



THINKING OUT OF THE ORDINARY: PROMOTING KNOWLEDGE GENERATION AND RESEARCH ON WATER

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Water is not an ordinary good” (Savenije, 2002)

“Knowledge is a strange good” (Foray, 2004: 91)

Abstract

Water is special while knowledge is a strange kind of good. Promoting creativity and new ideas, and the production, management and reproduction of knowledge is not as simple as producing any other commodity. The paper sketches the special character of water, knowledge and knowledge about water, and concludes that it requires ingenuity, creativity and commitment to find the lucky match between the strange and extraordinary aspects of water knowledge. The paper then formulates three questions that are meant to inspire and guide the discussions during the UNESCO-IHE Symposium. The questions are illustrated by some relevant examples and references. The first question deals with how research can be made more relevant and responsive to water-related development objectives. It is argued that if a genuine demand for specific knowledge would be able to express itself, it would boost the value of local knowledge and help set the fly wheel of innovation in motion. The second question is how research capacity in water can be strengthened and sustained locally and regionally. The paper provides some encouraging examples from Southern Africa. Apart from opportunities created by modern high tech technologies, the value of local and indigenous knowledge is also emphasised. The third question probes the role of the North in supporting research capacity in the South. Finding sustainable mechanisms for funding research funding is difficult everywhere but especially so in developing countries. External financial support may be required but may come at a cost and introduce new complications; yet we do not precisely know how success of capacity building efforts can be quantified. Finally the paper makes an urgent plea of the North opening up its scientific resources to the South.

Key words: capacity building, knowledge, research, research funding, technology, water

1. Introduction: defining the problem

This paper explores the specific characteristics of water, knowledge and water knowledge in order to gain insights into the ways in which the production of knowledge about water can be promoted, especially in developing countries.

Access to water is a decisive factor for the well-being of all human beings, both for health and productive considerations. Increasing people’s access to water requires the development of new water systems and, significantly, the overhaul and refurbishment of existing ones. It is increasingly being realised that the huge monetary and physical resources required are necessary but not sufficient to achieve the targets set by the MDGs.

What is required is adequate and appropriate local and regional (academic, technical, intellectual, organisational) capacity to analyse, plan, design, implement, manage, operate, maintain and renovate water systems. Such capacity is premised on adequate knowledge on water.

Knowledge on water, however, is unevenly spread across the globe, and whereas large chunks of water knowledge are generic and global, other aspects are locally or regionally specific. Transferring knowledge from one person to another, and from one region to another, is

burdensome and “sticky” (Von Hippel, 1994), and generating new locally or regionally specific knowledge that capitalises on, and adapts, knowledge developed elsewhere is not likely to occur spontaneously and requires active support (Opschoor, 2006).

The ability to reflect, the ability to critically analyse situations, define problems, define ways in which answers may be found, allocate the means, conduct research, interpret the results, act and adapt, and in the process produce new knowledge, are invaluable faculties. This type of “2nd order capacity” is a scarce resource everywhere (Watson et al., 2003).

One important locus where 2nd order capacity is being reproduced and nurtured is at the universities and other tertiary educational institutes. These are the places where the modernizing forces of society should be given space, where the value of science is promoted and the political and industrial spheres of life are being mediated (IAC, 2004a). As the report “Inventing a better future” of the InterAcademy Council states: science brings imagination and vision and allows people to analyse present and future situations, make sounder choices and invest their resources more wisely.

A proper university should not only be the locus of knowledge reproduction, but also that of knowledge production. Education and research go hand in hand. For society this is a felicitous combination that allows researchers to earn a living without a need to privatise the knowledge they generate (Foray, 2004). Moreover, without the research connection, education is more likely to remain stagnant or to become obsolete.

Thus it is making the obvious point when stating that higher education should be allocated sufficient resources, also in poor countries. Publications from many different institutions concur that it is in the self-interest of poor countries to invest in research and education, and science and technology. Moreover, it is in the interest of the global community that richer countries assist poorer countries with financing their educational programmes, because to solve the challenges that the world is facing requires the thinking power of all bright brains; leaving some of this capacity “under-utilised” would clearly be sub-optimal if not a waste.

Yet, in reality the situation is far from optimal. In Africa on average 40% of the established posts in science and technology training institutions are vacant, 55% of laboratory equipment is obsolete, and two thirds of the institutions do not meet the staff:computer ratio of 1:2 (ANSTI, 2005).

A clear and distinct global knowledge divide exist, whereby a relatively small group of rich countries produce nearly all academic publications (31 countries produce 97.5% of the world’s most cited publications; King, 2004; see figure 1). There is therefore a disconnect between the desirable state and the situation on the ground. When reviewing some recent literature on capacity strengthening of research and education, and science and technology (these fields are often lumped together), one is struck by the frequent use of the word “should”: developing countries should promote science and technology, should spend at least 1% of GDP on R&D, and should promote an open culture of scientific debate. Such formulations are lame if not accompanied by good and critical analyses of the current state of affairs and what is needed to force a breakthrough and achieve a fundamental change towards a more desirable state. Just throwing money at tertiary education and R&D may not be enough. But what is? This is the question that this background paper attempts to explore.

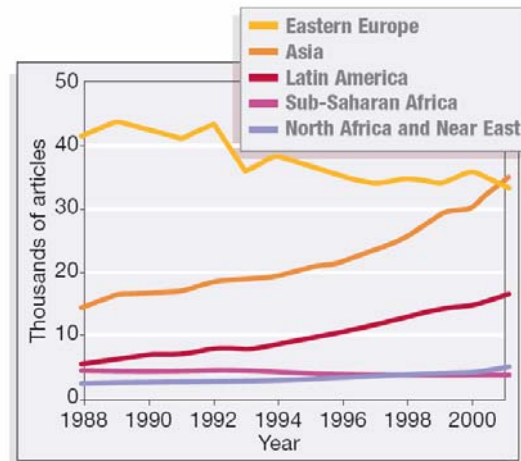


Figure 1: Publications by continent of origin (Source: Nature vol 432, 4 November 2004, p. 8)

We are aware that the stimulation of creativity and new ideas, and the production, management and reproduction of knowledge is not as simple as producing any other commodity. The paper sketches the special character of water, knowledge and knowledge about water before formulating a number of questions that are meant to inspire and guide the discussions during the Symposium. The questions are illustrated by some relevant examples and references.

2. Why knowledge on water is special

We probably all agree that “water is not an ordinary good” (Savenije, 2002), and that “knowledge is a strange good” (Foray, 2004: 91). If this is so, how special would “water knowledge” be? It is important to acknowledge the specific characteristics of both goods, otherwise simplistic solutions for the promotion of knowledge on water may be proposed that simply won’t work. Finding the “right” ways of stimulating the creation of new ideas and new solutions to important problems is therefore itself an exciting field of inquiry.

Water

Water has at least three attributes that makes it special, and that have important implications for its management: water is vital, finite and fugitive. Fresh water is *vital* to sustain life, for which there is no substitute. This not only means that water has a very high value to its users, it also gives it characteristics of a public good, as no people may be denied access to it for primary requirements.

Although water is a renewable resource, it is practically speaking *finite*. Many (consumptive) uses of water are therefore exhaustible or subtractable, meaning that the use by somebody may preclude the use by somebody else, and thus rivalry may emerge between competing uses. The finite nature of water confers to it properties of a private good, as it can be privately appropriated and enjoyed. Its finite nature also implies that water use often has negative externalities. It should be noted that some uses of water, or its services, are nonrival, such as navigation and flood control.

Water is a fluid and *fugitive* resource. It is therefore difficult to assess the (variations in) stock and flow of the resource, and to define the boundaries of the resource. This complicates the planning and monitoring of withdrawals as well as the exclusion of those not entitled to abstract water. Its fugitive nature makes it also more costly to harness, requiring the construction of reservoirs, for example. The fugitive nature of water, and the resulting high costs of exclusion, confers to it properties of a common pool resource.

Water resources management aims to reconcile the vital, finite and fugitive attributes of water, which is a unique combination. This is not a simple task. The property regime and management arrangements of a water resources system are therefore often complex. Different perspectives and approaches have been proposed for designing the right water institutions, but no consensus exists, especially when it comes to the economics of water, and the involvement of the private sector in services provision. There are also large regional variations, often influenced by climatic, biophysical, cultural and historical aspects. It is likely that for local problems often locally specific solutions need to be developed. No one size fits all knowledge base suffices to resolve the challenges.

Knowledge

Knowledge, just like water, is a special good. Knowledge as a resource has some features that sets it apart from other types of resources. This implies that promoting the generation of new (scientific) knowledge and its dissemination requires policies and measures that are not always that straightforward. The most peculiar aspects are that knowledge is non-excludable, its externalities are often positive, it is a non-rival good and it is cumulative (Foray, 2004; pp. 91-95).

The *non-excludability* of knowledge means that it is very difficult to make it exclusive or to control it privately. Knowledge is a fluid just like water, but unlike water it is not at all bulky but portable. Knowledge can, of course, be kept secret, yet as soon as it is revealed it slips out of one's grasp. Information and knowledge continuously escape from the entities producing them and can thus be used freely by competitors or rivals who benefit from it but from whom it is technically difficult to obtain compensation. Knowledge thus tends to have large *positive externalities*.

Knowledge is not finite, unlike water. It is inexhaustible, and its use not subtractable. It is therefore a *non-rival* good. The use of existing knowledge by an additional agent does not imply the production of an additional copy of that knowledge. The author does not have to produce an additional unit of knowledge every time its use is extended, nor does somebody else's use of that knowledge deprive any other person from that knowledge. Transmitting knowledge can therefore be considered a positive sum game that multiplies the number of owners of that knowledge indefinitely. The nonrival nature of knowledge has wide-ranging implications. Since the marginal cost of use is nil, cost-based pricing mechanisms do not work.

Knowledge is *cumulative* and progressive: it is an intellectual input that is likely to spawn new ideas and new goods. This means that externalities enhance not only consumers' enjoyment but also, and above all, the accumulation of knowledge and collective progress. Thomas Jefferson formulated it thus:

“The fact is, that one new idea leads to another, that to a third, and so on through a course of time until someone, with whom no one of these ideas was original, combines it all together, and produces what is justly called a new invention” (cited in Foray, 2004: 94)

The uncontrollability, nonrivalry, and cumulativeness threesome of the production of knowledge may create a powerful momentum. Knowledge production is therefore nonlinear and requires critical mass before obtaining a self-reinforcing dynamic.

Given these attributes of this strange good, it is a challenge to design institutional arrangements that will foster the development of knowledge. The problem is to adequately address the “knowledge dilemma”. Foray (2004: 116) formulates this dilemma thus:

“Only the anticipation of a positive price on use will guarantee the allocation of resources for creation, but only a price that is nil will guarantee efficient use of knowledge, once it has been produced.”

There may therefore be few incentives for the private sector to invest in knowledge infrastructure, unless adequate measures are in place. It is for the same reason that maintaining the backbone of a country's knowledge infrastructure have to be the duty of the state. Yet without the pull for new knowledge from the wider society including the private sector, the knowledge infrastructure may become moribund. A carefully chosen mix of public and private roles and incentives is therefore required.

Water knowledge

Managing water resources properly is important in terms of human development. Not doing so leads to serious social and economic costs. This has long been recognised and is reflected in the conclusions of the Earth Summit in Rio 1992 (Chapter 18 of Agenda 21), the Millennium Summit in New York (the MDGs) and the World Summit on Sustainable Development in Johannesburg in 2002 (the Johannesburg Plan of Implementation).

Given the serious challenges facing the world community with respect to water, there is a growing realisation that the capacity to properly develop and manage water resources and water systems is inadequate and unevenly available. It is therefore pertinent to understand the

conditions that allow the generation of knowledge on water resources and its development and management, and to investigate what policies and interventions may promote the creation of water knowledge. How could water research best be financed, taking account of its public good nature? Which types of investments should be prioritised; from enhancing the quality of primary and secondary education to applied research into robust water treatment techniques, small-scale pumping technologies, dynamic optimisation tools for water allocation, or the use of mobile phones for flood warning?

Since water is an extraordinary good whose management regime is complex, and knowledge similarly has a complex combination of attributes, it seems dauntingly difficult to formulate policy measures that will promote the development of knowledge on water. It will require ingenuity, creativity and commitment to find adequate solutions to properly identified and carefully formulated problems. It is the ambitious objective of the session “Knowledge generation and research” to contribute fresh ideas.

3. Knowledge generation and research – defining the questions

The session “Knowledge generation and research” will consist of a number of invited presentations on topical issues as well as three discussion rounds. The following three general questions will be discussed:

1. How can research be made more relevant and responsive to water-related development objectives?
2. How can research capacity in water be strengthened and sustained locally and regionally?
3. Should the North support and promote research capacity in the South? If so how?

A lot has already been said and written about these and related questions (see e.g. ANSTI, 2005; InterAcademy Council, 2004a, 2004b; Millennium Project (Juma and Yee Cheong, 2005), Rawoo, 2005; United Kingdom House of Commons, 2004; OECD/World Bank, 2006). The session wishes to take note of the lessons learned, as well as some recent experiences specific for the water sector. Here we offer a preliminary review, which aims at kick-starting the discussion.

3.1 A more responsive and development relevant research capacity

Evidence seems overwhelming that without research capacity economic and social development cannot occur. As was earlier referred to, a knowledge divide between nations exists. There is a clear distinction between countries that have less than 1,000 experts per million people working in the research and development sector, and those who have more (Figure 2). Only if there is sufficient critical mass does a relationship emerge between the number of researchers and the Human Development Index rank. Under-spending on R&D therefore is inefficient; it is arguably a waste of money.

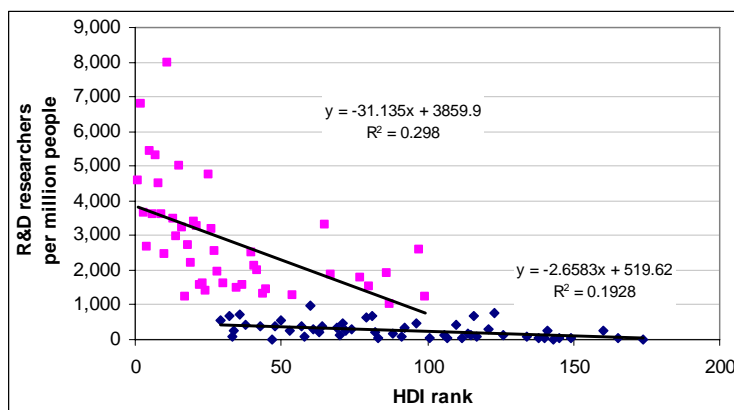


Figure 2: A country's rank on the Human Development Index HDI and the number of researchers per million people (Data of 177 countries taken from UNDP, 2006)

But this evidence is circumstantial and indirect. It is very difficult to demonstrate the direct economic returns to investment in research capacity (but see Conningarth Economists, 2004). And even then it could be argued that just investing in science and technology may be missing the point. Science and technology in themselves are not sufficient to cause social progress and economic development.

“The real challenge lies in embedding science in all spheres of government policy, and introducing educational, regulatory and fiscal measures to enable innovation to flourish across the economy.” (Dickson, 2007)

Often the limited knowledge resources of a country are underutilised, and its researchers are employed by ill-funded institutions that are frequently isolated from the large societal questions. Just boosting the budget of such organisations may not make a change. It may however fulfil a prerequisite for significant change to occur (see e.g. Ghana where a new and straightforward government policy results in a significant and structural increase in the financial resources channelled to primary, secondary and tertiary educational institutions).

The above argument is characteristic for a supply-driven perspective. We should of course also consider the demand-side: where is the demand for new knowledge, for new technologies, and for new and locally specific solutions (be they sophisticated and based on the latest developments, or basic) to age-old problems? Why does demand often remain hidden? If a genuine demand for specific knowledge were able to articulate with the potential sources of such knowledge, it would boost the value of local knowledge and set the fly wheel of innovation in motion. Why does it often prove difficult to match the demand for knowledge with those who could potentially develop it? Here we briefly look at one example of rapid innovation where a dynamic linking of supply of a new technology and a demand for it did evolve.

An area where a genuine and strong demand for innovation is unfolding is in communication technology. If we take Africa as an example, a true revolution is occurring. Whereas in 1998 there were in total 14 million households connected to telephones (landlines or mobile networks), by 2006 there were 160 million mobile phone subscribers, and every year more people get connected: 48 million during 2005 alone (Figure 3). Ten years ago few people correctly predicted this development. The first lesson is: information matters and is valued; much more so than many observers realised. What makes mobile phones so attractive and even essential? Mobile phones provide access to information about markets where hitherto no

such information existed; for a farmer who needs to know where the demand for her perishable tomatoes is highest; for a job seeker to be quickly reachable by peers whenever an opportunity arises. Other exciting applications have emerged: early warning for spatially specific threats (floods, contaminations), banking and money transfer, the simultaneous mobilisation of masses during periods of political tension (e.g. Philippines), and, finally a really unanticipated application, the measurement of rainfall.

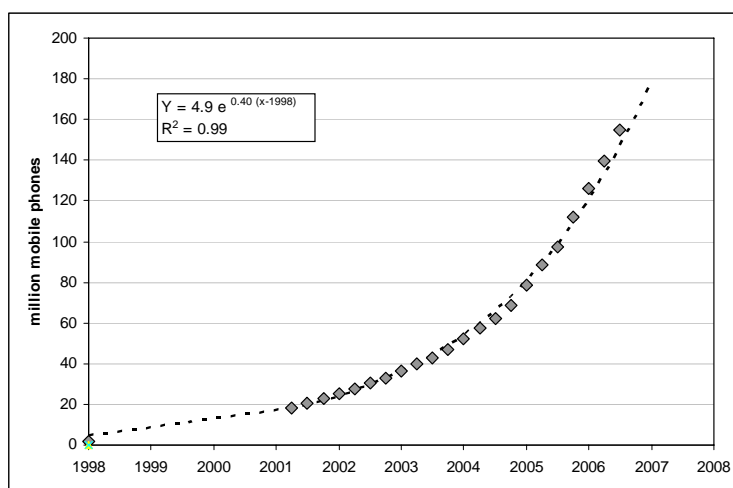


Figure 3: Number of mobile phone subscribers in Africa, 1998-2006 (Source: GSM Association Statistics Q2 2006; <http://www.gsmworld.com/news/statistics/index.shtml>)

Concerns about restricted access to the web in developing countries are real and cause of concern. However, access to mobile phone networks must be a good indicator of future access to the internet, since once you are connected to a mobile phone network, access to the internet is a real possibility. This bodes well for the youth who are eager to widen their horizons, learn and make a difference!

In all, this new technology has completely changed the opportunities open to many people. People have welcomed it, assimilated those technical features that fitted their needs and aspirations, have found new applications, and have been willing to pay a price for it. This latter aspect is the clearest manifestation of the existence of a real demand.

In the water sector, and especially for hydrology and water resources management, new opportunities are opening up by the rapidly increasing applications of remotely sensed data from satellites. Rainfall, cloud cover, surface albedo, temperature, actual evaporation, crop yields, surface area of dams and changes in groundwater volumes can all be measured from space. Although the accuracies and reliability of these measurements vary greatly, these can only improve in future. This technological opportunity is especially relevant for countries that lack adequate transport and other infrastructure, and will certainly lead to better water management decisions. This potential, however, will only bear fruit if two conditions are met. First, a real demand for better information on water resources and their management should exist. Second, there should be local capacity to utilise these new techniques, to critically evaluate and creatively experiment with them, and find new, locally relevant, applications.

For such knowledge capacity to be present, the local knowledge institutions must be functional, up to date and connected to global developments. Hence the importance of universities having access to the relevant scientific journals, with lecturers being engaged in

research, and postgraduate students conducting thesis research. The positive spin-off of such research activities is that it would help to maintain and improve academic quality of undergraduate and postgraduate programmes at universities.

What types of research and which research themes should receive priority would be determined by the need for it, and heavily depends how knowledge institutions and research groups are connected and embedded in society. However, innovation capacity requires some level of redundancy within the knowledge infrastructure, as well as space for curiosity driven research.

3.2 Sustaining research capacity in water

Research funding

A plea to increase research funding is often heard. Experts have made several suggestions how this could be done, e.g. through fixing a percentage of GDP, and through sectoral funding (whereby a portion of a nation's tax levies on for-profit corporations are redirected into a special fund for financing the conduct of research in selected S&T areas of economic interest to the nation). Often also a case is made in favour of public-private partnerships: this would ensure that research is directed to promising applications and would yield immediate results.

But the question is why research remains under-funded. It would appear that politicians and entrepreneurs see little value in research compared to other priority areas. They seem to lack faith in the capacity of researchers to address real problems and doubt whether research investment will ever pay off.

An example where funding for research has been institutionalised, with an enormous positive impact, is the Water Research Commission (WRC) in South Africa (Box 1). The WRC is an interesting example of how a country maintains and stimulates knowledge and research capacity. It would be interesting to know how South Africa, through the WRC, manages and has shaped and strengthened the interface between research and society.

Box 1: The Water Research Commission of South Africa

The Water Research Commission (WRC) of South Africa is a statutory body which has a budget that is independent and separate from the government budget and composed of revenue from a small tax on all bulk and commercial water uses in the country. The WRC has boosted the water research infrastructure in that country, both private (mostly engineering companies) and public institutions (mostly universities), through a system of regular solicited and unsolicited calls for research projects. The WRC also disseminates the research findings in through reports and an open access scientific journal (Water SA; http://www.wrc.org.za/publications_watersa.htm). A recent report analysed six research projects funded by the WRC, and found that the economic benefits resulting from these projects were significant. These investments in research had a benefit-cost ratio of nearly 25! (Conningarth Economists, 2004).

The WRC concept may not be replicable everywhere, since it is premised on significant commercial water use by users that have an ability to pay. Nevertheless, the WRC has been the inspiration behind the establishment of the Water Research Fund for Southern Africa (WARFSA). This fund is open to any researcher or institution resident in a SADC country, and a thorough system of peer review ensures that only the best research proposals are selected for funding. A Board consisting of researchers with different professional

backgrounds and from different countries in the region formulates the research policy of the fund and defines priority areas. The fundamental difference between the WRC and WARFSA is that the latter is donor-funded (mainly by Sida and Danida), which may put a greater challenge on ensuring responsiveness to the needs of the region. WARFSA is currently searching for ways to better link societal demands to the research community, and is reviewing its potential role in promoting that connection.

The question of how research funding can be made sustainable is a difficult one. We should acknowledge here that in many countries it will not (yet) be possible for the water sector to generate sufficient funds to maintain a fully fledged research programme. Cross subsidies from other sectors or from donor countries may be necessary. The question then is how under such circumstances the right research priorities will be articulated, the right research products be generated, and how the knowledge infrastructure can be maintained while remaining sharp and responsive.

Knowledge networks

Several recent publications have suggested that one important way of stimulating research is to identify leading research centres, to heavily invest in these and to connect them to similar centres elsewhere. This focus on supporting “centres of excellence” has been strongly identified by the InterAcademy Council (IAC, 2004a: 5), but has a potential pitfall. As it singles out the relatively stronger research groups, this focus may turn into exclusivity and exclude small research groups that on their own would not have critical mass but if connected could make meaningful contributions. An example of a more inclusive regional network of knowledge institutions is WaterNet in Southern Africa (Box 2).

Box 2: WaterNet of Southern Africa

WaterNet links some 50 university departments and knowledge institutions in 12 southern and eastern African countries. What these departments have in common is an interest and expertise in topics relevant to water. Individually they have insufficient breadth to cover the broad field of water resources management, but in pooling their knowledge resources together they cover all major water aspects, from hydrology to water and sanitation technologies, from environmental engineering to economics and law etc. In so doing WaterNet is in a position to offer a unique and regional Master programme in IWRM, in which six universities are directly involved (University of Dar es Salaam in Tanzania, Chancellor College of Malawi, Polytechnic of Namibia, University of the Western Cape in South Africa, University of Botswana and the University of Zimbabwe), as well as many guest lecturers from other WaterNet member institutions. The WaterNet Master programme in IWRM involves 12 months course work and a 6 months thesis research. Over the period 2001-2006 nearly 180 students have graduated.

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

On top of all this, there are synergies between initiatives such as the WaterNet network and the WARFSA fund (Box 3). WaterNet also implements two major research projects in which several member institutions as well as international knowledge partners collaborate: the

Challenge Programme on Water for Food, and the Small-holder System Innovations programme. These are of particular interest and significant. The Southern African case provides a good example of how research and capacity building can go hand in hand.

Box 3: Synergies between the WaterNet network and the WARFSA research fund

Because the WaterNet Master programme in IWRM includes a 6 months thesis research project, there are some interesting synergies with the WARFSA fund. WARFSA supports several research projects in which WaterNet member institutions and their academic staff are involved. Such projects provide a good research environment/infrastructure for MSc thesis research as well. This combination of tertiary education and research proves a powerful combination. Many WaterNet graduates have through their thesis research contributed new insights in a variety of aspects of water engineering and management. Some of it has been presented at the annual WaterNet/WARFSA/GWP-SA Symposia and published in the journal *Physics and Chemistry of the Earth*, which annually publishes a special issue with the best Symposium papers. This is a growing body of scientific output that currently consists of five special issues containing more than 200 papers. This is significant: one out of six scientific articles with “water resources” and “Africa” in title, abstract or key-words published in the period 2002-2006 originated from the WaterNet/WARFSA Symposia. These articles are also frequently cited: on average 1.75 times (Van der Zaag, 2006).

WaterNet is a first step towards a knowledge community characterised by a strong connectivity between its parts, a sharing of resources and distributed access. These elements are the ingredients for a learning society that is able to frame its own societal problems and find new ways of resolving them. Sharing of knowledge and wisdom between the WaterNet members, clearly a key factor in the success of the network, has not been identified as problematic. In order to learn lessons for other networks, it would be useful to better understand why this is the case.

Three additional points should be taken into account when considering how research capacity can be sustained and promoted:

- Apart from South-South cooperation, the need for North-South cooperation and “triangular” forms of collaboration remains evident.
- The focus of this paper has been very much on higher education and research. We should not lose sight of the need to foster a culture of experimentation, of stimulating creativity and curiosity driven approaches. This certainly requires other types of interventions, also at the level of primary and secondary education.
- The possibilities of new technologies that may have the potential to unlock new opportunities should not result in neglecting, or worse belittling, local and indigenous knowledge. A valid question is how “local” knowledge can remain to be respected rather than neglected, ignored or despised, and remain a source of inspiration and even a source of scientific discovery, patents and income.

3.3 Should the North support and promote research capacity in the South?

Opening up

This final section asks a nearly rhetorical question. The North does, in our view, have a role to play to support and promote research capacity in the South. However, the key lies in the type of support that the North can and should offer. There can be *active* and *passive* types of support. Starting with the latter: If the global knowledge divide is to be bridged the North should open up, and share its knowledge resources with the South and make them accessible.

The importance of this type of support is often conveniently overlooked but it is likely to have few negative consequences and should therefore receive priority. An increasing number of journals are open access, such as the journals *Hydrology and Earth System Sciences* and *Ecology and Society*. However there is a down-side simply because journals do need a financial basis. In the case of these two journals it is not the reader but the *author* who pays (depending on size and some other details, an author would pay around Euro 500 per published article). *Water SA*, another open access journal, is free for both reader and author, and is funded by the water consumers of South Africa through the WRC (see above). Most other scientific journals are not freely accessible, but actually prohibitively expensive for most universities in developing countries. Students and staff at many universities in developing countries are thus often practically speaking excluded from access to up to date academic knowledge. The Online Access to Research in the Environment (OARE) initiative is therefore important. OARE will allow free access to key journals for institutions located in the poorest developing countries (Box 4).

Box 4: Online Access to Research in the Environment (OARE)

Set up by Yale, UNEP, MacArthur and Hewlett Foundations, and 300 of the largest and most prestigious publishers and scientific societies and associations, Online Access to Research in the Environment (OARE) now represents the largest collection of scholarly, peer-reviewed scientific research in the environment related sciences - including water - currently available to 106 least developed nations in Africa, Asia and the Pacific, Latin America and Eastern Europe. The project provides access to approximately 70% of the world's most prestigious scientific journals, together having an annual US retail subscription value in excess of \$1.3 million.

Source: Personal communication Dr P. Walberg

Generally there is a need for new approaches to replace copyrights with more suitable ways of protecting intellectual property rights and rewarding innovators, while supporting the public interest in having broad and rapid access to knowledge and technology. Related to this is the protection of local knowledge and local species from being captured and monopolised by the North.

Capacity strengthening

Turning to ways in which the North could actively support and promote research capacity in the South: the Symposium solicits the views of the South. A first observation is that frequently support by the North for capacity strengthening in the South results in the opposite, namely in weakening local capacities as new dependencies are created. Which modalities of support are preferred? Which types of support and interventions have proven to be effective in capacity strengthening? What lessons may be learned and best practices deduced?

Secondly, often the brain drain is blamed for the weakening of local capacity. But is this always the case? Can the brain drain sometimes be turned into a gain? What roles do the intellectual diasporas play, and how could their positive contribution be enhanced?

Thirdly, is there a special role for international and UN organisations in capacity building? If so what? How can such institutions cooperate with other donor institutions and local partners? Finally, how can success of capacity building programmes be measured? What are useful indicators? These are questions that beg for answers.

4. By way of conclusion

We have argued that since water is special, and knowledge similarly has a complex combination of attributes, it is not easy to identify ways of promoting the development of knowledge on water. It will require ingenuity, creativity and commitment to find the lucky match between the strangeness and the extraordinary aspects of water knowledge, and identify adequate and locally relevant institutional responses to the problems identified. This paper has raised a number of questions. Hopefully these will trigger debates during the Symposium session on knowledge generation and research.

The first key question is how research can be made more relevant and responsive to water-related development objectives. How can we stimulate the demand side for knowledge and better link it to potential sources of knowledge? If a genuine demand for specific knowledge would be able to articulate itself, it would boost the value of local knowledge and help set the fly wheel of innovation in motion.

The second key question is how research capacity in water can be strengthened and sustained locally and regionally. After providing some encouraging examples from Southern Africa it was concluded that apart from South-South cooperation also North-South cooperation and “triangular” forms of collaboration will increase in a globalising world. Whereas the paper has mainly focused on higher education and research, the deeper question is to stimulate a culture of experimentation, which should start with providing young children with toys that trigger their imagination, curiosity and creativity. Apart from new possibilities created by modern high tech technologies, the need for local and indigenous knowledge will always remain. Actually, one could argue that the modern technologies need these local perspectives for unexpected innovations to emerge. Local knowledge should remain to be respected and remain a source of inspiration and scientific discovery.

The third key question asked about the role of the North in supporting research capacity in the South. We argued that making research funding sustainable is difficult, especially in developing countries. These may require assistance from donors. This does not necessarily solve all problems, because under such circumstances it may be more difficult that the “right” research priorities will be identified. Which modalities of support do work? How can success of capacity building be measured? Finally, a case was made in favour of the North opening up its scientific resources to the South.

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