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Water scarcity: An alternative view and its implications for policy and capacity building

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Abstract

This article focuses on the somewhat ambiguous concept of scarce water, or, more accurately stated, on the rather more ambiguous concept of scarcity. Still today, water scarcity in a region is defined largely in physical terms, typically gallons or cubic metres per capita if a stock or per capita-year if a flow. However useful purely physical measures may be for broad comparisons, they cannot adequately reflect the variety of ways in which human beings use water — neither to their wastefulness when water is perceived as abundant nor to their ingenuity when it is not. This article argues that water scarcity should be defined according to three orders of scarcity that require, respectively, physical, economic and social adaptations. It goes on to demonstrate that perceiving scarcity mainly in physical terms limits opportunities for policymaking and approaches for capacity building.

Keywords: Adaptation; Capacity building; Efficiency; Scarcity; Water policy; Water use efficiency; Water demand management.

"Resources are not; they become."
(Zimmerman, 1951: 15)

1. Introduction

Prior to World War II, natural resources were primarily seen as physical substances, some of which could be turned into marketable commodities or useful services. Of course, economic texts had recognized that natural resources *in situ* were a form of capital (Scott, 1955), and, at least from the work of Pigou early in the 20th century (1932), concepts of externalities in the exploitation of natural resources had been worked out. The 'wise use' doctrine of the early conservation movements implied policies for coping with demand (short time preference), and limits to demand, if not to growth, but its economics tended to be muddled (Barnett and Morse, 1963). Not surprisingly, public policy and capacity building regarded natural resources in the physical sense, and presumed that national wealth could be determined in considerable part on the availability of (or, in a colonial era, access to) a greater or lesser quantity of natural resources.

Careful analysts had always challenged the predominant physical concept of natural resources, but a broader perspective did not become more widely accepted until the 1950s. The report of the Paley Commission (President's Materials Policy Commission, 1952), the establishment of research groups such as Resources for the Future, and the introduction of texts and courses that went beyond a description of natural resources signalled a new intellectual era. The development, use and conservation of natural resources became matters of economic efficiency and efficient management, not just man *vs*. nature. Already by 1952, Ciriacy-Wantrup could write that:

> ". . . resources, their scarcity, their depletion, and their conservation are concepts of the social sciences *par excellence*. . . . resources are variables in a socially most significant function in which man, his objectives, his knowledge, and his institutions are other variables" (Ciriacy-Wantrup, 1952: 28–29; emphasis in original).

These ideas developed further with the publication of *Scarcity and Growth* by Barnett and Morse (1963), which demonstrated, on the basis of statistical evidence, that technological progress had fully compensated for depletion in the best sources of natural resources. In a prescient

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qualification, Barnett and Morse did limit their apparently cornucopian optimism with the warning that the quality of environmental resources, water among them, did appear to be declining. According to the economic definition of water scarcity, water resources are valuable because they are limited compared to demand, and this definition has been and continues to be reality for many countries, particularly those with arid or semi-arid climates (Winpenny, 1994; Brooks, 2001). Still, many nations, many institutions and a great many politicians continue to operate on the old principles. As recently as 1995, Michael Porter and Claas van der Linde (1995a, b) of the Harvard Business School felt it necessary to insist that national prosperity does not come from industrial access to natural resources but from industrial ability to innovate.

Physical water scarcity is not without meaning. Falkenmark's (1994) widely-cited distinction among water adequacy, water stress, and water scarcity is based on this measure — though Falkenmark has been careful to emphasize that she is referring to demographic scarcity, which is only part of the picture (Falkenmark, 1996; FAO, 2000; Ashton, 2002). However, despite changing concepts for many other natural resources, water continues to be seen primarily as a physical substance, particularly in public discussion. Perhaps its link to life gives water a special place in people's thinking. And certainly some nations, and many regions within nations, are critically limited in both absolute water quantity available and water service provision. Jordan is a clear example: no matter what development path the nation follows, and no matter how carefully it is used, water will always be in frighteningly short supply for its citizens (Shannag and Al-Adwan, 2000; Beaumont, 2002). However, many nations that are physically short of water manage their water service provision quite well with the limited supplies they have. Barbados is a good example (Burke and Moench, 2000); so, too, is Botswana. Israel is another example, though in this case the situation is complicated by Israel's current use of water that will flow to Palestine after a final peace settlement (Lonergan and Brooks, 1994). In stark contrast, others in a similar situation — Yemen, Zambia, Pakistan and many parts of China and India, for example — report declining aquifer levels and impending disaster (Al-Sakkef et al., 1999; Burke and Moench, 2000). From the other end of the spectrum, Canada, which lies near or at the top of quantitative indicators for availability, is now struggling to meet the water use and quality standards exemplified by other nations with much lower levels of physical availability. Even in the central Canadian province of Ontario, which borders on the Great Lakes, water shortages are not uncommon (Dolan et al., 2000).

Around the world, the context for decision-making about water has changed. Water quantity and quality problems are intensifying, at least during some parts of the year, and they extend to regions and sectors that never before experienced shortages. Individuals, communities and nations are struggling to find ways of coping with less water and lower quality water. Typically, if unfortunately, the individuals and institutions[1] in Canada and abroad are resisting change and adaptation. In the view of Burke and Moench, recognition of problems with supply and delivery of water is widespread but ". . . understanding of the social, economic, institutional and political dimensions essential for effective management lags far behind the complementary geophysical knowledge" (2000: 10).

This disparity in people's ability to deal with different types of information makes it critically important that we now re-frame the concept of water scarcity, so that we understand better its origins and dimensions, and so that we can pose better questions about water for the future. Our focus on policy alternatives in the short term and capacity building for the long term reflects that this need, as suggested by almost all the global change models, will become greater with time (Abu-Taleb, 2000).

2. An alternative view of water scarcity

Perspectives on the nature of water scarcity are changing slowly. The response is shifting: from emphasis on scientific information and specific technologies (hydro-geology and handpumps for example) to research on cultural environments and institutions. Ohlsson and Turton (1999) are explicit about these changing perspectives: they expand quantitative water stress and conflict indices to include socioeconomic indicators. In their terms, a shortage of naturally occurring water endowments, or whether a country has abundant or scarce water resources, pertains to the first order of scarcity. And they extend the range of analysis to include the 'social adaptive capacity' available to cope with this situation. A society that is unable to manage its way around first order scarcity is subject to a second order scarcity.[2]

In the mid-1990s, academic researchers made the distinction between first and second order scarcity. The foundation was Homer-Dixon's (1995) research on ingenuity gaps and the implications for the so-called 'developing' countries. Through his research, Homer-Dixon challenged the endogenous growth theorists' dominant analysis of the origins of society's material well-being (Aghion and Howitt, 1998). Their perspective, and that of most of our institutions, is almost exclusively focused on technologies — machinery for production, dams for water supply, DNA sequencing for drought resistant crops — as means to stimulate growth and development.

[1] For the purpose of this research, institutions are defined as "Any agreements made between people, and can be informal, such as contracts, administrative regulations, laws and organizations, or informal, such as cultural habits" (Alaerts, 1996: 55).

[2] The term 'order' is drawn from the original authors and denotes a more integrated typology of the issues and barriers in water resource management. The different orders of scarcity may extend from first through third responses but values and perceptions may alter that path.

In contrast, Homer-Dixon identified alternative determinants of social adaptation to complex and dynamic stresses. One of his principal modifications, and using his terms, was to distinguish between technical and social ingenuity. "Ingenuity," in Homer-Dixon's analysis, consists of "ideas applied to solve practical social and technical problems" — in effect, a second order analysis. He argued that ideas for how to arrange people, their social relations and institutions, are ultimately more important than ideas for technologies or natural resources. Further, Homer-Dixon argued, social ingenuity is a precursor to technical ingenuity. If market institutions are not effectively organized, an inadequate flow of new technologies will result.

Larger human populations and higher consumption of resources combine with more powerful technologies for the movement of materials, energy and information to increase the density, intensity, and pace of human and environmental interactions. These changes boost the requirement for social and technical ingenuity. In that process, the new, and potentially most significant, challenges surface as management complexity rises. A current example is the need to balance growing pressure for decentralization and privatization, on the one hand, and environmental protection and equitable distribution, on the other.

Specific research on the nature of scarcities can be found in the literature on mineral, fish, and forest resources. For example, John Tilton suggested in this journal that, "innovation and technological change may be far more important than changes in mineral endowment" (2000: 49). Tilton also noted that, contrary to the traditional view where mineral endowments dominate most discussions of market competitiveness, the incorporation of social and technical innovation allows a wealth of diverse policy responses. Because of this second order abundance, the United States has not, despite a century or more of active mining, passed from a minerals-abundant to a minerals-scarce nation. A caveat to this mining research, and the application of Tilton's alternative view, is the issue of substitutability. There is, for instance, no adequate substitute for many of the services water provides. Copper, the case in point in Tilton's article, has substitutes for each of its uses, and new ones are still being found, for instance, silicon replacing copper wires in the telecommunications industry.

To build upon these wider views of scarcity and resources, we find it helpful to subdivide Ohlsson and Turton's "second order scarcity", into second and third order scarcities. In our formulation, second order scarcity would be those adaptations — whether technological or institutional — that make management of a natural resource more efficient. Responding to third order scarcity, in contrast, would shift the efficiency emphasis away from the technical and microeconomic to the social realm, and would therefore depend on substantial social, political, and cultural changes. In a conceptual sense, second order scarcity involves anything that moves society onto the production possibilities curve, whereas third order scarcity changes the position of the curve (i.e. uses alternative criteria and 'success' objectives). Both are forms of social adapative capacity, but the latter is much more fundamental than the former. In many ways, second order scarcity can be overcome by a capacity that allows one to do better what had been done in the past ("more crop per drop" in the irrigation jargon), and therefore to meet existing demands with fewer resources. Third order scarcity requires social adaptive capacity that develops through education, cultural change, and revaluation of lifestyles. It is one thing to manage water better in the production of food to meet current diets, but quite another to promote shifts toward low-meat or vegetarian diets". The demand curve does not change much in coping with second order scarcity (though of course quantities demanded will vary with price and income), but adjustments in the position and shape of the demand curve are the essence of third order coping mechanisms.

First, second, and third orders of scarcities can overlap within a country or region but they are not necessarily sequential or cumulative. Nor do opportunities proceed neatly from lower cost and more marginal options to more expensive and larger ones. The Red Sea to Dead Sea ("Red-Dead") Canal recently put back on the table by Jordan and Israel would be a mega-project by any definition, but, because it is aimed at increasing the supply of fresh water, it is really a first order approach. On the other hand, proposals to raise prices to end users, or to limit water use in irrigation, both second order approaches, raise deep political issues with varying winners and losers.

One striking, although short-term and small scale, example of second-order scarcity despite water abundance comes from Canada. During an extreme rain event, a well supplying the municipal water system in Walkerton, Ontario, was contaminated by *E. Coli* 0157:H7. A cascade of events, including a misguided provincial political and financial agenda, faulty environmental planning, and grossly negligent operations culminated in seven deaths and thousands ill. For weeks afterward, Walkerton was water scarce and dependent on bottled water. The town did not lack water because of a first order scarcity, but because a second order scarcity of economic, institutional, and political resources had reduced the viability of their water supply.

Israel is another nation with a first-order water problem, but one that has already pursued a variety of second-order approaches for managing its water resources (Lonergan and Brooks, 1994). Widespread application of drip irrigation equipment, efficient manufacturing technology, and residential water conservation efforts, together with some of the highest prices for water in the world, moderate Israel's industrial, agricultural, and residential demands. Further, in areas such as crop choices and water allocation, Israel is beginning to address problems of a third order. However, even with Israel's long-standing attention to water, and centralization of responsibility for water under a national water commissioner, major gaps in management can occur when those responsible become too confident in their own models. The nation was unprepared for the three-year drought from 1989 to 1991, and found that it had to react with disruptive short-term measures to avoid damage to its aquifers (Ben Zvi et al., 1998). Moreover, Israel, like Jordan, is failing to look ahead to the longer-term future; future water policy is seen as an extension of current policy (plus desalination) without looking at opportunities that might emerge from changing demands.

By framing our understanding of water within these three orders of scarcity, the perception of water resources is no longer limited to a natural gift to be consumed by those who have, and coveted by those who have not. Instead, fundamental modifications of our questions about water management become possible. The range of policy options and institutional opportunities expands at all stages of management, and, in order to support institutional and technological decisions, the importance of effective, operational capacity increases. As Tilton puts it, managers are no longer relegated to a status of "helpless bystanders", but "instead are crucial players who through their innovative efforts significantly control their own destiny" (Tilton, 2000: 51). We will return to this issue in the section on capacity building.

3. Different policies for different orders of scarcity

For first order scarcity, the range of options for policy response is limited. It is wider for second order scarcity, and almost unbounded for third order scarcity. To over-simplify, engineering is the key discipline in policies appropriate for first order scarcity; economics is the key discipline for second order scarcity; and almost all of the social sciences for third order scarcity. Demand is all but ignored as a variable in first order scarcity; it is taken as an economic and demographic variable in second order scarcity; and it becomes a social variable in third order scarcity (Table 1).

Unfortunately, but not surprisingly, as the scope for action increases so does the range of issues that must be taken into account, and thus the complexity of policy response. Though the range of options may be more limited for lower orders of scarcity, that does not imply that government will be any less involved or that the policies will be any less expensive. Indeed, sometimes quite the reverse is true. Again to over-simplify, first order policies tend to be expensive in dollars and environmental impact; third order policies tend to be expensive in management and social impact.

First order scarcity stems from actual or perceived inadequacy of supply, given levels of demand that are presumed to be largely if not entirely outside policy control. Water use may be subject to adjustment in times of drought, but over the longer term it can be projected forward (and inevitably upward) on the basis of history. Working almost entirely on the supply side, government agencies or parastatals (or international organizations) seek to expand supply by building dams and dikes, or by drilling into aquifers, and then running pipelines to large irrigation projects or major cities.

Supply-side approaches to first order problems need not be large in scale. Water harvesting from roofs or fields is, in effect, a supply-side approach that is applicable at small scales. However, the adaptations typical of water harvesting, and the common need to re-learn ancient techniques, give rainwater harvesting (and many other local forms of water management) characteristics that are more in keeping with second order approaches (Brooks, 2002).

Today, water agencies concerned with first order scarcity are turning their attention to desalination, inter-basin transfers by pipeline, and large-scale water shipments by sea. All of these options are technically feasible, but none is cheap or easy. Many have severe ecological impacts; most are politically complex, and all are capital and/or energy intensive.

Though inadequate for the future, first-order approaches have been remarkably successful up until now. They have accomplished the task given to them with competent (in some cases, spectacular) engineering. The problem lies not with the engineering but with the goal. If one makes the logical assumption that the best and cheapest sources of water have already been tapped, the scope for future construction is limited. Where does one go when a region is already withdrawing 58% of all available water, as in the Middle East, or 41% as in Eastern Europe (Raskin et al., 1996)? Already a decade ago, the cost of new water supply projects was two to three times that of existing projects (Serageldin, 1995).

Table 1. Policy options for varying types of water scarcity

Order of scarcity	Role of public demand	Range of policy choice	Dominant discipline	Responses
First	Forecasts based on history	Low	Engineering	Supply-side projects (dams, pipelines, canals, wells, desalination)
Second	Projections based on economic variables	Moderate	Economics	Demand-side management; water as an economic good; technical fixes
Third	Scenario options based economic and demographic variables	High	Social sciences within bio-physical limitations	New options and reallocation, technological change, 'water-soft' paths'

As a result of the limitations of supply-side policies, or their expense, most nations have turned to second order policies (as we define them above) even if they have not explicitly re-defined the problem. The essence of second order policies is found in a combination of good management and economic efficiency, where efficiency is a realization of maximum output per unit of input. Common tools include management by objectives, benefit-cost analysis, and demand-side management. Of course, these tools have long been in use, but when policies begin to rely on them for decision-making, much greater attention is paid to economic values as reflected in markets or inferred from surrogate measures. This attention in turn encourages both the pricing of water to end users, and the concomitant need to measure water flows. (In more sophisticated systems, effluent flows may also be measured.) Water is now seen as an economic good, and quantities demanded are no longer considered immutable, but rather subject to valuation by consumers. Elasticities may be low in some uses, high in others, but in no case are they zero. Benefit-cost analysis is no longer used to select among supply-side approaches but to compare supply options with demand options. Forecasts give way to projections. Future water use becomes the dependent variable subject to changes in population, income levels, and perhaps patterns of industrial development.

Adoption of policies appropriate for second order scarcity can go far toward resolving gaps between water demanded and water supplied. Even when the policies are not fully implemented, gains can be significant. Demand-side management, for example, typically identifies cost-effective savings of 20 to 50% of the water consumed (Gleick, 2000; Vickers, 2001). The International Water Management Institute looked at the next 25 years and concluded that half the additional demand could be met by increasing the effectiveness of irrigation alone, and much if not all the rest by small interventions (Seckler et al., 1998). Moreover, second order approaches permit the inclusion of environmental considerations that tend (for no inherent reason) to be neglected in policies dominated by first order considerations. The value of greater water supply must be assessed against the value of water for recreation or habitat protection in the lakes or rivers where it occurs.

For favoured water-rich countries around the world, second order policy approaches may be sufficient, at least for many years into the future (Falkenmark and Lundqvist, 1998; Seckler et al., 1998; Raskin et al., 1996; Raskin, 1997). However, at some point, second order considerations in most, perhaps all, countries will have to give way to third order policies designed, as indicated above, not just to resolve supply-demand problems for water more efficiently but to create new options, and, with them, new levels of efficiency (Rosegrant et al., 2002).

The most important policies for third order scarcity are directed not at consumption but at demand — not so much how to use water more efficiently but why use water in this way at all. Not so much, for example, about how to build low-flow toilets but why use water in toilets. Not so much about more efficient irrigation techniques but about ways to develop agriculture with rain-fed techniques, or about processes for shifting the regional economy away from agriculture altogether.

In contrast to typical economic approaches, policy analysis for third order scarcity does not take wants as given, and also challenges patterns of water use, whether based on long tradition or on recent habits. Does watering lawns or washing cars make sense in a world increasingly short of water? Even if it does, should water for such uses be of potable quality? Does it make sense for nations in arid regions of the world to use the bulk of their water to grow food? Even if it does, is it sensible to grow crops for export, which is an important, if indirect, way of exporting water? Obviously, such shifts in allocation may be equivalent in water terms, but they are anything but equivalent in social, political and environmental effects. Third order scarcity raises the questions, but it does not presume the answers.

In the fullest development, policies appropriate for third order scarcity merge with what are coming to be called water soft paths (Brooks, 1994; Gleick, 2002), developed by analogy from a highly instructive approach to energy analysis (Lovins, 1977). Recently, Gleick has listed a number of characteristics of such paths, but the key principles can be reduced to three:

(1) The first principle is to resolve supply-demand gaps in natural resources as much as possible from the demand side. Human demand for water, beyond the 50 litres-per person-day needed to maintain life,[3] can be satisfied in many different ways, and the choice among them needs not to be limited to efficiency criteria.
(2) The second principle is to match the quality of the resource supplied to the quality required by the end use. It is almost as important to conserve the quality of water as to conserve quantity. High-quality water can be used for many purposes; low-quality water for only a few. But, happily, we only need small quantities of potable (high quality) water but vast amounts of irrigation (low quality) water.
(3) And the third principle is to turn typical planning practices around. Instead of starting from today and projecting forward, start from some defined future point and work backwards to find a feasible and desirable way (“a soft path”) between that future and the present. The main objective of planning, after all, is not to see where current directions will take us, but to see how

[3] Gleick proposed that the 50 litres per day, a bare minimum compared to the water consumption in many industrial countries, includes “drinking water, sanitation services, bathing, and food preparation” but does not include water to grow food. The actual number is less important than a commitment to the principle and action to meet the goal of provision (Gleick, 1999).

we can achieve desired goals with current and future water availability. There is now a sizable and instructive literature on such "backcasting" (Robinson, 1988, 1990).

Given the divergent types of policy appropriate to different orders of scarcity, it is tempting to say that the respective packages have little in common. That would be going too far. All of the policy approaches require good information systems, and all of them depend upon sound research. Good geological maps and extensive hydrogeological modelling will be critical to the design of appropriate policies no matter which order of scarcity is the rule. Future water systems may be characterized by much more conservation of water than today's, but they will always require extensive and efficient water supply (and equally extensive and efficient effluent removal) systems. All three orders of scarcity must be brought into play for future water policy.

4. Redefining scarcity and our capacity building options

According to White (1998), difficulties in water resources management continue because

> "the constraints of professional training and competence, the limits of organizational authority and the ignorance of the outcomes of many actions, past and future, impede the balanced formulation of all potential solutions and options" (White, 1998: 25).

These missed opportunities — in effect, lost potential for building second and third order responses in water management — are no longer concerns only for 'developing' countries. Canada's Climate Change Impacts and Adaptation Directorate (CCIAD, 2000) found that water resource managers are 'generally complacent' toward the impacts of climate change and that they believe existing tools will be sufficient to address impending risk and uncertainty. The pressures to decentralize management, privatize operations, and increase stakeholder participation are straining institutional arrangements. For decision makers, this restructuring, coupled with environmental uncertainties, adds greater risks and responsibilities. The new responsibilities are often perceived as a threat to the organization, as indicated by Gunderson and Holling:

> "Human systems have much greater powers for both rigidity and novelty. The ability of the bureaucracy of a government agency to control information and resist change seems to show a level of individual and group ingenuity and persistence that reflects conscious control by dedicated and intelligent individuals" (Gunderson and Holling, 2002: 328).

Although undoubtedly written with a sense of humour, the quotation retains an element of truth. In many cases, the people responsible for our water systems are struggling to integrate the most useful information or knowledge. Individual and institutional adaptation in water management is only slowly beginning to evolve toward a second order focus. Third order priorities, exemplified by a water soft path, remain even more elusive.

Alaerts (1996) defines 'capacity' as the "knowledge, skills, attitudes and values as we find them in individuals, and as they are aggregated in organizations, communities and in all other forms of arrangements that define individual and collective behaviour" (p. 59). From that perspective, he then suggests that the purpose and nature of capacity building are to:

> "provide the individuals with the intellectual skills, and the institutions with the skills and procedures to help them meet their objectives. . . . capacity building is concerned with the sector's overall performance, it will at the same time assist in critically assessing the objectives of the organizations, as well as the institutional architecture in which they are supposed to function" (Alaerts, 1996: 58).

Implicit in Alaert's definition of capacity and its objectives is the notion of adaptation and innovation to unanticipated problems. The questions that emerge related to capacity building are straightforward (although the solutions and implementation are not):

- If our water managers are learning, but not implementing, what can we do to encourage a change in behaviour?
- Are responses similar across geographic or political boundaries?
  - If not, what can we learn from other countries that are struggling with similar water management problems?
- And if resource management institutions are unwilling or unable to react effectively, how do we remove barriers to innovation?

If the definition of scarcity is altered to include second and third order priorities, research is needed to examine how capacity building, and its subcomponent of knowledge management, responds (Table 2).

The capacity building requirements in second and third order definitions are immensely more complex than those of a first order. The value of water across diverse societies, equity issues, broader political, economic and technical or information limitations must all be addressed at the second order. For the third, systemic complexity of capacity building increases even further as institutions are recognized as embedded in society's norms.

Research has found that capacity building may not make resource management projects more successful. Michael suggests that "if the focus is only on ideological

Table 2. Capacity building options for varying orders of water scarcity

Order of scarcity	Objectives	Responses/activities	Key challenges
First	Training hydrologic engineers, geologists, irrigation and water treatment technicians	Locate and develop water supplies, large-scale construction of dams and irrigation schemes, urban and rural water and sewage infrastructure.	Technical issues; supplying sufficient water for all demands. Financing supply infrastructure and services.
Second	Generate and implement (training) based on a neoclassical efficiency; institutional reform in line with economic priorities	Establish economic values of water. Utility-based conservation programmes. Rationing during droughts. Reform water institutions based on economic principles. Allocative decisions based on water-use efficiency.	Financial, administrative, technical limitations. Social resistance to water as an economic good. Inadequate attention to equity.
Third	Implementing 'water soft paths'	Change incentives and conditions at the individual, institutional, societal levels. Responsive to individual constraints on learning with pre- and post-training activities and targeted participation. Evaluation of capacity building operational effectiveness for the institution and individual.	Increased systemic complexity — water institutions are embedded in social and physical context. Need for societal education.

and operational matters, then no attention will be given to providing the psychological safety essential for coping with the personal need to incorporate learning into the methods for dealing with the challenges of ecological management" (Michael, 1995: 471). Conventional perceptions of knowledge imply that the greater the supply of information (facts and data), the more likely learning, decisions, and adaptation will occur. However, Michael argues that the result can be the opposite:

> "learning, which mostly upsets beliefs and habits in individuals and in organizations, is hardly likely to be embraced easily or enthusiastically, even though there is a growing, and sometimes powerful, recognition of the need for change" (Michael, 1995: 470).

For capacity building to be effective at the second and third orders of scarcity, we need to understand the individual, how people learn, and the influence of institutional adaptive cycles on information availability. Unfortunately, the individual's bias toward the *status quo* results in a systemic bias where institutional change tends to solidify the 'sanctioned discourse' (Turton and Ohlsson, 1999: 10) and positions of authority or power (Livingston, 1993).

Building upon findings about the behaviour of water resource 'users' (Brooks et al., 2001) and communities' adaptive capacity (Moench et al., 1999; de Loë et al., 2002), research could focus on the individuals and institutions that design, promote, and conduct polices and programmes in the water sector. Capacity building must find a way to tackle the uncertainties of the individual, perhaps by directing efforts toward the third orders of scarcity so that "the fate of the individual and the whole are inextricably linked" (Livingston, 1993: 816). The current transition in capacity building from a supply focus (first order) to efficiency of use (second order) focus presents a solid foundation from which to begin. By linking capacity-building priorities with the new concepts of scarcity, discussed above, we might be able to reshape the analysis of our water problems and design more effective responses.

5. Conclusions

Scarcity of water is a more complex concept than simple ratios, especially physical ratios, can indicate. Once one looks at water scarcity more analytically, measurement problems and possible interpretations multiply, but so, too, do opportunities for alternative forms of public policy and new approaches to capacity building. A remarkable reflection of these implications appears in the recently produced *World Water Vision* (Rijsberman and Cosgrove, 2000). The vision is based on three scenarios, the design of which is neatly encapsulated in the abstract of a recent article by Gallopin and Rijsberman:

> "The alternative scenarios are the Business-as-Usual scenario (BAU), representing the future trajectory if those who don't believe in the crisis prevail, and no major policy or lifestyle changes take place; the Economics, Technology and Private Sector scenario (TEC), which could result from policies favoured by those who rely on the market, the involvement of the private sector and mainly technological solutions, largely national/local or basin-level action; and the Values and Lifestyles scenario (VAL) that could materialize through a revival of human values, strengthened international cooperation,

heavy emphasis on education, international mechanisms, international rules, increased solidarity and changes in lifestyles and behaviour" (Gallopin and Rijsberman, 2000: 1).

Such three-part scenarios have been used in the past, particularly in analyses based on the so-called soft energy path (Lovins, 1977; Bott et al., 1983). What is new is their application to water, and the different models that underlie the scenarios. However, because the three scenarios are not meant to provide explicit policy and programme choices, but rather to indicate different directions in which to look for those choices, they reflect rather closely the three orders of scarcity as outlined above.

All three scenarios, as with each of the three orders of scarcity, require difficult choices. None of them is easy, and all depend on better knowledge, more extensive integration, and considerable investment. It is even possible that both TEC and VAL are sustainable (BAU certainly is not), though Gallopin and Rijsberman, as well as the authors of this article, doubt that TEC ultimately will prove truly sustainable. Ultimately, both VAL and Third Order strategies stress human values and the choices deriving from those values. The resulting policies extend to efforts to change individual human behaviour, on the one hand, and to refocus the type and scale of societal development, on the other.

The real differences among the three scenarios, and among the three orders of scarcity, lie with questions as to where better knowledge will be applied, what is being integrated, and what sorts of investments are being made. Both scenarios and orders suggest a partial shift away from a focus on the natural resources themselves to one on people and institutions. The advantage of the approach through orders of scarcity is that more micro-level choices become evident — within one basin or community; in one sector; for one end use — than with the more global choices implicit in scenarios.

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