The democratisation of decision-making processes in the water sector I

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ABSTRACT

The paper introduces an inversion of the structure of the decision making process in the water sector that has been so far followed in most countries, and in almost all so-called 'third world' societies. It is commonly observed that the general population becomes alienated and effectively disempowered through this existing 'top-down' knowledge transmission process. The disenfranchisement of large parts of the general population and the grievous harm done to these parts through their resulting disempowerment has led to an outcry against the water professionals, who are seen at the very least as accomplices, and often as initiators in 'crimes against humanity'. Empowering the population as a whole as genuine stakeholders in water resources then becomes the basic objective of water professionals in introducing an alternative paradigm, as exemplified in the second part of this paper (this issue, pp. 35–48) by the design of a new system capable of supporting 'knowledge-intensive' agricultural practices. What is being proposed here thus corresponds to an inversion of the so-far established order of knowledge/power in that it corresponds to an inversion in power relations that is realised by an inversion in knowledge relations. The system proposed here by way of an example is then primarily a means of realising this inversion. The economic sustainability of such a system within a 'third world' context necessitates the consideration also of knowledge/value relations, and these are also briefly introduced. The system itself is essentially a knowledge self-management system, comprising three principal components:

- a knowledge centre connecting to (other) knowledge providers;
- an inner knowledge periphery that receives, processes and transmits knowledge passing between the centre and;
- an outer knowledge periphery situated primarily at the end-user level.

The use of 'scientific discourse' at the centre and of 'narrative discourse' at the outer periphery sets the overall specification of the inner periphery.

Key words | decision making, management, water management

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THE CRIMINALISATION OF THE WATER PROFESSIONS

An increasing number of popular publications, ranging from newspaper articles, through television programmes, to complete books, are sowing the notion among the general public that water professionals are at least collaborators, and in many cases instigators, of actions that do so much harm to such large numbers of persons that they might be castigated as 'crimes against humanity'. At the same time, the legal basis for the notion of 'crimes against humanity' has itself become more firmly established by several bodies, ranging in turn from international

organisations to national law-giving assemblies. These efforts have led to the formation of such bodies as the International Courts of Justice, situated in The Hague, The Netherlands, which have already sentenced several persons to long-terms of imprisonment for 'crimes against humanity' involving direct physical violence.

Alongside this stream of development there is another, in which groups of citizens come together to oppose the actions of certain existing institutions and organisations that are perceived by these groups as unethical to the point of behaving criminally. The most dramatic (because most widely publicised) of these oppositions occurred in Seattle in November 1999, when a combination of organisations of citizens was able to prevent the holding of the regular WTO conference and its surrounding activities. However, other such protests, less publicised and usually less successful in meeting their objectives, have long taken place in the water sector. Going back ten years, for example (Roy 1999, pp. 46–48):

> On Christmas Day in 1990, six thousand men and women walked over a hundred kilometres, carrying their provisions and their bedding, accompanying a seven-member sacrificial squad that had resolved to lay down its lives for the river. They were stopped at Ferkuwa on the Gujarat border by battalions of armed police and crowds of people from the city of Baroda, many of whom were hired, some of whom perhaps genuinely believed that the Sardar Sarovar was 'Gujarat's life-line'. It was a telling confrontation. Middle Class Urban India vs. a Rural, predominantly Advasi, Army. The marching people demanded they be allowed to cross the border and walk to the dam site. The police refused them passage. To stress their commitment to non-violence, each villager had his or her hands bound together. One by one, they defied the battalions of police. They were beaten, arrested and dragged into waiting trucks in which they were driven off and dumped some miles away, in the wilderness. They just walked back and began all over again.
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> The struggle in the Narmada valley lives, *despite* the State.

It is important to realise the relative scales and essential natures of the activities that are involved in the water sector as compared with those that are presented as 'crimes against humanity' elsewhere. Thus (*ibid*, p. 19):

> That's what it works out to, thirty-three *million* people. Displaced by Big Dams *alone* in the last fifty years. What about those who have been displaced by the thousands of other Development Projects? At a private lecture, N.C. Saxena, Secretary to the Planning Commission, said he thought the number was in the region of 50 million (of whom 40 million were displaced by dams).

It may be safely assumed that the reduction of life expectation alone among these displaced and consequentially destitute persons amounts to the likes of some millions of complete human lives. Moreover (*ibid*, p. 21):

> A huge percentage of the displaced are Adivasis (57.6 percent in the case of the Sardar Sarovar dam). Include Dalits and the figure becomes obscene. According to the Commissioner for Scheduled Castes and Tribes it's about 60 percent. If you consider that Adivasis account for only 8 per cent and Dalits another 15 per cent of India's population, it opens up a whole other dimension to the story. The ethnic 'otherness' of their victims takes some of the pressure off the National Builders. It's like having an expense account. Someone else pays the bills. People from another country. Another world. India's poorest people are subsidising the lifestyles of her richest.

Thus these millions of one racial group are being physically displaced, impoverished, and in a large measure eliminated by persons of another racial group, the last process of which has the precise name of *genocide*. However, 'crimes against humanity' that can be construed as genocide are already the subject of prosecutions and sentences at the International Courts of Justice, and then for cases involving 'only' the elimination of two or three thousand persons, and then of persons not so different genetically from their eliminators but differentiated more by religious beliefs.

It seems clear that just to the extent that water professionals come to be perceived as accomplices in 'crimes against humanity' and especially when they appear as instigators of such 'crimes', they must in time expect to be arraigned before the appropriate courts of law. This will be the natural and inevitable consequence of the presently ongoing process of criminalisation of the water professions.

THE RESPONSE OF THE WATER PROFESSIONALS

Of course, among the water professionals themselves there will be few if any who will subscribe to this view. For by far the greater part, they see themselves as having carried out their professional duties to the best of their

abilities. If any fault at all is to be found, they will say, it must be sought elsewhere, such as at the political and administrative levels of government. Some may perhaps accept that they may have been beguiled into activities with unfortunate consequences, but even these would see themselves, at worst, as what Lenin, an expert in the manipulation of well-meaning persons, described as his 'useful idiots'.

Despite these denials and disclaimers, however, over the past decades, at least, there has been a gathering realisation among some water professionals that many problems of the water sector in many societies, and especially in societies in the so-called 'third world', are themselves to a greater or lesser degree consequences of the actions of these professionals. There has in fact been a marked increase in the preparedness of water professionals not only to speak out the truth about their various failings, but, just as important, to listen to the truth. Thus, for example, when talking about 'Learning from the past' in the area of capacity building in the water sector (Alaerts *et al.* 1999, p. 18):

> The World Bank has been instrumental in putting capacity on the African development agenda. Nevertheless, an evaluation in 1994 indicated that only 28% of the projects achieved their objectives in terms of strengthening institutions, and only 23% were likely to produce sustainable capacity building benefits. The reasons include: (a) the Bank's rather narrow vision of capacity building, (b) a project cycle that inhibits capacity building, (c) an inordinate reliance on technical assistance that precludes capacity building, (d) badly formulated civil service reforms, and (e) the neglect of higher education in capacity building.
>
> The Bank may even have contributed to capacity erosion. It has tended to substitute for Africa's capacity deficiencies, rather than build capacity. Despite the rhetoric of self-reliance, all too often governments have found cosy accommodation with dependency.

At the same time, as things currently stand it is not normally the water professionals themselves who initiate changes that might improve the current situation. Thus, to take the situation prevailing in India (Alaerts *et al.* 1999, p. 21):

> Already since the eighties, sector professionals called for delegation of decision-making power to the lowest appropriate level. For water supply and irrigation, this would mean setting up of local utilities and water user associations.
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> But in India, as in many other countries, the local government level (*Panchayat*) was not recognised as an executive entity by the Constitution. Hence, no *Panchayat* could formally take part in decision-making processes, or in maintenance of infrastructure. It could not even open a bank account. The 1992 Constitutional Amendment gave this power, and thus created vast new opportunities for better water provision.
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> However, it was not the water sector's plea that caused this fundamental change, but rather external forces, that this time benefited the water sector . . .

Despite developments of this kind, failures not only persist, but appear even to accumulate in the water area. In his own analysis of World Bank assessments of project failures, Alaerts concluded that (Alaerts *et al.* 1999, p. 52):

> Many failures can be attributed to systemic deficiencies in the institutions that determine policy, project design and operational management.

Moreover, the overall policy that underlies these failures remains basically unchanged beneath the surface of the Bank's new-found, 'progressive', rhetoric. Thus (Fidler 2000):

> Figures compiled by the Bank for a report suggest that 223 of its projects under way last October [i.e. 1999] would lead to the involuntary resettlement of 681,000 households and more than 2.6 million people . . . An earlier draft on the same report dated in May [1999] said 40 % of all projects involving resettlement were 'likely to have significant adverse environmental impacts' . . . almost all having a 'potential adverse impact'. However, these breakdowns were excised from the final version of the report.

PERCEIVED FAILURES OF ENGINEERING INTERVENTIONS IN THE THIRD WORLD WATER SECTOR

Starting some 30 years ago, to the author's knowledge, with criticisms of irrigation projects for promoting cotton production in certain Asian states of the former Soviet Union, the volume of condemnation of engineering interventions in the water sector has grown exponentially. As exemplified above, from being a concern of only a few 'outside experts', this rising tide of discontent, which is now moving in some places towards a torrent of outrage, has caught up many millions of persons who have been

directly influenced by such engineering interventions and has generated an increasing volume of ever more serious and detailed criticism in support of these persons. The point is more and more often made that not only have such engineering interventions as dam constructions and irrigation schemes failed to deliver many of their expected benefits, but they have had many negative consequences, and for the most part for the poorest parts of the populations concerned and for the natural environment. We may group together some of the principle criticisms as follows:

1. The special property to water, that it moves itself under no other influence than an always present and gratuitous gravity, makes it very easy to transfer the benefits that water confers from one community to another with little or no physical expense. Thus one region can enrich itself at the expense of another, either by laying legal claim to the waters of this other region, or by damming up or otherwise extracting the flow for its own use and thus denying it to the other region.

2. In this process of redistributing the benefits of water, the overall economic considerations are often swept to one side. Thus, going back to an earlier period, initiated in the USA of the 1930s (Reismer 1988, p. 119):

> Economics mattered little, if nothing at all; if the irrigation ventures slid into an ocean of debt, the huge hydroelectric dams authorised within the same river basin could generate the necessary revenues to bail them out (or so it was thought).
>
> . . . The natural landscape of the American West, was to undergo a man-made transformation the likes of which no desert civilization has ever seen.

3. Such projects commonly deliver very different results to one part of the population to the results that they provide to other parts: their benefits are often very unequally distributed even across the society that receives the water. This is very clear in the case of dam constructions, which have led to the formation of large lakes that in turn have necessitated the displacement of many people. As observed above, it has been estimated that the construction of some 3,300 large dams in India since independence has led to the displacement of between 30 and 40 million persons, for by far the larger part wrenched from their livelihoods with no compensation. (Only those owning land and satisfying certain citizenship conditions could claim some compensation as Project Affected Persons (PAPs).). Irrigation schemes have similarly led to relatively small groups that benefit and larger groups that are disadvantaged, and often severely disadvantaged, by such schemes. Increases in public health risks are often clearly pronounced in many irrigation and land reclamation schemes and these tend to affect the poor far more than the better-situated inhabitants.

4. The so-called 'secondary physical effects' of such projects are often severe and effectively irreversible: a much augmented evaporation of water from dam-enclosed reservoirs and serious sediment erosion and accretion problems arising from dam constructions, and the effects of waterlogging and salination in irrigation schemes, are well-known examples. Remedial actions are usually difficult, if not politically impossible, and often prohibitively expensive.

5. The protection of land by empoldering in some areas commonly leads to the raising of water levels and longer durations of flooding in areas upstream of the empoldered region. There is generally again a shift of damages and associated costs from one part of the population to another part.

6. The construction of infrastructural projects together with water-related projects again leads to new shifts in employment, business activity and wealth, such as towards intensified truck-based traffic operations at the cost of ferry-boat operations. The net social effect may well be negative.

7. The large scale of most projects is often associated with a monotonic agriculture, the sustainability of which depends on large inputs of agrochemicals and mechanisation, both of which necessitate increases in working expenses, imports and associated costs. They also have deleterious consequences for groundwater and, especially in the case of herbicides and insecticides, on the ecosystem generally. These developments are reinforced by the introduction of genetically modified (GM) crop species that may necessitate new seed purchases at each new planting, reduce ecosystem diversity and thus endanger ecosystem stability. For example (Shiva 2000):

> Spending on pesticides in Warangal, Andra Pradesh, has shot up from $2.5 million in the 1980s to $50 million.

8. The construction of new projects often disrupts the existing methods of cultivation of the land and water, it breaks up long-established cultural patterns, it disrupts the ritualistic framework of social cohesion and otherwise causes grievous social harm. The destruction of existing agriculture practices together with the social, and especially cultural, contexts with which these are synergic is seen increasingly as a major threat both to the peoples of the third world and their natural environment. For example (Shiva 2000):

> Recently I was visiting Bhatinda in Punjab because of an epidemic of farmers' suicides. Punjab used to be the most prosperous agricultural region in India. Today every farmer is in debt and despair. Vast stretches of land have become water-logged desert. And as an old farmer pointed out, even the trees have stopped bearing fruit because heavy use of pesticides have killed the pollinators—the bees and the butterflies . . .
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> For me it is now time radically to re-evaluate what we are doing. For what we are doing to the poor is brutal and unforgivable. This is especially evident in India as we witness the unfolding disasters of globalisation, especially in food and agriculture (Houlder, 2000).

Alongside this, on the side of the natural environment, the consequences are now seen to be nothing but catastrophic. The latest report of the World Conservation Fund shows that, for example, nearly one in four of the world's mammal species is threatened with extinction as a result of human interventions, most of it in agriculture (Houlder, 2000).

9. The relatively limited number of beneficiaries of these projects is not normally sufficient to pay back the capital, with interest, that has been used to realise the projects. Instead the debt burden has to be passed on to the population as a whole, a large part of which has however been so disadvantaged by just these projects as to be unable to contribute to the necessary repayments. In the words of the Director of the Centre for International Studies at Harvard University (Sachs 2000):

> The IMF and the World Bank have been mouthpieces of deception [of poverty alleviation] with their charade of 'debt sustainability' of the poorest countries. These analyses have nothing to do with debt sustainability in any real sense, since they ignore the needless deaths of millions of people for want of access to basic medicines and nutrition . . . The IMF knows very little about economic development challenges, from disease to tropical environment to environmental degradation . . . The World Bank is equally ineffectual.

Similarly, speaking for Oxfam about the IMF–World Bank 'debt relief' programme for highly indebted poor countries, Watkins (2000) observed that:

> failure to reduce debt to [truly] sustainable levels will have grave consequences for social sector financing . . . Fiddling the figures while debt continues to destroy the lives of desperately poor people is not an appropriate response.

10. The construction of projects in this way serves the interest of certain influential political constituencies and these reinforce the power of the state officials, including engineers, who elaborate and supervise projects. The added presence of so-called 'first-world' consulting engineers and contractors, working in collaboration with local consultants and contractors, facilitates the availability of loans for such projects from the large lending agencies. The major sources of scientific knowledge that have been implanted into 'third-world' societies, such as the Surface Water Modelling Centre and the Environmental GIS Centre in Dhaka, can themselves only become sustainable business operations by supplying knowledge to the consultants and contractors which are engaged in this kind of activity. Knowledge passed to the state apparatus usually goes nowhere at all. Thus, for example, information supplied to the Public Health Offices or the Agricultural Extension Offices in Bangladesh may be most valuable in itself, but it is the essential nature of these centres that introduces the basic problem. Being governmental institutions they carry the burden of bureaucracy, but they are at the stage at which they have few suitable communication devices, and, most essentially, they appear to have no real commitment to provide the services to the general population for which they were originally created in the first place. To reverse this within the existing paradigm appears to be exceedingly difficult, if not impossible.

Within the present dominant paradigm an apparently financially sustainable, technical–administrative 'caste' is created and maintained, but this is almost entirely self-serving, providing few services to the great mass of the population as a whole and practically nothing at all to the poorest. This situation is so obviously shocking that even

the carefully selected review panels and other such missions that assess various aid projects can hardly avoid missing it, and these regularly make recommendations to improve the situation. The consequences can never be more than cosmetic, however, since the entire structure that has been put in place in this way is inherently inimical to such interests of the general population. Indeed it is already quite widely accepted that the knowledge and experience of organisations with 'grass-roots' foundations are essential when assessing what are the real needs of people and what is the extent of existing knowledge when considering other kinds of services than those which are directly water related. This is especially accepted in the case of advice in the field of agriculture, but it also applies to the advice related to marketing products, access to wider markets, market opportunities for crop diversification and similar opportunities. This knowledge comes primarily from microbanking and other such organisations that have their own kinds of 'philanthropic vested interests' in the alleviation of poverty, but it may also originate from other existing organisations, such as many NGOs working in different areas. However, in the initial stages of the 'new paradigm' of knowledge provision that is introduced shortly, the input about the kind of knowledge that has to be provided, usually in the form of advice, has to come for much the greater part from people involved in 'grass-roots' networks, simply because they are so much closer to the principal 'sources' and 'end-users' of this knowledge.

THE QUESTION CONCERNING EMPOWERMENT

It should be emphasised that water professionals are in a very special, and possibly even unique, situation compared with all other professionals. Water is essential to all life on Earth and to the human economy as well, and the danger confronting life on Earth and the human economy is greater in the case of water sector than it is anywhere else.

The realisation of the systemic nature of the existing and now well-established structure of knowledge/power in the water sector has then naturally led to questionings from several persons and at various levels in the existing hierarchy. In some cases this questioning has led only to the outright rejection of the existing structure. One manifestation of this is the call by many professionals linked to 'third-world' societies to turn a collective back upon the whole panoply of modern technology and science and to return to 'traditional' farming and other practices. Essentially, the same reaction is apparent in the case of the established knowledge centres in many 'third-world' countries, where an exceptionally high proportion of younger staff leave every year for more advanced studies and possibly future employment in the 'first world', in many cases outside of the water sector. In other cases, however, this situation has led to a search for another way of making use of science and technology that would make their fruits available to the greater part of the population, and on a much more equitable basis. Of this latter approach, which is followed here, we may observe the following:

1. It is this search that has led to the identification of an alternative approach that can make use of certain facilities that have been built up in 'third-world' societies. This approach is then essentially anti-systemic: even though it proposes to use certain facilities that have been established and developed within the existing paradigm, it proposes to use those facilities in entirely other ways than those for which they were originally intended, as well as for entirely different, and indeed opposite, purposes.

2. The essential feature of the change in paradigm that is thereby announced is its reliance upon an already accomplished change of paradigm, such as has been realised by the micro-banking community in some countries, and principally in Bangladesh. The basic strategy is to introduce a new structure in knowledge/power relations in the water sector in these countries, and indeed a structure that is anti-systemic with the existing structure, preferably by allying itself with organisations that are already anti-systemic with respect to the more generally established social paradigm in banking, mobile telephony and other areas that are closely related to the water sector. At a deeper level, which will be identified in the second part of this paper (this issue, pp. 35–48), we have to do here with engineering a change in knowledge/power relations by introducing changes in knowledge/value relations.

3. The pattern of the taking into possession of water rights by some at the cost of the dispossession of others of their water rights, as realised through the application of technology, has to be broken. This can only be done by the application of another kind of technology, which is in turn embedded in another kind of social context.

4. As is now being increasingly accepted elsewhere, the mobilisation of people and the dissemination of the right information in appropriate form is more critical than the provision of new 'hardware'. The definitions of 'the right information' and 'appropriate forms' are the central concern of the water-technical persons involved here, and these definitions lead to the posing of totally integrated social, technical and scientific problems. The mobilisation of people and their provision with the right kind of information appears in particular as a central concern of the micro-banking and other organisations directed to raising the living standards of the general population, including the poorest.

5. As hydroinformaticians we naturally ask how we, as professionals, can change this situation for the better. As sociotechnologists we then ask in the first place why some protests, such as the WTO protests in Seattle, succeeded, and why the protests in India for the most part failed. Anyone who was unaware of the reasons before September 2000 could no longer be aware of the reasons for success in the one case and failure in the other after the protests that swept across Western Europe against increases in taxation occasioned by rising oil prices. Thus, from an editorial in the UK *Financial Times* (16 September 2000):

> A week ago, British politicians and investors could look at the lorry blockade in France with some satisfaction. Industrial strife [in Britain] was a thing of the past.
>
> . . . The extraordinarily effective protest by hauliers and farmers has destroyed this illusion . . .
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> . . . Economic links are not limited to physical transportation. For all their dislike of their continental competitors, British truckers and farmers are in a similar boat and have learnt from the success across the English Channel. Modern communications enabled them to be highly effective without needing backing from a union or industry federation. The government found it almost impossible to counter such unstructured protests effectively.

In this case, 'modern communications' does not refer only to television broadcasts of large numbers of 'ordinary' people—farmers, lorry drivers, business owners—arguing their case with passion and conviction, and expressing their feeling of being disenfranchised within the present political system, but it refers also, and much more significantly on the organisational side, to the use of internet and mobile telephones. As mobile telephony moves further into broad-band communications with the third-generation capabilities promised by the year 2003, thereby offering all internet capabilities, so the possibilities to organise and coordinate such protests will increase exponentially.

The lessons for the water professionals even in the first world must be quite clear: the general public must be empowered in a responsible and equitable way or otherwise this public will empower itself, and possibly less responsibly and very likely, through the influence of special-interest groups, in inequitable ways. Once again the technical side of the sociotechnical system required to do this must be provided by the new generation of telecommunication equipment and services. This mode of operation has already led some water professionals to investigate how the general public can be so empowered with responsible knowledge/value that this general public will itself behave in a responsible way. Now, however, the water professionals have to proceed yet further again, to provide tools that will inculcate attitudes of social responsibility and consideration, and this not only towards human societies but also and inseparably towards the world of nature.

THE IMMEDIATE PURPOSE AND NATURE OF THE NEW APPROACH

The immediate purpose of the developments introduced here is to provide the peoples of the 'third-world', including the very poorest, with knowledge, initially in the form of advice, about all water related risks and opportunities with which they may be confronted at any time. Within this perspective, water is seen as a great unifying agent, within human and natural economies and, ultimately, between these economies—as has been celebrated over the millennia in any number of myths, legends and sagas of the

peoples of the 'third world'—and as such continues to be sustained by ritualistic practices. Within the framework of this paradigm, it is such autochthonic forms of knowledge, such as are grounded in a collective wisdom, that are regarded as the foundations of all other forms of knowledge of by far the greater part of the populations of these societies. Accordingly, by far the greater part of the knowledge and the means of providing advice are already implicitly present among the 'ordinary' people, including, if only potentially, among the poorest. The manner in which this knowledge and corresponding advice is expressed is comprised of those combinations of ordinary language, simple illustrations and practical emulation that we shall call, quite generally, 'narrative discourse'.

(Now in much postmodern writing, and especially in the area of literary criticism, the word 'narrative' has acquired a rather special connotation and this has more recently entered into the discussion of the preferred structure of broadband entertainment. Given media that lend themselves, and indeed are directed, to interaction between the 'entertainer' and the 'audience', in which these two roles may interchange between the participants, the notion of 'narrative' has become associated with (modern, rather than postmodern) forms of entertainment, such as are best suited to broadcasting. The latter are associated with 'linear programming' in which 'stories', understood as content that has a definite beginning, a definite middle and a definite end, unfold in time. This is to say that they have a broadcaster-given 'story line'. It is then argued that broadband entertainment will be better served through the provision of means to produce nonlinear content, as a kind of 'emergent', self-structuring content. Such a change in direction naturally involves very profound changes in attitude, and especially within the existing media companies. The aim of a system of the type to be described in the second part of this paper is to provide interactive, nonlinear, content for some purposes, but not for others, with the constraint that the nonlinear content must also run on more traditional media as well as third-generation (3G) telecommunications equipment. While fully accepting the relevance of these issues, the word 'discourse' is still however used here in its more traditional, mundane, sense, as any recounting of experiences that are either facts or appear as facts, so that it applies here to nonlinear content provision, as well as linear.)

This kind of autochtonic knowledge and its practical everyday extensions, together with the 'narrative discourse' that embodies it as 'narrative knowledge', has more recently been joined in most parts of the world, and to a very considerable degree in several nominally 'third world' Asian and Latin-American countries, by another kind of knowledge, which we call 'scientific knowledge'. Inseparable from this is another kind of discourse, which we call 'scientific discourse'. By the application of scientific knowledge through the agency of scientific discourse it has become possible to do many things that were much more difficult, and even impossible, using the 'traditional' forms of narrative knowledge and narrative discourse. Thus, for example, in the present context it now becomes possible to foresee weather, flood and soil conditions considerably further forward in time, to estimate crop yields subject to various agricultural practices accordingly, and so provide advice on preferable farming operations. There are, of course, very many such examples of the possible benefits of applications of modern science and technology. At the present time, on the other hand, few of these kinds of benefits of scientific knowledge are available for most of the people of the 'third world', and very few indeed are available for the poorest of these peoples.

One of the objectives of the present approach is to reinforce the existing pool of narrative knowledge with all available scientific knowledge and to make the resulting knowledge available for all the people of the 'third world', including the poorest, by couching this knowledge in narrative forms that these peoples can assimilate and thereby integrate with their existing, personal and autochtonic, knowledge. Clearly, however, the value of this service will still be quite limited unless it is customised to interact with the existing knowledge and interests of its *individual* end-users. This is because the nature of the knowledge required as well as its mode of presentation will often vary greatly according to the 'traditional' knowledge and general situation of the individual recipients of this knowledge: the state of their physical and knowledge assets, their obligations, capacities, intentions and every other factor of this kind. The value of the integrated body

of collective narrative knowledge/wisdom and scientific knowledge, no matter how appropriately this is presented technically, will be limited unless the full nature of each individual recipient 'on the ground' can be identified. This identification and the means of such identification must then also be translated from its existing narrative form into a form that can interact with the other forms of collective knowledge.

The other immediate aim of the new paradigm is then to direct the attention of all available narrative and scientific knowledge to the real-world constraints, opportunities and aspirations of the *individual* recipients of that knowledge. From this point of view there is no such thing as a 'rice farmer' *per se*, but a great variety of different individuals, families and communities who cultivate one or more different varieties of rice together with various other crops and exhibit a very wide range of physical and knowledge situations, social situations and levels of ambition. This is to say, to introduce the technically precise term, that the repositories of science and technology will have to be provided with *intentions* that mirror the needs of the recipients of their knowledge if this knowledge is to be truly relevant. These repositories of knowledge have thus to seek out rather precisely the knowledge that is most relevant to each individual recipient of this knowledge and translate this knowledge into the best advice for each such individual recipient, at the same time providing the means to formulate this knowledge in an appropriate narrative form. By the same token, these repositories of knowledge have themselves to be provided with knowledge, in appropriate (and for the moment, in practice) scientific form, about the various situations and intentions of the individual families and communities that are the recipients of the narratively presented scientific knowledge.

The requirement that the repositories of the knowledge have to be structured and ordered in modern-scientific and correspondingly potentially technocratic forms may understandably appear as unfortunate to many persons, and especially the most well-meaning. After all, we can identify within modern science the very sources of the spiritual narrowness and subsequent wrong-mindedness of the existing technocratic paradigm in this field (Abbott 1999*b*, 2000*b*). However, the originators of the new paradigm cannot themselves entirely escape the culture of modern science and technocratic attitudes with which they have themselves been formed (Husserl, 1938//1973; Abbott 2000*b*). Even the vocabulary and rhetoric required to give expression to this proposed new paradigm cannot escape from this exigency. We thus have to do here inevitably with a two-way flow of knowledge, with one way proceeding from the 'ordinary people' to what are unavoidably for the moment the 'scientific people' and the other way proceeding from the 'scientific people' to the 'ordinary people'. Both directions of flow have to pass through a 'translation layer', in the one case corresponding to a translation from narrative discourse into scientific discourse and in the other case corresponding to a translation from scientific discourse into narrative discourse. In the case of applications to agriculture of this paradigm we may then speak of a *knowledge intensive agriculture*. In much the same way we could just as well speak of a *knowledge intensive aquaculture*, a *knowledge intensive health provision* and other such developments. The pivotal and irreplaceable role of hydroinformatics in these initiatives is discussed later in this paper.

There is a further object of the new paradigm that is by no means so immediately and explicitly expressible, which is to maintain, and indeed in many cases to re-establish, a more sustainable balance between the needs of the human and the natural economies. We should observe, on the one side, that many of the traditional myths, legends and sagas in all civilisations are concerned with just this balance, whereas many traditional agricultural and other practices provide means to maintain the balance. On the other side, the joining together of narrative knowledge and scientific knowledge in the way that is now being proposed provides new and powerful means to overcome the increasingly common situation whereby, the more that mankind encroaches upon the needs of nature, the more nature responds by releasing 'natural catastrophes' upon mankind.

THE BASIC STRUCTURE OF THE CORRESPONDING SOCIOTECHNICAL SYSTEMS

The new paradigm proposed here introduces an inversion of the structure of the decision making process that has been so far followed almost everywhere in the 'third

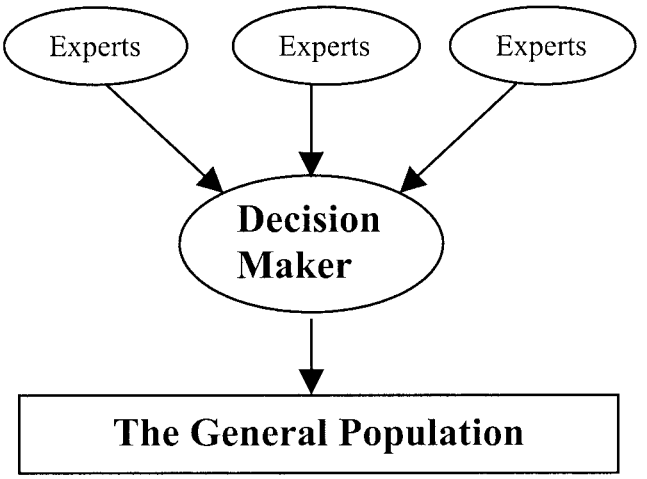

Figure 1 | The established order in 'technocratic' decision making.

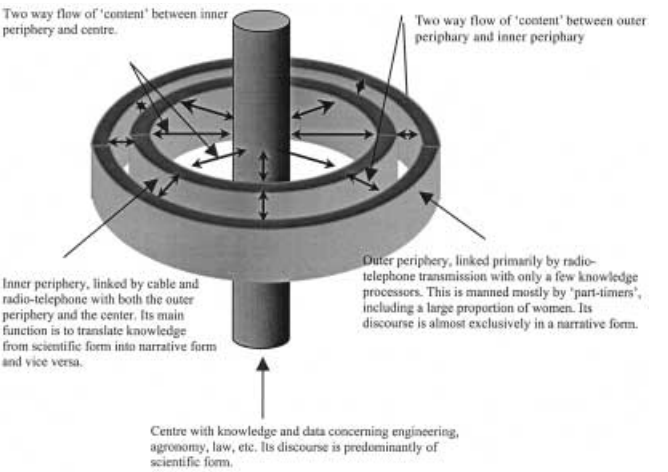

Figure 3 | Knowledge management structure of the proposed system.

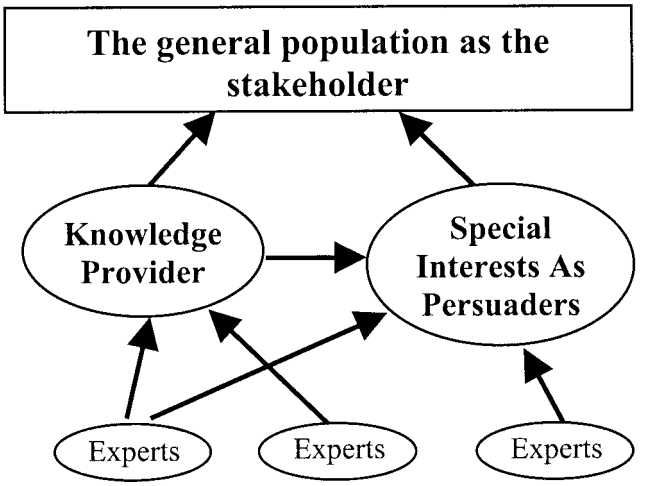

Figure 2 | The inversion of the existing order.

world'. The structure employed almost exclusively so far is schematised in Figure 1.

It is commonly observed that the general population becomes alienated and effectively disempowered through this process. Empowering this population as genuine stakeholders in water resources, as schematised in Figure 2, is the basic objective in designing the structure of a new class of systems.

What is being proposed here as a new paradigm thus corresponds to an inversion of the so-far established order. It corresponds to an inversion in power relations that is realised by an inversion in knowledge relations.

The systems that are proposed here as means of realising this inversion, which are essentially knowledge self-management systems, can clearly be organised in many ways: many architectures present themselves for this purpose. For the introductory, explanatory, purposes of this paper, a quite closely coupled and concentric architecture is described, but it is well understood that more loosely coupled and more distributed, or more general 'agent-orientated', architectures may well prove to be preferable in practice. In the architecture introduced here, then, the principal components in the resulting system are as follows:

- a knowledge centre connecting to (other) knowledge providers and to:
- an inner knowledge periphery that receives, processes and transmits knowledge passing in both directions between the centre and:
- an outer knowledge periphery situated primarily at the village level.

The corresponding structure can be visualised as shown in Figure 3.

This is clearly a *hydroinformatics system*. It is correspondingly within the present context a sociotechnical system: its technical components cannot function

effectively without the simultaneous introduction of appropriate social (including institutional) arrangements and the social changes that it should release cannot be catalysed, and thus cannot be sustained, without the provision of appropriate technical means. These socio-institutional components are related as also shown in Figure 3 (see also Abbott & Jonoski 1998; Jonoski & Abbott 1998; Thein & Abbott 1998, 2000; Abbott 1999*a*; Jonoski 2000).

In basic outline, such a system comprises:

1. A core group of professionals initially responsible for the design and analysis of the system and specifically of its centre, its inner periphery and its outer periphery.
2. The resulting knowledge centre.
3. The inner periphery (with other kinds of 'professionals'); and
4. The outer periphery (with a very few 'professionals' in the conventional sense), mainly run by 'lay persons', and predominantly because necessarily by women, and then to a considerable extent also necessarily on a part-time basis (see Abbott 2000*a*).

The *core group* is responsible for the first realisation of the system and the establishing of its components. It comprises, so to say, the 'construction team' of the system.

The *knowledge centre* is the primary repository of knowledge rendered in the form of modern-scientific and current-technological discourse. It has:

(1) to draw upon knowledge and data emanating from the outer periphery, as modulated by the inner periphery; and:
(2) to communicate with a variety of (other) knowledge providers; and:
(3) to provide the outer periphery with appropriate narrative and scientific knowledge, originally mostly with a scientific form of expression, but arriving at the outer periphery in narrative form, having been mediated by the inner periphery.

The *inner periphery* has:

(1) to 'translate' knowledge from and, about the individual end-user arriving from the outer periphery that is primarily expressed in narrative discourse into knowledge for the centre that is primarily expressed in the manner of scientific discourse; and, on the basis of this knowledge;
(2) to 'translate' knowledge and data arriving from the centre that is primarily expressed in the manner of scientific discourse into advice departing to the individual users situated within the outer periphery that is primarily in the form of an existing knowledge-sympathetic narrative discourse; and:
(3) to process two way data exchanges between the centre and the outer periphery.

The *outer periphery* is the primary repository of narrative knowledge. It has:

(1) to inform the centre, through the intermediary of the inner periphery, what is happening 'on the ground' and especially the situations of each of the individual end users, and, further to this again, to communicate what these end users expect to happen (on the basis of an often long experience and their own individual knowledge); and:
(2) to draw upon scientific knowledge emanating from the centre, as merged with autochtonic knowledge by the centre, and as translated into narrative form by the inner periphery in order to provide advice to individual end users in the local population; and:
(3) to act as a knowledge conductor between individuals and communities within the outer periphery.

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