FINITE WATER AND GROWING NEEDS AND WANTS

OPPORTUNITIES AND CHALLENGES FOR INTERDISCIPLINARY RESEARCH NETWORKING

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1. Living at the mercy of the hydrological cycle

1.1 Purpose of article

With reference to the situation in South Asia and also in other parts of the world, a pertinent question is the following: to what extent are improvements in living conditions conditioned by the natural resources' situation, such as water and land? Or a little more precise: What is required to ensure that the amount of goods and services that people need and expect from the natural world can be increased to cater for a seemingly continuous growth in aggregate demand? Since a majority of the population in South Asia live in basins crossing political and other boundaries, it is also relevant to pose a question, which is often raised in the current debate: does an increase in demand for freshwater and the associated competition stimulate co-operation, technical progress and the forging of bonds between people or does it lead to violent conflict or even "water wars"?

Technology does, of course, play a key role in the relations between humans and the landscape where we live and from where most of the basic necessities and other goods and services derive and where the waste products are disposed and accumulate. But technology is not the sole answer for proper natural resources utilisation and environmental stewardship. Its relative significance seems to decrease rather than to increase. A growing number of colleagues convincingly argue that management in a wide sense must be improved. Management has to do with institutions, rules and roles, incentives and sanctions and similar aspects. But in the end, it is human beings who make up the institutions. People could either accept or not accept the rules and regulations, they might be capable or not capable of pursuing sound and efficient practices, etc. From this perspective, management and resource utilisation has direct and indirect links to notions such as social capital (Putnam, 1993), ingenuity (Homer-Dixon, 2000), social (second order) resources (Ohlsson, 1999) and, generally, to cultural traits.

If we agree that the above lines of argument are relevant in discussions about the fate for people in South Asia and for the relations between South Asia and other parts of the world, it becomes important to ask how networks between natural and social scientists may be promoted and what kind of questions that should be addressed. It is also relevant to make queries about what kind of communication and networks that exist between the scientific community and other groups who have an influence on the interface between society and "nature", e.g. decision makers who are responsible for resource management and environmental issues.

In this paper, an attempt is made to show that water resources are a strategic component for social, economic development and political stability in South Asia. The purpose is to highlight the relevance of social science in this area. It is not only the availability and accessibility of water, which is important. The ongoing degradation of these resources and the landscape as a whole, that is, the quality aspects, represents a major threat to the livelihood of millions of people.

The title of this article refers to the fact that the amount of water that is available for society and for processes in the landscape is, in principle, finite. A certain amount of water is constantly renewed as a result of the hydrological cycle. Precipitation over an area represents the renewable resource for each community or country. Inter-basin transfers are possible but expensive, technically complicated and often sensitive. The long-term availability is therefore a fraction of the precipitation over the basin. A certain part of the precipitation is “lost”, mainly as evaporation. Climate change may affect the amount of water available in rivers, lakes and below ground. But in the short run, the resource flow is fairly constant, albeit subject to considerable variations over seasons and geographically. Demographic trends and human aspirations represent a contrast. An increase in basic human needs for water is inevitable since survival is impossible without a minimum amount to cater for drinking and household requirements. Similarly, the production of food and fibre for a reasonable diet, shelter, etc. is also necessary for which huge volumes of water are necessary. In addition to requirements related to basic human needs, a much larger set of human wants is determining the total, aggregate demand for water. Purchasing power, political position and what is deemed socially and culturally desirable are among the factors that will influence the “wants” in society (Lundqvist & Gleick, 1997).

Analyses concerning water resources used to be the domain of engineers and to some extent natural scientists. With fairly few exceptions, social scientists have tended to shy away from this most basic and fundamental component of life, development and destitution. Alternatively, they have not been engaged in a fruitful dialogue with those who have set the water agenda. There are different explanations for this division. Many of the colleagues in engineering and life sciences do not recognise the relevance of social scientists, let alone colleagues from the humanities. But part of the explanation is probably to be found in a prevailing perception within the social science community itself: development, or the lack of it, should be interpreted with reference to social, economic, political, etc. relations within society. Nature and the availability of natural resources have either been taken for granted or have not been seen as relevant for analyses of social issues. The two cultures of scientific discovery and understanding, which are institutionalised at most universities and other places of learning, as discussed by C.P. Snow (1959; 1993), have mirrored and re-enforced this division for quite some time.

The context is changing. The links between development and environment, or between society and natural resources, have been penetrated at a number of international and national meetings, the UNCED (Rio 1992) being only one of these. Obviously, the links are quite complex but they must not be seen as inextricable. And it is a bit awkward if it is people in Government Departments and UN agencies rather than the scientific community, who are at the frontier when it comes to defining important gaps in our knowledge. True, it takes time and effort to build institutions and networks that are susceptible and capable to combine the types of disciplinary competence across faculty borders that is required. For most university departments, the search for (new) knowledge is based on established theoretical and conceptual frameworks/paradigms within disciplines. This is an academically legitimate approach, but if these frameworks are not sufficiently in tune with crucial contemporary and future challenges of society, it is relevant to facilitate communication across conventional scientific divisions and to support attempts, which could generate knowledge that addresses new challenges. SASNET obviously has an important task to pursue.

It is possible that established universities are slow to modify research orientation and curricula in a direction where development-environment aspects are penetrated. Research institutes and various centres outside Universities, including NGOs, in South Asia and maybe elsewhere, may be more active in this regard. As already indicated, there is considerable need for this type of knowledge and it is an academically rewarding task as well. Considering the complexity of the issues and the need for a change at large, the efforts of single departments or centres are not sufficient. Networks need to be developed which facilitate a dialogue between, *inter alia*, natural and social scientists, scientists and policy makers, scientists and community representatives, scientists and media. In this article, comments refer primarily to the need for a dialogue between natural and social scientists.

1.2 The indispensable resource for social and economic development

Water, which is sometimes referred to as the "liquid gold" in India, is both a pre-condition for and a victim of development. It is a *sine qua non* for life, human dignity, ecological functions and, generally, for development. Food production and photosynthesis, in particular, are simply not possible without water. One of the most basic components of human security and stability of society is thus intimately related to water. As compared to most other natural resources, on which we also depend, water is different in the sense that it can not be substituted. It can be used more or less efficiently and equitably, but in most of its functions it can not be replaced. This has important implications for local and regional development and it is compounded by the practical difficulties to transport large volumes of water over long distances. Unlike oil and mineral resources, it is logistically and economically not a feasible option to transport water over longer distances, with the exception of bottled drinking water. Moreover, the production of freshwater, e.g. through desalinisation is costly and energy intensive and the brine has to be taken care of.

In addition, water is a vulnerable resource. Today, as well as historically, we have ample evidence to show that its quality is often subject to significant degradation with a loss of use options and health and other hazards as a result. Depending on type of pollution, rehabilitation of degraded sources may take a long time and it is often, but fortunately not always, associated with considerable cost. Nutrients in waste-water, for example, do not always require expensive treatment but could be used as a substitute for commercial fertilisers. For countries in South Asia, water related problems are nevertheless considerable. While a lowering of ground water tables is happening in many places, water logging is also occurring. Desiccation and conversion of streams into dry valleys, toxic drains and "stone dead" landscapes are, unfortunately, other and fairly common sights (Irin, 2001; Bhatia, 2001; Agarwal, Narain & Sen, 1999; Lundqvist, 1998)

Explanations to the water and environmental crisis may seem frustrating. Some analysts see poverty as the main cause, while others regard (economic) development as the driving force for an accelerated resource exploitation and the associated depletion and degradation of the resource. In both cases, demographic trends amplify the consequences. Hence, the frustrating implication is that poverty, poverty reduction and also development are all associated with environmental costs and risks. Even if the rate of population growth has slowed down, the increase in the number of people per resource unit will be considerable in years to come, particularly in areas where water availability is most constrained and erratic. Simple arithmetic tells us that two or three persons will have to share the same amount of water, which perhaps one person can use today. (It is a bit more complicated than that. We should make a distinction between the amount of water that is *available* in streams, lakes etc. an the amounts which are *made accessible* through taps, canals, etc. See, for instance, FAO, 2000).

So what to do? Feasible strategies for efficient, fair and environmentally sound utilisation of the resource are very much needed. While the environmental risks of poverty (alleviation) as well as development are real, it must also be recognised that there is no acceptable alternative to an improvement in the standard of living for the poor and, indeed, for most segments of society. *Status quo* is neither politically nor socially accepted. The important point is that it is not development *per se*, which is the worry, but prevailing policy and management practices together with thoughtlessness. Excessive use of the resource and a wilful neglect to avoid pollution are common (Lundqvist, 1998). To the extent that these malpractices are allowed to continue, water and society will be in crisis. A proper management pre-supposes a dialogue between major interest groups (usually referred to as "stakeholders") and institutions and mechanisms that will make it possible to accommodate realistic perspectives and the required skills.

1.3 Dangers of an a-natural perception

The basic importance of water and the multifunctional roles it plays in society as well as in nature are seldom contemplated. Information in literature and chats with people we meet, give us reason to assume that the natural conditions (mainly climate and landscape features) under which water is available are poorly understood by large segments of society. It is rather another perspective, which is perpetuated. A majority of humankind obviously expects that it is the obligation of some agency in society, usually the public sector, to make sure that adequate amounts of water are available in taps and through other technical means in places where people choose to settle.

Since more and more people get water through technical and institutional arrangements – or are promised this kind of service – the concern about climatic context becomes weaker. For the growing proportion of the world's population who reside in urban areas and who tend to be physically far away from dependable water sources, do not know from where "their" water is coming. Gradually, it appears that urban people see the public utility or some other agent or technical system as the source of water rather than the rainfall or the water in rivers, lakes, aquifers, etc. Similar attitudes are found among farmers who rely on publicly run irrigation systems. Most probably, an even smaller number do not know where the water runs after it has been used. Presumably, many do not care. Consequently, very few people are aware of the requirements and implications that are associated with the flow of water: to society, within society and away from society, i.e. back to streams and ground water aquifers from where it is abstracted. There is a need for awareness raising campaigns so that realistic perspectives are fostered and proper management is executed. Networks between the scientific community, the public and decision makers are required. Media and "honest brokers", who could bridge the gaps in understanding between various professional and other groups in society could play an important role in this connection.

It is, indeed, ironic, that as we enter a new millennium, with all the sophisticated technologies and a tremendous potential in terms of accumulated knowledge and human experience, some of the basic knowledge concerning livelihood conditions seems to vanish or is considered less important. In the same vein, it is ironic that the key challenge for sustainable development in this era of sophistication, good management of the world's most basic resources – its water and land resources and air - will remain a major task.

The contrast between a simplistic understanding and the complexity of natural resources is striking in many respects. Irrespective of hydroclimatic pre-conditions, provisions of water have been liberal and heavily subsidised. In terms of the amounts required to cater for basic human requirements of drinking water, there are hardly any hydrological constraints in places where people live but the investments to arrange these supplies are substantial. The amounts required for food and biomass production are significantly much higher. Investments in irrigation structures are also substantial. If water is not allocated and used efficiently and in a fair manner, the societal costs are high (Kemper, 1996; Blomqvist, 1996). Subsidies on water are easy to motivate with reference to its fundamental importance for human welfare. If the rich had paid and the poor had enjoyed subsidised provisions, it would have been OK. But that is not the case. In the case of irrigation supplies it is not the landless and marginal farmers who get water first. Attempts to reduce subsidies and restrict withdrawals from streams or ground, often meet fierce resistance and protests (Lindberg, 1995). About a billion people lack access to water services provided through public sector arrangements. Quite a large group, for whom subsidies are intended, are thus left high and dry. Subsidies are instead primarily enjoyed by the wealthy segments of the community. The poor and disadvantaged groups depend on vendors and so-called independent providers to whom they have to pay the actual cost of water services, or they spend time and energy to collect water on their own. They have no choice but the accept that “there is no such thing as a free lunch”.

Concurrently with this a-natural perception of water as something that should come out of a tap or flow through a gate, at no or low cost to the consumer, and the inequitable access, there is a lingering worry about the increasing scarcity of water. For some people, scarcity is related to climate change whereas others refer to growing disharmony between hydrological and demographic parameters. Still others see it as a consequence of poor management (FAO, 2000). Basically, it is not water that is becoming more scarce, but it is the human pressure on a fairly stable amount of water which is increasing in combination with an inability of society to improve management. Over a longer time period, climate change may alter the picture significantly. If demand continues to mount at the same rapid pace as it has done in the past, a reasonable balance between a realistic level of supply and human claims for more water will be impossible and significant development challenges are inevitable. It is also plausible that tensions between groups in society increase. The likelihood that these escalate and bring countries into armed conflicts is a recurrent theme in literature.

To conclude this section: development, poverty reduction, sustainability, stability, or whatever concept we hope would apply to the South Asian region, hinge to a considerable degree on how the growing needs and wants on a finite and vulnerable resource can be handled. Since the amount of freshwater is not going to increase (in fact, it is decreasing as a result of quality degradation) and since demands are growing, there is no other option but to improve the use of each unit of water with due consideration to social distribution of benefits and environmental sustainability. This is a social and institutional issue rather than a natural science one. But above all, it requires a dialogue between the “two cultures”.

2. What nature provides and what society demands

It is not possible to provide a short and accurate presentation about the water situation and trends in demands in South Asia. A few hints about important aspects illustrate the situation. Availability in rivers, lakes, etc. is different from the amounts that are made accessible. The former varies significantly over time and geographically as a result of climatic and topographical variations while accessibility is mainly conditioned by political decisions, that is, how much is withdrawn from natural sources and how this volume is allocated to various sectors in interests in society. In addition, statistical information refers primarily to the “blue water”, i.e. the amounts available in rivers, lakes and aquifers, whereas the “green water” (soil moisture) is not included in spite of the fact that this component is much larger than the “blue water” (FAO, 2000).

A simple presentation may give a rough picture of the relationship between what nature provides and what society demands. For the world as a whole, the annual average per capita availability of "blue water" was about 6,000 to 7,000 m^3 at the end of last century (Shiklomanov, 1997; Cosgrove & Rijsberman, 2000). For Sweden it is about 20,000 m^3. India and Pakistan have about the same level of water availability, or slightly below 2,000 m^3 whereas Bangladesh has at least five times more water on a per capita basis. Comparisons may also be made to the situation in the Middle East where availability is as low as 100 to 300 m^3 on a per capita basis in the western parts of the region, that is, around the Jodan River basin. Needless to say, the above figures, which are compiled by UN agencies, are utterly uncertain. Availability varies significantly between States and seasons and a large part of the river flow is trans-boundary, which means that double counting occurs.

If availability is below 1,666 m^3/*per capita* and year, a country is said to be water stressed. If availability is 1,000 m^3/*per capita* or less, the country faces water scarcity. The concepts "water stress" and "water scarcity" are originally developed in Falkenmark (1989). Most of this water is required for food security. On average, between 2 – 6 m^3 of water are required to produce the food items and calorie intake that we need daily. On an annual basis, the requirement for food security is thus around 1,000 m^3/*per capita.* The amounts required for drinking and household needs and for industry are comparatively much less, or around 150 – 500 m^3/*per capita* and year. Food production is thus the major worry. With current growth in population, the *per capita* availability will be reduced accordingly and many countries will be water stressed or experiencing water scarcity. In some of the States and river basins in South Asia, the possibilities to harness water are already fully utilised. The first option, as presented above, is no longer possible to pursue. This is, for instance, the case for most rivers in Tamil Nadu. For a summary of the discussion around the above figures, see, for instance, FAO (2000).

In a large number of river basins in India as well as in other countries in South Asia, the situation is serious both in terms of the amounts of water that is accessible on a *per capita* basis but also in terms of pollution. River courses downstream of industrial towns are heavily contaminated and agriculture is using considerable amounts of pesticides, fertilisers and other chemicals, most of which are only slowly decomposing. A large part of these reach the water system. Drinking water provision is therefore a major problem. Production is also affected: industries shift location and have to invest in new supply systems and farmers have to shift to other crops or they simply do not accept to be supplied with water from the reservoirs due to fears that it may spoil both crops as well as the soils. This is, for example, the case in command areas connected to Noyyal river downstream of the booming textile centre in Tirupur, Tamil Nadu (Blomqvist, 1996). Similar situations are found in all parts of the subcontinent. In Subernarekha River in Eastern India (crossing three States: Jharkhand, Orissa and West Bengal) the dilution factor during the dry season is about 4 as against the acceptable ratio of 30 and farmers have been forced to grow crops which give them a lower income as compared to the situation before the pollution became a dominant feature in the river (Bathia, 2001). Alarming reports illuminate the serious degradation which is documented for the Indus river in Pakistan (Irin, 2001).

Stories telling basically the same situation can be repeated for many places in the sub-continent. A similar situation can be found in other parts of Asia, e.g. China and in other continents. Efforts are, of course, made to reduce the threats and to turn the trend. These efforts are vital in a policy for environmental sustainability and decent livelihood. Water is in crisis and the consequences and challenges for society are massive and urgent.

3. Options to handle the challenge

What then are the main options for how to handle the situation in South Asia and do the various options have implications for other parts of the world?

In principle, the pending water crisis may be handled in five ways, which to some extent overlap.

- The conventional approach is a technical one. The most common strategy to handle the situation in the past has been to increase the provision of water to society through the construction of more regulations, storage facilities, lift devices and conveyance structures. For the world as a whole, the last fifty years or so, have seen a tremendous increase in the number of dams and reservoirs, from about 5,000 (1949) to about 45,000 (end of last century) (WCD, 2001). Almost half of this number refers to dams in China, whereas countries in the rest of Asia have built around 9,000 dams. India alone has about 4,000 dams (ibid.). The rate of construction of new dams and augmentation of storage capacity has been substantially reduced since the mid 1970's, particularly in USA and other western countries. For countries in South Asia, the rate has also dropped as a result of massive protest, escalating cost and simply because the sites for new structures are wanting. For an illustration of the fierce protests that are voiced in, for instance, India, see Roy (2000).

  For countries in South Asia as well as elsewhere, the construction of dams is part of history and mirrors a certain attitude to nature. One of the most fascinating and, perhaps, deceptive perceptions in this connection is the view that water that goes to the sea is wasted. This perception echoes through history. According to rock inscriptions in Sri Lanka, one of the early political leaders, Parakrama Bahu I, (1153 - 1186) made statements which continue to beset the minds of many people "… not even a little water that comes from the rain must flow into the Ocean without being made useful to man…" (Attanayake et al., 1985). Agarwal et al. (1999) quote a former director of Ganga Action Plan as saying" .. engineers, irrigation engineers in particular, from all over the world have always wanted to dam, deflect, divert or use up the water of any river. The basic ethos being that freshwater just cannot be allowed to be 'wasted' by flowing into the sea." (p. 62-63). Similarly, president Theodore Roosevelt in a speech prior to the launching of the legislation that made the conquering of the American West possible, argued that "…the Western half of the United States would sustain a population greater than that of our whole country today if the waters that now run to waste were saved and used for irrigation" (Reisner, 1993; Ohlsson & Lundqvist, 2000).

  Guided by this ethos, political leaders backed up by international and national financial and technical agents have developed and implemented a policy which has made it possible to increase the accessibility of water in society at a much higher rate as compared to population increase. For the world as a whole, the rate of withdrawal from natural streams and ground has been about two an a half times faster as compared to population growth during the last century (Falkenmark & Lundqvist, 1995).

  One result of this policy has been a substantial increase of the area under irrigation. In India, the area under irrigation was about 19 million hectares (mha) at the time of

Independence, now it is over 70 mha. During the same period, total food production and yields have increased substantially. Similar developments have taken place in other South Asian countries. In Pakistan, a complex of 22 dams and barrages on the Indus have made it possible to arrest huge volumes of water in the river and divert these to about 18 million hectares of land, the world's largest contiguous system of irrigation. Another result of this policy is that the withdrawals and the consumptive use at this magnitude have significant consequences for downstream landscapes and communities. Reduction of the amount of water remaining in downstream segments and at the mouth of the river is considerable. For Indus, the number of days with no water flowing into the sea has increased from zero to 85 after the commissioning of the large barrages built in the early 1960s (WCD, 2001). Similar experiences are reported from a large number of rivers and lakes around the world, e.g. Colorado River, the Aral Sea, Yellow River, Murruy Darling in Australia. Indeed, human effort to reduce the amount of "water going into the sea as waste" has been effective. Once considered as the only strategy to create water security, the construction of dams is today a contested approach. In many cases, it will however continue to be an attractive option. In areas where precipitation is very erratic and where annual rainfall is concentrated to a very short period, perhaps a few weeks, the regulation of river flow represents one of the few options to improve water security (Ahmad et al., 2001; Vyas, 2001).

- A second option refers to management and actual use of water. Instead of focusing on physical structures and supply, the attention is shifted to demand can be managed and indirectly how proper use can be promoted and misuse reduced. In simple terms, the intention is to improve management so that each unit of water is used in the most worthwhile manner. Expressions like "more crop per drop", "some for all rather than more for some" and "make water everybody's business" illustrate that efficiency in use together with a fair and equitable allocation are central concerns in the current urge for policy reviews (WWC, 2000). The possibilities to increase efficiency in use are obvious in irrigated agriculture, which is the sector consuming most water, or about 60-70% of all water withdrawn from streams and ground. The other sectors of society require much less water. Moreover, their use is only to a limited extent consumptive, i.e. a large fraction of the water used in industry and in households returns to streams and aquifers after use, albeit of another quality. Industrial and urban sectors may re-circulate and re-use water, in principle, in perpetuity although not in practice. This is not possible for ecosystems and agriculture where large volumes return to atmosphere as evapotranspiration.

Consequently, the possibilities and the potential to increase efficiency and to reduce wasteful use look quite different depending upon which sector in society that is considered.

In absolute figures, the most significant potential to increase efficiency is found in countries which have a comparatively large irrigation sector simply because this sector is such a heavy consumer of water and since, generally in most countries, the level of efficiency in this sector is low or very low. Most countries in South Asia have these characteristics. For India, for example, the level of water use efficiency in the canal system varies from a very low level or some 15% to about 40%. For ground water systems, the level is often much higher. Figures are very uncertain and should only be seen as indicative.

The challenge to improve the efficiency in use together with a more fair allocation is considerable. People in South Asia as well as in many other countries have been accustomed to liberal subsidies and a lax control system. Uncertainty about the schedule of water deliveries from irrigation authorities is also stimulating farmers to withdraw more water than they need, whenever water is accessible. Political promises about improvements in water services are common, although rarely translated into practice. A combination of improvements in system management and incentives and sanctions are necessary. Fees and charges for water is a much discussed tool, but powerful water users and many other groups resent such a move.

The third option presumes structural changes of the economy and it adds an international dimension. It is based on the premise that, as water becomes relatively more scarce, it is necessary to compare the productivity of water across sectors of an economy. If aggregate demand exceeds what can be supplied, choices must be made. It is then relevant to ask where water could yield the most desirable benefits, i.e. which activities and which areas of a country should be given water on a priority basis? Answers to such questions usually illuminate that a continuous liberal provision to irrigated agriculture is not only very costly, but also that the return per unit of water is low. In economic terms and sometimes also in social terms, a cubic metre used in the industrial or service sectors could generate significantly much higher returns per unit of water (employment, income, foreign exchange, a.s.). This simple argument needs a lot of elaboration in order to highlight the *pros* and *cons*.

Re-allocation of water from one sector to another, e.g. from rural to urban sectors, presumes strong political will and power. One basic question is what will happen to farmers who no longer will be supplied with liberal quantities of water at subsidised rates. Maybe it is not the poor who will be directly affected since many of them do not own or control land, but probably they will suffer since job opportunities may be lost. Alternative employment opportunities are rare. Also, the very notion of rural/regional development as it is understood in many countries, not least in South Asia, would change. If such a policy would be practised on a large scale, it would have considerable consequences for world food trade, including price of food. It is also based on the assumption that food can be produced “somewhere else” and that the importing country is able to pay for imports, something which is not at all clear. World food security is one of the biggest challenges that humankind faces. In spite of these difficulties, it is an option which is seriously debated and it is practised in parts of the Middle East simply because there is not enough of water in the region to produce the food required (Allan, 2001; FAO, 2000).

Hence, it is a relevant policy primarily for countries – or States - facing a growing pressure on finite water resources. For them it is necessary to employ a careful analysis about how much water to withdraw from natural sources (i.e. what environmental costs are acceptable), how to allocate it between competing interests, and on what terms. A realistic combination of agricultural and industrial development must be sought. By way of example, many colleagues argue that Israel and other Middle East countries should, and will be forced to, use *all* of their tiny freshwater resources to cater for household requirements and to support the development of urban sectors, including industrial and tertiary activities, tourism and similar. Agriculture should only be supplied with treated waste water (Shuval, 1997). With such a structural change of the economy, it is possible to generate enough of revenue, i.e. a high economic productivity of water, to attain or maintain a high standard of living (ibid.). It is necessary to import agricultural products and the logic is that import is paid for from the income earned in other sectors. Needless to say, this policy, often referred to as “virtual water” strategy, is not possible for all countries and it is quite a tricky course of development.

- A fourth option is to “create” new sources of (fresh) water. Desalinisation is one possibility and treatment of waste water for re-use is another one. Both approaches are practised, although on a small scale. They primarily refer to urban areas and to better-off segments of society. The technology to produce water from saline sources and also from waste water has improved. The cost today is said to be around 0.5 – 0.7 US$ per m^3, which is quite acceptable to those who prefer to drink bottled water and it may be acceptable for some industries and other urban trades. The cost is comparable to many new long-distance transfers. For poor people the price will still be quite high, particularly when distribution costs are added. For most farmers, it is far too high and the logistics of supplying large volumes of desalinated sea water or treated waste water to extensive agricultural lands also makes it an impossible option.

- A fifth option is to look for solutions outside the water sector, usually referred to as an “out-of-the-box” thinking (WWC, 2000). It is, for instance, argued that progress in biotechnology will make it possible to increase food production in marginal areas where conventional crops can not be grown as a result of, for instance, uncertain or low water availability. Use of sophisticated, but user-friendly IT technologies is another tool which could facilitate communication, spread of innovations, etc.

Which one(s) of the above options that can be selected depends on the degree of pressure on the available water, financial, institutional and technical capacity. The second option is the most sound option. But it does require considerable political will, a readiness by segments of the community to reduce their demand for water and to find financial and technical solutions to the tremendous challenges associated with mounting pressure and growing loads of pollution. It is only those groups who use water excessively who are expected to cut down on their demand. For the poor and other disadvantaged groups it is often motivated to increase provision of water and, of course, other social services.

4. Emerging networks and lines of action

During recent years, the problems briefly summarised above have been subject to considerable activity. It seems, however, that networks and required activities have not so much taken place within the university system. At conferences and international meetings where these issues are penetrated, it appears as if colleagues from Government Departments, the UN system, NGOs and individual researchers are the main actors. Courses and training programmes at universities are comparatively rare. Journals where these aspects are discussed obviously receive more manuscripts on disciplinary topics as compared to manuscripts which attempt to present a view which cuts across conventional scientific divisions.

The emerging networks are often initiated and driven by colleagues outside the university system. This is, for instance, the case with World Water Forum and Global Water Partnership. A number of professional associations and scientific symposia do, of course, exist, but many of these are organised along established lines of disciplinary knowledge.

Social scientists and colleagues from the humanities are very much needed in this context as discussed in this paper. Dialogues and networks can be created between committed individuals, but it is essential that institutional arrangements are made which stimulate a cross-fertilisation of perspectives and knowledge and in order to stimulate and enable young scientists to find a base for this kind of research. Courses, training programmes, field excersises, could be an "associated activity" to the networks. Research programmes where the questions are defined from the experiences of the people concerned in an area rather than from theoretical departures, could be another avenue for the promotion of exiting networks.

5. Concluding remarks

The discussion in this paper has hopefully illustrated that:

- The natural resources situation is a vital component for the livelihood and development aspirations of people in South Asia. Water, both in terms of quantity and quality, is a key element in this connection.

- Many of the problems associated with water are social issues. Dialogue between social scientists and colleagues representing engineering and life sciences is important and could be academically rewarding. In addition, it is a promising field for policy review and development.

- Networks are needed not only between social and natural scientists but also between scientists and the public, policy/decisions makers and those who can disseminate the understanding to various groups of stakeholders. "Knowledge brokers" should be part of the network.

- The University system should accelerate effort to promote courses and training programmes which facilitate a constructive dialogue between various professional groups but which would also stimulate young scientists to be engaged in these vital issues. SASNET is a good example in this regard.

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