tasks, guidances, experiences and tools can be linked to one or more (in this case water-related) activities. Technically, this interfacing is done by linking the policies and related policy implementation tasks with the available RTD results and tools by means of keywords. The concept of science-policy interfacing developed within the framework of Harmoni-CA, has been elaborated in Willems and de Lange (2007).

As the WISE-RTD portal links EU Water Directives to research tools, models and experiences through an intelligent set of keywords users may see to what specific policies a specific model or experience relates to and vice-versa. It is the only Water Knowledge Portal which has collated water related directives and all research results in one place which would otherwise be scattered all over the world wide web.

On the other hand, as the WISE-RTD portal intelligently links water research to water policies, through acting as a "switch board" and directing information searches towards the research project

websites, it is observed that an attempt to make sure that all EU-funded projects maintain their websites online after their completion seems not feasible because of the defined project period and costs. Critical evaluation of the current version of the WISE-RTD Web Portal has shown that some of the Links (URL) to the location on the World Wide Web (www) where the details can be found are non-existent. This is a point of attention that needs to be addressed.

As a recommendation and for a better utilization of the WISE-RTD Web Portal, it would be important to insert a "report button" that informs the Web Portal management team that some of these links are not working so that a corrective action can be taken. This will make the "switch board" concept in the portal more relevant for science-policy interfacing. Thus, it is important to keep research projects' websites alive. To this effect, all future EU-funded projects ought to be mandated to clearly indicate in their proposals how they are going to maintain their websites even after project completion before being granted funding. Projects should now realize that this should not be seen as costly but a valuable component which makes research information/results available to a growing network of users.

Concluding Note

The recommendations given above are intended as a starting point for an effective science-policy interface. Additional study is necessary to develop these recommendations based on institutional practicability, costs and human resource that enable policy makers to design policies based on scientifically-sound and up-to-date information.

Acknowledgment: This research was conducted within the framework of the Interuniversity Programme in Water Resources Engineering (IUPWARE) and was funded by the Flemish Interuniversity Council, Belgium (VLIR). The authors are grateful to the STEP-WISE Project funded by the European Commission (FP7) and the WISE RTD Association members (http://www.wise-rtd.org/) for providing the information for the research.

REFERENCES

Aumen, N. G., and K. E. Havens. 1997. Needed: a new cadre of applied scientists skilled in basic science, communication, and aquatic resource management. *Journal of the North American Benthological Society* 16(3):710–716.

Baskerville, G.L. 1997. Advocacy, science, policy, and life in the real world. Conservation Ecology [online] 1(1): 9. Available from the Internet. URL: http://www.consecol.org/vol1/iss1/art9/.

Cullen, P. 1990. The turbulent boundary between water science and water management. *Freshwater Biology* 24:201–209.

Cullen, P., P. Cottingham, J. Doolan, B. Edgar, C. Ellis, M. Fisher, D. Flett, D. Johnson, L. Sealie, S. Stocklmayer, F. Vanclay, and J. Whittington. 2001. *Knowledge seeking strategies of natural resource professionals.* Synthesis of a workshop held in Bungendore, New South Wales, 5–7 June 2001. Technical Report 2/2001, Cooperative Research Centre for Freshwater Ecology, Australia.

De Lange WJ, Plyson J, Willems P, Vansteenkiste T, Provost F, Hattermann F, Vaes G, Swartenbroeckx P. 2010. WISE-RTD-a portal for Science & Technology transfer to policy making & implementation in Integrated Water Resources Management. In: Quevauviller PH (ed) Water system science and policy interfacing, chapter 4.2. RSC Publishing, Cambridge, pp 310–332.

E.C., 2011. Green Paper, From Challenges to Opportunities: Towards a Common Strategic Framework for EU Research and Innovation funding, Off. J. Eur. Commun. 9.2.2011. Final document available under: http://eur-lex.europa.eu.

Grayson, R. B., S. A. Ewing, R. M. Argent, B. L. Finlayson, and T. A. McMahon. 2000. on the adoption of research and development outcomes in integrated catchment management. *Australian Journal of Environmental Management* 7(3):24–35.

Harmoni-CA, 2003. Harmonised Modelling Tools for Integrated River Basin Management, Harmoni-CA E.C. funded concerted action; contract EVKI-2001-00192, http://www.Harmoni-CA.info.

Kinzig, A. P. 2001. Bridging disciplinary divides to address environmental and intellectual challenges. *Ecosystems* 4:709–715.

Norton, B. G. 1998. Improving ecological communication: the role of ecologists in environmental policy formation. *Ecological Applications* 8(2):350–364.

Poff, N. L., J. D. Allan, M. A. Plamer, D. D. Hart, B. R. Richter, A. H. Arthington, K. H. Rogers, J. L. Meyer, and J. A. Stanford. 2003. River flows and water wars: emerging science for environmental decision-making. *Frontiers in Ecology and the Environment* 1:289–306.

Quevauviller Ph, Vervier P, Durot M-P 2010. Concept of interfacing and perspectives. In: Quevauviller Ph (ed) Water system science and policy interfacing, chapter 5.1. RSC Publishing, Cambridge, pp 393–398.

Quevauviller, Ph., Balabanis, P., Fragakis, C., Weydert, M., Oliver, M., Kaschl, A., Arnold, G., Kroll, A., Galbiati, L., Zaldivar, J.M., Bidoglio, G., 2005. Science–policy integration needs in support of the implementation of the EU water framework directive. Environ. Sci. Policy 8, 203–211.

Rogers, K. 1998. Managing science/management partnerships: a challenge of adaptive management. *Conservation Ecology* 2(2):R1. [Online.] URL: http://www.ecologyandsociety.org/vol2/iss2/resp1.

Roux, D. J. 2001. Strategies used to guide the design and implementation of a national river monitoring programme in South Africa. *Environmental Monitoring and Assessment* 69(2):131–158.

Saywell, D. L., and A. P. Cotton. 1999. Spreading the word: practical guidelines for research

Vaes, G. P. Willems, P. Swartenbroekx, K. Kramer, W. de Lange, K. Kober. 2009. Science-policy interfacing in support of the Water Framework Directive implementation. Water Science Technology 60 (1):47-54

Walters, C. J. 1998. Improving links between ecosystem scientists and managers. In: M. L. Pace and P. M. Groffman (ed), pp 272–286.

Westley, F. 1995. Governing design: the management of social systems and ecosystem management. Pages 391–427 *in* L. Gunderson, C. S. Holling, and S. Light (ed). *Barriers and bridges to the renewal of ecosystems and institutions.* Columbia University Press, New York, New York, USA.

Willems P., De Lange W.J., 2007.Concept of technical support to science–policy interfacing with respect to the implementation of the European water framework directive. Environ. Sci. Policy 10, 464–473.

DOI 10.4409/Am-056-13-0049