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Water poverty indicators: conceptual problems and policy issues

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Abstract

In the wake of a growing concern about both the unchecked rise of poverty and the local and global consequences of water scarcity, the relationships between water and poverty are the object of a sprawling literature. Indicators are presented as indispensable tools for informing and orienting policy-making, comparing situations and measuring performance. This paper first reviews different conceptions of water scarcity and shows the variety of associated causes. A brief look at the virtues and shortcomings of some of the indicators used in the development sector then serves to introduce a review of the major water-scarcity/poverty indicators found in the literature. The reasons for their popularity and vitality are critically examined, and the links between indicators and policy-making are discussed.

Keywords: Indicators; Irrigation; Water policy; Water scarcity

1. Introduction

The world, as conventional wisdom has it, is facing a “looming water crisis” and runs the risk of having its water supplies “tapped out”. Prospective studies suggest that the number of countries that will face water scarcity in 2025 will increase dramatically, as additional world water requirements are estimated to grow between 25 and 57% (Seckler *et al.*, 1998). This global water shortage narrative, combined with a recurrent discourse by international institutions emphasizing the role of water in the fight against poverty, has put water issues at the top of many national and international agendas. Because of the vital role of water in human life, deprivation of water is unmistakably associated with poverty and is often seen as an offense to human rights and dignity. Researchers and planners are challenged by the interlocked issues of water availability, water use efficiency, water productivity and water allocation in order to ensure that human needs are met.

Yet, matching supply and demands appears more intricate than believed at first sight. Planners have to deal with several dimensions of water needs and use, in particular with their heterogeneous and fluctuating spatial and temporal manifestations. This elicits the need to develop tools that may inform decision-making. Several researchers have attempted to develop indicators as a way to capture the "state of water" in either a specific or a holistic way. It is believed that such a way of planning, and even management, of water resources may be better oriented and progress measured in more concrete and quantitative ways.

This paper looks critically at the potential of water indicators to define and quantify a state of "water poverty" and to inform policy with regard to the remedial actions that need to be taken. It first attempts to disentangle the various occurrences and perceptions of water scarcity and to show the multifaceted aspect of water scarcity. It then examines the strengths and weaknesses of a number of indicators used in development studies before reviewing several water-poverty indicators recently proposed in the literature. The subsequent section attempts to understand, in the face of the intrinsic limitations of indicators, their ever-growing popularity and concludes by reexamining the place of indicators between science and policy.

2. The multiple dimensions of water scarcity

Since water is such a vital and omnipresent factor of life, it is no surprise to find that the deprivation of it, or its scarcity, may be associated with many circumstances and have many different impacts. A first distinction must be made between the different uses of water and the impact of its scarcity on people or the society. We may distinguish five[1] categories of water use:

[U_1] *Drinking water*. This is the most vital and inelastic use of water and has been considered as a human right. Depending on the climate, humans need between 1 and 5 liters of water per day for their life.

[U_2] *Domestic water*. This category represents other vital domestic uses of water, most crucially water for cooking, hygienic purposes and laundry.

[U_3] *Food security needs*. This category of water use corresponds to individuals who need additional water to grow the food they consume (or part of it), or to carry out other activities on which their subsistence depends critically. The most common example is that of smallholders and peasants who irrigate their fields and who depend on this agricultural production for their food and subsistence.

[U_4] *Economic production*. This refers to uses of water that are part of the production of goods by people who depend economically on this production but whose basic domestic and food needs are not drastically affected by the water shortages that might constrain this production or its expansion.

[U_5] *Environmental needs*. Since humans are part of the ecosystem, they are also affected when the amount, quality and timing of water flows necessary to support ecosystems is not ensured. Loss of biodiversity, health impacts from pollution, aesthetic degradation and other negative impacts are caused by such water scarcity.

[1] These categories do not cover all water uses (for example, religious functions, in-stream uses such as transportation, recreation, etc.) but they offer a grading of possible scarcities that directly and most commonly impact on poverty, from basic needs to economic activities and health.

Obviously, it may not always be easy to segregate water scarcity strictly according to these five categories, because scarcity is highly dynamic and may affect these different "layers" at different points in space and time, and for varied durations.

The cause of water scarcity is of central concern when we want to determine under which conditions or through which measures scarcity can be combated and redressed. We may distinguish between five types of constraints:

[S_1] Physical scarcity corresponds to an absolute type of scarcity, where the water sources available are limited by nature. This is the common situation in arid and desert areas, where water sources are limited to only a few wells, springs or *qanats*.

[S_2] Economic scarcity is the impossibility to cater to one of the above water needs or uses because of the incapacity to commit human resources (e.g. labor and time needed to procure water from very distant wells) or financial resources (e.g. payment for water) to access water.

[S_3] Managerial scarcity may occur because water systems are not properly maintained or managed: reservoir carryover stocks may not be considered, aquifers mined, irrigation schemes chaotic, water distribution networks leaking, etc. Improper management induces this scarcity, since users who should normally receive water fail to be served properly.

[S_4] Institutional scarcity is a subtler dimension of induced scarcity, signifying a society's failure to deal with rising supply/demand imbalances and to preserve the environment. Water shortages can be partly ascribed to the inability to anticipate such imbalances and to supply adequate technological and institutional innovations. This may also include (although it is also linked to [S_3]) third-party impacts, that is, water problems experienced by some users because upstream[2] patterns of land and water use change and impact on downstream access to water (in quantity and/or quality).

[S_5] Political scarcity occurs in cases where people are barred from accessing an available source of water because they are in a situation of political subordination.

The great variety of situations are illustrated by the above two classifications, which define a matrix of 25 quite different cases. U_2S_2, for example, is a case where water for domestic use is available but where a person cannot afford it. U_4S_4 can be the case of a peri-urban horticulture farmer who is unable to use surface water because its quality is degraded. U_4S_3 can represent the case of irrigators who suffer from a shortage of water because upstream reservoirs have been ill-managed. U_3S_4 represents the case of villagers drawing their income from mangroves that have been destroyed by return flows of polluted water from irrigation schemes. The cases of Zimbabwe, South Africa and other countries from southern Africa provide vivid examples of an extreme case of politically constructed water scarcity of category $U_{3/4}S_5$ (Swatuk, 2002).

These various types of scarcity may also vary in their temporal forms. Scarcity can be temporary or constant, characterized by a continuous gap between the water needed and the water available. Such a shortfall in water supply is more critical for the first two uses (U_1 and U_2), since this can be considered as the nonfulfillment of a human right. Scarcity may have occurred as a reduction of the quantity of water used earlier and is then perceived as a stress that generally induces adjustments and reduces

[2] In the case of aquifer overexploitation, the interaction is not necessarily upstream/downstream.

output. But it may also manifest itself as an impediment to future growth or intensification (of agriculture), if users can *potentially* use more water (and wish to do so) but this additional supply is not available.

In brief, it is apparent from the complexity uncovered by the above distinctions that the water–society nexus cannot be reduced to a mere question of providing technical and financial means to quench whatever demand for water is expressed. Water stress is usually defined in general terms. The World Water Assessment Program (WWAP, 2001), for example, sees it as “the condition of insufficient water of satisfactory quality and quantity to meet human and environmental needs”, but what characterizes “insufficient” as well as the category of “needs” is anything but a straightforward universal notion. Water scarcity has to do with how societies spread over space, how their activities modify the environment and how this, in turn, impacts on them, and with how different segments of these societies are able (or unable) to mobilize financial resources and power in order to shape the patterns of access to water within the society.

3. The water–society nexus and its quantification

The above brief categorizations of water scarcity point to a baffling diversity and complexity of manifestations, causes, impacts and alleviation strategies. Several water indices and indicators are used or are proposed to capture one or a few of these manifestations of water scarcity. This section first reviews a number of indices commonly used in different disciplines (linked to development), illustrating their utility and limitations. It then moves to a more critical analysis of the use and misuse of indicators, and of the success they enjoy. Lastly, it examines, in this light, a series of recently proposed “water indicators”.

3.1 Indicators and their pitfalls

This section is not aimed at a comprehensive review of indicators but, more modestly, provides a few illustrations of the limitations inherent in the use of indicators, as a way to inform the subsequent discussion on water indicators.

The most well-known and widely used indicator in economics/policy fields is the GDP (Gross Domestic Product). The GDP, often taken as a measure of wealth or progress, has been widely criticized on several grounds (Bradbury, 1996; Falt, 2003; Redefining Progress, 2003). It ignores all activities (household labor, community service, etc.) that are not directly linked to the production of marketed goods or services; it includes all activities that are generated by the malfunctioning of societies or disasters (fight against pollution, police and prisons to combat crime, health care and treatment of diseases provoked by stress or pollution, etc.); it does not account for all the externalities of economic activities on the environment (loss of biodiversity, destruction of ecosystems, etc.); it does not capture the so-called informal economy and tells nothing about the distribution of the value-added derived from this production (Brazil is the ninth economy in terms of GDP but the worst country in terms of inequities). These drastic shortcomings have led to the development of alternative indicators (Hoon *et al.*, 1997): a “Green GDP” index has been proposed to account for the destruction of trees and nature. The Genuine Progress Indicator (GPI) and the Index of Sustainable Economic Welfare (ISEW) have retained the monetary approach of the GDP but have tried to incorporate the externalities created by destructive activities and to account for household activities. The UNDP has chosen a nonmonetary approach and developed the Human Development Index (HDI) based on three indicators: life expectancy, school enrolment/literacy and income.

However, the most instructive attempt to replace GDP by an environmentally sensitive index is probably that of the European Environmental Pressure Indices Project, which is intended “to provide the European Union with a tool that supports environmental policy by giving a comprehensive and systematic description of human activities affecting the environment” (Jesinghaus, 1999). The Sustainable Development Index (SDI) is based on 60 environmental pressure indicators, 6 for each of 10 categories (indices) that include loss of biodiversity, ozone layer depletion, climate change, water pollution and water resources, waste, dispersion of toxic substances, etc. Bearing witness to the difficulty of defining multidimensional indicators, the project started without a clear definition of how the 10 indices would be collapsed into one SD index but with an acknowledgement that there was considerable overlap between the indices and that “the underlying data for the published indicators is often of poor quality” (Jesinghaus, 1999). Ironically, the “information iceberg” provided by the project (see Figure 1) confirms that what eventually remains visible are the (aggregate) indices, while the “invisible work” is done by experts and remains out of sight. Jesinghaus also shows that there may be no agreement between farmers and environmental experts on what distinguishes “good” and “bad”, such as for land use practices. The lack of consensus on what the desired agri-environment “landscape” in Europe is, means there will also be no clear indicator of performance for this environmental problem.

In some cases, it is apparent that the quality of the indicators is assumed to be in direct relationship to the number of variables considered. A pathological example is the Environmental Vulnerability Index (EVI), which claims to integrate 52 indicators[3] while lamenting that the “availability of data tended to set a practical limit to the number finally” (EVI Project, 2003).

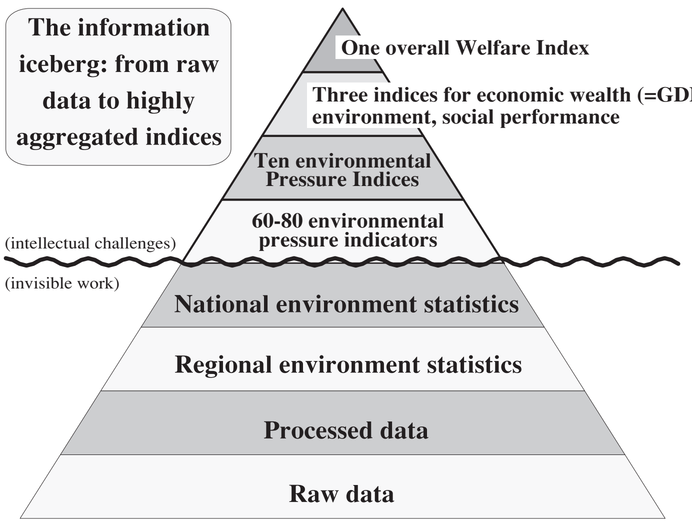

Fig. 1. “The information iceberg”. (Source: Jesinghaus, 1999.)

[3] The EVI includes such diverse and exotic variables as sea temperature, the rate of overfishing, population density, the number of volcanoes and tsunamis, the area of land planted with genetically modified organisms, the maximum 24 hour SO_2 concentration, the number of vehicles per square kilometre of land area, etc (EVI Project, 2003).

The weight given to subindices in composite indicators is arbitrary. When cross-country comparisons are made, the local differences in the importance of problems are ignored. That aggregated indicators may depend on one's value is also well illustrated by the "Friends of the Earth" website which allows the visitor to "create his own ISEW, by changing the weight given to the 19 components of the final indicator".

In sum, indicators tend to be marred by problems ranging from inadequate quality of data, arbitrariness of weights, incommensurability of values and incorporation of judgments/ standpoints, to classical loss of information in the aggregation process as well as in the construction of composite indices. For all these reasons, they are prone to become black boxes, making it difficult for outsiders to unravel calculations, assumptions and meanings.

3.2 Examining water indicators

Early water indicators focused on the physical availability of water (generally at the country level) and how it related to population. The Available Water Resources (AWR) per capita measured the ratio of the renewable water in the hydrological cycle to the number of people (Falkenmark *et al*., 1989; Gleick, 2000). It is easy to see that "renewable water" might include floods and, more generally, all the renewable water resources which are not controlled, neither of which helps much in understanding the situation. A refinement of that crude index led to the consideration of "water withdrawals" (or water diverted/abstracted) instead of renewable water (Raskin *et al*., 1997), but the large differences in the amount of water used for irrigation made comparisons dubious. How to compare countries like Thailand, with a large share of irrigated rice exported, with Iran, which uses irrigation to reduce dependence on world food markets, and with temperate countries where the bulk of agriculture is rain-fed? In addition, these two indicators are usually considered at the country level and often pool together regions or river basins with totally different waterscapes (Amarasinghe *et al*., 1999). For example, a recent issue of *Nature* (2003) using an AWR data-based index shows Brazil in the "relative sufficiency" top class (>1700 m^3/year/person), the dire situation of the Nordeste region being outweighed and masked by that of better-endowed regions Similar observations apply to other countries, such as Chile, Senegal, India, Mali or Iran, which find themselves in the same upper category. It is not clear, for example, whether these last two countries really differ from Tunisia, which appears in the absolute scarcity category (under 500 m^3/year/person). Likewise, what is the meaning of pooling together the Colorado and Mississippi basins, or the Yellow and Yangze rivers?

Lastly, the relationship between water withdrawals and water effectively used (that is, depleted) is all but straightforward. In some basins, half of the water diverted returns to the river and goes to the sea; in others, no more than 5% of the total runoff reaches the downstream end of the basin. Seckler *et al*. (1998) have rightly pointed to the above limitations and have remarked that, for example, while Zaire fared very high with the two indices and had great potential water resources, this meant very little to the population, which is subject to severe limitations of water supply. Their study attempts to take into account both supply and demand and estimates water use by sector as well as by return flows. The result is a much more qualified view of the world situation in 1990, as well as projections for 2025. Yet, as the authors acknowledge, poor data quality and in-country heterogeneities create "serious problems… and much work needs to be done before the methodology can be used as a detailed planning tool".

Salameh (2000) has focused on the amount of water needed for domestic needs and for the demand of food production in relation to population size. He considers both available surface water and groundwater and accounts for rain-fed agriculture. Applied to countries of the Middle East, his index shows that Syria, for example, which is "in the red" in Seckler *et al.*'s (1999) study, is not water-poor. While the indicator provides a very useful means of estimating a water stress with relation to food self-sufficiency, it does not yet consider environmental needs and disregards the question of virtual water, or whether shortfalls in water can or should be made up by imports of food grains. Malaysia, for example, has long abandoned the objective of self-sufficiency in commodities like rice but cannot be said to be water-short.

Feitelson & Chenoweth (2002) take a different angle and give priority to water provision for domestic use and environmental services, two aspects identified by these authors as being on top of today's agenda. Water poverty is defined as a "situation where a nation or region cannot afford the cost of sustainable clean water to all people at all times" and the index computes the cost of developing an adequate water supply and sanitation that is compared to the GNP as a way to estimate one country's affordability. The exercise is tantamount to a planning and prospective operation at the national level. It focuses on the economics of providing water and sanitation facilities and disregards more complex dimensions.

The Malthusian focus implicit in these approaches of resource/population ratio ignores both virtual water and adaptations. Just as the ever-looming Malthusian food crisis has so far been warded off by global food markets and by technical and institutional change, simple indices are mute about the crucial capacity of humankind to respond to resource scarcity. Ohlsson & Turton (1999) distinguish between a "first-order scarcity" of natural resources (water) and a "second-order scarcity" of the social resources required to adapt to the former. They are concerned with distinguishing between situations in which social resources enable society to adapt, and others where conflicts and social unrest are likely to be the outcome. Ohlsson (1998) constructs a Social Water Stress/Scarcity Index, arrived at by dividing WSI by the Human Development Index (HDI), considered as a "workable proxy for the social adaptive capacity of a society"[4]. This arguably leaves large opportunities for further refinement, a task undertaken more recently by Turton, who attempts to define five key indicators of second-order resource scarcity (Turton & Warner, 2002). However, such works seem to invariably produce "anomalies" in the index, which have to be explained by additional, site-specific and qualitative considerations, suggesting that indices fail to capture and represent the complexity of particular situations.

Lawrence *et al.* (2002) and Sullivan (2002) recently presented the results of a research project aimed at establishing an International Water Poverty Index (WPI) that would combine a measure of water availability and access with measures of people's capacity to access water. The WPI is an index ranging from 0 to 100, where a maximum of 20 points is attributed to 5 different indices, themselves based on a total of 17 indicators. Their attempt to combine several dimensions of water scarcity comes at a cost: the problem of multidimensional indices is that they conflate disparate (and often correlated) pieces of information, with arbitrary weights, giving rise to intriguing associations. The ranking established by the WPI creates strange bedfellows, whereby New Zealand stands next to Nicaragua, Papua New Guinea next to Yemen, the USA to Laos, Peru to Switzerland and Thailand to Sweden. This is acknowledged by the authors who note that "the information is in the components rather than in the final single number".

[4] Ohlsson (1998) admits that the "field of developing quantitative indicators is not yet very well developed" and defines a Water Stress Index as hundreds of persons per million cum of renewable water (the inverse of AWR, made a "standard indicator in the literature").

Even when the five (sub)indices are examined separately, several of the shortcomings discussed above can be observed. The "Resources" component is a derivative of the AWR on a log scale. Here, again, the Netherlands stands next to Mexico, Denmark to Morocco, and Peru to Canada. The "Access" component combines access to safe water, sanitation and water for irrigation. Egypt is second on the list, because of its high rate of irrigation, which obscures the situation on the two other fronts. The "Capacity" component combines GDP, under-fives mortality rate, HDI and the Gini coefficient of income distribution. This introduces the crucial aspect of equity but subsumes it into the indicator, amid 16 other indices.

Recent approaches that use a grid approach (Meigh *et al*., 1999), river basins (Alcamo, 1997) or a mix of basins and administrative units (Amarasinghe *et al*., 1999) seem to be promising in that they address supply and demand within hydrological boundaries. However, because of a lack of data these approaches cannot avoid making simplifying assumptions on such factors as the relationship between water diverted and used, irrigated area, and regulation allowed by reservoirs. The latter point is crucial because the ratio of water withdrawals to renewable water depends critically on the share of runoff that is regulated.

In conclusion, it can be seen that it is crucial to distinguish between indicators that focus on a particular aspect of water scarcity (e.g. percentage of population with access to tap water) and those who address more systemic dimensions, where management or sociopolitical aspects, for example, are paramount. The former are subject to data problems and loss of information in the aggregation process but are straightforward. The latter are challenged by the complexity and fluctuating nature of hydrology (e.g. "efficiency") or by that of societies and their historical background, making attempts to integrate the complexity of the manifestations of water use and scarcity problematic. In all cases, they even out spatial and temporal heterogeneities that are paramount in the occurrence and understanding of water scarcity.

4. Can the water–society nexus be measured?

4.1 The spread of indicators

The brief review above, as well as a perusal of the reports issued by national and international agencies, demonstrates the sweeping spread of indicators, of which the UNDP annual report provides a vivid example. In addition to the GDP per capita, the gender-related development index, the HDI and the Human Poverty Index, it displays indicators that measure how democratic the world is, how free the press is, how high women's participation is and the progress regarding the eight main objectives of the Millennium Development Goals. The vitality and popularity of indicators across virtually all disciplines seem to remain unabated by their intrinsic shortcomings and by the criticism directed at them. Why they are so appealing and the role they play therefore deserve scrutiny.

Simplifying the world. Indicators, as an outgrowth of quantitative rationalization and accounting, are undoubtedly linked to the constitution of states and centralized bureaucracies (Porter, 1995). Indicators can be construed as a quintessential attempt at legibility and simplification. By their uni-dimensionality, they best exemplify the constant endeavor by the states or international agencies to reduce a "social hieroglyph into a legible and administratively more convenient format" (Scott, 1998). Policy-making and the planning of development projects provide a typical situation of tension between, on the one hand, the attempt by the state to rationalize, simplify and apprehend the world and, on the other, the complexity, heterogeneity, messiness and dynamic nature of the real world (Scott, 1998; Arce & Long, 2000). Clearly, indicators contribute to repelling the "specter of messiness". However, when an international initiative is led to consider that "indicators are our link to the world" (IISD, 1999), the risk is high that they may be used as quick substitutes for a more insightful, but painstaking, understanding of the world.

The use of blueprints in development is frequent because of the uncertainty faced by decision makers (Roe, 1991) and because the cost of understanding local settings is high and may, in addition, lead to questioning the project objectives. This familiar trade-off between project feasibility and the tackling of local complexity drives the popularity of tools such as cost–benefit ratio and IRR (internal rate of return), which are supposed to measure the economic return of a particular project. They allow decision-makers to avoid complexity by reducing it to money values and collapsing it into one single number. As Porter (1995) noted, "the remarkable ability of numbers and calculation to defy disciplinary boundaries and link academic to political discourse owes much to this ability to bypass deep issues".

Scientific and institutional legitimization. Another key aspect of the popularity of indices is that their quantitative nature gives a gloss of *scientificity* to the message they are meant to convey. This *scientificity* is crucial to legitimize a viewpoint, an approach or a decision that is likely to be nonconsensual. This is also required because policy-making and planning deal with complex systems characterized by interlocked issues and processes, imperfect decision makers' knowledge and conflicting interpretations and viewpoints. In such conditions, standardization and quantification approaches are perceived as bringing some "mechanical objectivity" into the debate (Porter, 1995). As King & Kraemer (1993) put it, "in the heat of the political battles, some numbers beat no numbers every time". This is germane to the role played by simulation models in policy-making and debates.

The legitimacy of numbers, however, needs to be built. The size or importance of the institutions involved in the design of indicators, the magnitude of the budget attributed to their elaboration and calculation or the public perception of the expertise of the scientific panel convened (Weiss, 2002), for example, are key parameters of success. If the choice and processing of numbers fed into calculations remain out of the reach of the public, "their authors will only be believed if they can impress their readers somehow with their skill and probity" (Porter, 1995). This is also very clearly stated by Jesinghaus (1999), who stresses that the success of the Environmental Pressure Index is linked to the fact that it comes from Eurostat, the Statistical Office of the European Communities and a Directorate General of the European Commission – "in other words, a highly credible and official source"[5]. Because "without some form of institutional backing, the project would produce merely private opinions of a group of academics…the CG [*Consultative Group on Sustainable Development Indicators*] should try to find a 'strategic alliance' with an indicator process that has a strong institutional background." Eventually, it seemed "difficult to reject the 'collective choice' made by these scientists", while "legitimization through expert surveys allowed Eurostat to proceed with data collection and, finally, an indicator publication containing 'real statistics'." While what the author means by real statistics (and the reasons to bracket it) is open to interpretation, the double process of institutional and scientific legitimization is forcefully made explicit.

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[5] This is strengthened by the fact that "fifteen national statistical offices, and many other important data providers, such as the EEA and national environmental agencies and ministries, supranational research projects, etc., have expressed their willingness to supply data for this project" (Jesinghaus, 1999).

The alleged impersonality of numbers – here the value of indicators – is also crucial for their authority (Porter, 1994). Indicators are supposed to be generated by a processing of numbers independent from passions and opinions, that is, based on scientific procedures that are seen as warranting objectivity and dissolving idiosyncrasies. This can be done only through a highly impersonal language, where ethics and politics are absent (Porter, 1995). In addition, stressing the gap between the real world and the simplification made does not necessarily weaken the approach, as it also enhances the crucial role of experts in the lower parts of the "information iceberg" in making complexity seemingly understandable to the many. The best example of an indicator that illustrates all these dimensions is probably the IRR. The IRR provides scientific support and legitimization, and (still[6]) is a powerful tool "to clothe politically desirable projects in the fig leaf of economic respectability" (Marshall, 1965). Of course, this claim for objectivity has remained neither unchallenged nor exempt from contradictions, but judging by their resilience and even vitality, indicators and quantification altogether seem to retain some features of idealized science, at least in the public's view.

Legitimization therefore runs in two directions: one towards the public, emphasizing scientificity/objectivity with the result of excluding and circumscribing debates; another towards other decision-makers/parties directly involved in the policy process, with strategies aimed at (a) persuasion or at the outflanking of rival views or (b) seeking alignment and alliance formation through finding a vocabulary for a political compromise type of legitimization.

The need to measure impacts, evolution, and to compare. Another feature of indicators is that they give the illusion of measuring something, and therefore allow bureaucracies to give concrete expression to the impact of their activities, to justify their existence and budget and to deflect public pressure. This partly explains why development banks and other agencies, which regularly come under criticism for having failed to reduce world poverty, attempt to build indicators that would show the impact of their actions, even if this comes at a risk[7].

Indicators are deemed particularly useful when a group of countries agree on certain targets and policies and need to monitor changes under a common policy framework. This is exemplified by the need to monitor the strategy of integrating environmental and socioeconomic concerns into the European Common Agricultural Policy (CAP) (Vidal, 2002). This led to the definition of 34 agri-environmental and 50 economic and social indicators addressing several dimensions of European agriculture.

Communication and political tools. Foremost, indicators are communication and political tools, a point often emphasized by their very authors. Jesinghaus (1999) remarks that the "primary goal of aggregation is communication of complex issues to the non-expert". The language has to be simple, sophisticated arguments must be avoided and newspaper readers must get the point straightforwardly. In other words "it must be simple and stupid… as journalists will dislike any index with more than three components". Obviously, whether complex problems are understood by the public because they have

[6] Despite a substantial critical literature on the issue, and while economists readily admit in private that the methodology can be manipulated so as to obtain very contrasting results (Ingram, 1971; Bauman & Haimes, 1987), the CBA and the IRR are faithfully and routinely churned out to justify investment projects that are usually decided on totally different grounds.

[7] "Unfaithful" indicators may head the wrong way and be revised. This commonly occurs with the calculation of consumer prices or unemployment indices, whose methodology is often altered in order to redress negative trends.

seemingly been made simple is problematic. The view by Hoon *et al*. (1997), for whom "communicative indicators articulate the problems and educate the participants and the public by providing appropriate information", is probably a particular reading of what "educating" means.

Another dimension of communication is that, between scientists and other policy advisors, indicators can function as what the social studies of science and technology literature call "boundary objects". These are devices through which different interest groups are able to communicate with each other across the boundaries of their own paradigms, institutions and interests. Lying at the boundary, all groups can relate to them (though in different ways in all likelihood) and they appear as useful instruments for achieving alignment in policy negotiation. Although the result of the attempt to define indicators for the European CAP mentioned earlier is technically not fully convincing, the consensus-seeking process between Eurostat and its partners made the statistical services of the EU move towards a common standard set of indicators. Standardization and consensus building are important aspects of the definition of indicators (Vidal, 2002).

Lawrence *et al*. (2002) admit that "the purpose of an index is political rather than statistical", while Streeten (1994) sees indices as useful in focusing attention and simplifying the problem. "They have considerable political appeal. They have a stronger impact on the mind and draw public attention more powerfully than a long list of indicators, combined with a qualitative discussion. They are eye-catching." While they emphasize the impact of such communication means on the public, Feitelson & Chenoweth (2002) are more interested in the opposite effect, whereby indicators need to "be meaningful and point out the problems so as to galvanize decision makers into action". This is also one of the stated objectives of international indices that establish rankings by country (in particular those published by UN agencies and development banks). Whether governments are influenced by such rankings is hypothetical and remains to be proved[8], against Srinivasan's (1994) contention that "there is no evidence that HDR's [Human Development Reports] have led countries to rethink their policies, nor is there any convincing reason to expect it to happen".

Yet, if the measurement issue is a problem, if they are loosely defined, or an aggregate of correlated variables given arbitrary weights and, if in addition, they are potentially powerful political tools, indicators are all likely to lend themselves to manipulation. Examples of national statistics (e.g. yields, unemployment, inflation) or financial indicators (management accounting) that distort reality purposely are common and well known. Mehta (2001) has shown how the perception of water scarcity in Gujarat was manufactured with the aim of supporting the construction of the Sardar Sarovar dam. In this kind of struggle of discourses, indicators are potentially powerful tools because of their capacity to convey a particular concise, simplified (yet biased) viewpoint to a large public, while purporting to be based on expert knowledge and objectivity.

Even with no intentional distortion, indicators are hardly ideologically neutral. Figure 2 shows the chart of the GDP and the GPI for the United States; it also shows how two diverging viewpoints about "progress" can be expressed through the use of aggregated indicators. The curves do not "tell the same story" and obviously convey very different messages.

Indicators invariably picture a situation in terms of "excess" or "lack", and their evolution over time is interpreted in terms of progress or degradation. They quantify a lack and implicitly call for and legitimize actions (research, investments, reforms, etc.) which must be supplied to "targets" in order to

[8] Maxwell (2002) reports that "much international experience confirms that setting targets influences the behaviour of public administrations, and not always in helpful ways. India is a case in point."

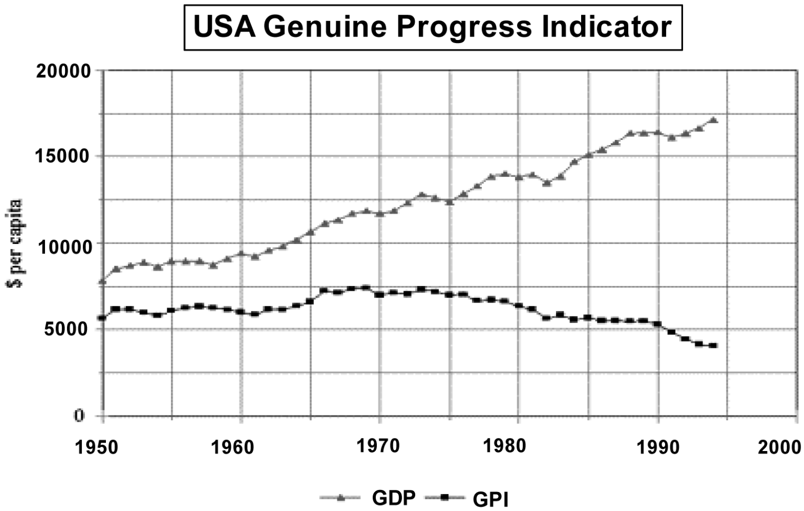

Fig. 2. GDP and GPI indicators for the USA. (Source: Redefining Progress, 2003.)

"fill the gap" or to "catch up". By doing so, emphasis is laid on the investments and actions that are deemed necessary. Indicators do not ask "why such a situation?" "what are the consequences?" or "what are the options?"; they tend to depoliticize and decontextualize problems (Srinivasan, 1994) and to present them as technical issues demanding the intervention of outsiders and the application of the recipes of the moment (new infrastructure, structural reforms, private-sector investment, participatory development, etc.). What counts, and how this is quantified, are defined by experts. Like abridged maps, indicators do not successfully represent reality, "nor were they intended to; they represent only that slice of it that interested the official observer" (Scott, 1998). For some social activists (see Jain, 2003), this is tantamount to denying local stakeholders the right or the possibility to define the priorities and solutions to their own problems, and ultimately the course of their own life. More generally, our values, worldviews and mental baggage are incorporated in the way we define indicators. In other words, "we measure what we value, and we also come to value what we measure" (Hoon *et al*. 1997).

In brief, indicators appear not only as communication tools between academic/bureaucratic elites and the public, but also as boundary objects between stakeholders or parties in the policy process. Comparisons between countries may show contrasts and also influence policy-making. However, they are also political tools in that they tend to be reductionist, evening out heterogeneities, crowding out rival worldviews, defining problems and solutions along lines of technocratic intervention and depoliticizing the issues of access to resources.

4.2 Water and poverty: between science and policy

The preceding discussion has emphasized both the complexity of the water–society nexus and the crudeness of indicators aimed at grasping its multifaceted nature. Indicators which seem to readily make sense and elicit fewer objections are those which count (e.g. people with access to tap water) or measure (e.g. per capita CO_2 emission) a reality that appears as relatively mono-dimensional and objective. Comparisons between countries (e.g. population connected to public wastewater treatment plants in

OECD countries) may also be instructive and signal to some policy-makers that their country features rather poorly in a given domain. Even in such cases, however, the quality of the measurement is usually hard to ascertain and casts doubts on whether comparisons are meaningful.

When the spatial variability of the reality measured is high (and this typically tends to be the case with variables that describe access to resources or poverty levels), indicators only measure an aggregate reality and tend to be counterproductive if policy is precisely aimed at addressing imbalances. The OECD (2001), for example, exhibits an evolution of per capita resource abstraction to the renewal of stocks but admits that such "a national level indicator may hide significant territorial differences and should be complemented with information at subnational level". Planning, therefore, has to be based on a finer knowledge of local realities and needs, and is ill-informed by aggregate indicators. To overcome this difficulty, it is often claimed that indicators can also be calculated at a local scale. The corresponding data collection and situation analysis are then useful (especially if, like for the WPI, they cover a large range of issues), but it is not clear in what way this differs from a conventional study and what the final number arrived at adds to the understanding such a study provides.

With the use of multidimensional indices, meaning is increasingly blurred, not only spatially because spatiality is lost but also because some subindices may rise and others decline, some may be high and others low, without these key contrasts being emphasized. Invariably, one is led to examine the components individually in order to recover some meaning and interpret the intriguing bedfellows generated. The assertion, for example, that "the links between poverty, social deprivation, environment integrity, water availability and health becomes clearer in the WPI, enabling policymakers to identify where problems exist and the appropriate measures to deal with their causes" (EDC News, 2002) seems to run against common sense, since the alleged benefits are precisely the weaknesses of composite indices. When taken up again by news agencies[9] the message is that the WPI will "help local officers get water to more people, clean up pollution and avoid fights over scarce resources by tailoring projects to a community's most critical needs" (*Times*, 2002). Whatever the benefits of the indicators are, they arguably do not reside in helping designing local solutions. The indicator as a communication tool may have gone astray[10].

Indicators provide little insight into the causes, impact of, and remedies to water scarcity and are unlikely to be able to solve such a wide range of problems. They may do so when the problem is limited to, say, connecting more people to the mains, but not in more complex situations, as exemplified in the first section. At the most, better problem solving will be a felicitous outcome of an increased awareness to water problems elicited by the virtues of indicators as communication and political tools. Altogether, the almost nonexistence of research and knowledge on whether and how indicators influence policy-making at different levels (international, national, regional and local) contrasts sharply with their bustling development and with the emphasis placed on their role in planning and decision making.

Conversely, the downside of the simplicity (and usual mono-dimensionality) of indicators may be that they contribute to generating simplistic conceptions, or misconceptions, that acquire the status of common wisdom and durably hinder the progress of understanding. Despite its obvious shortcomings,

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[9] The IISD workshop (IISD, 1999) highlighted "the need to educate decision-makers and journalists about the interpretation and use of aggregate data", suggesting that simplicity and "stupidity" may have collateral effects that need to be redressed.

[10] See also: The WPI "will contribute to a more equitable allocation of water resources, by considering water issues from the perspectives of both the supply of water, and the demand for it, in order to identify who needs water, when and where" (Sullivan, 2001).

the repeated and widespread use of the per capita annual renewable water resources index has resulted in lending to its definition of scarcity and to its scarcity thresholds a kind of universal and unquestioned validity. That this was not intended by their authors provides a good illustration of the danger awaiting simple indicators, when they are taken up and disseminated outside of their original context and intent. The global efficiency of water use in irrigation, to take another example, seems to have been definitely set at 40%, a value contritely acknowledged by managers even in basins where 95% of resources are depleted! In such cases simple indicators and categories tend to oversimplify and reify reality, making it harder for policy-makers to deal with complexity.

5. Conclusion

Just as food poverty is a multifaceted issue with complex historical, social and political roots, water poverty cannot be easily reduced to a few numbers. Standards poorly adjust to different physical and cultural settings and their quantitative foundation is often weak. One may wonder whether a coarse index marred by poor data is better than no index, and whether the information that we can draw from them is more illuminating than misleading. However, although most authors stress that data are not yet reliable enough to be used for policy-making, in practice this caveat ends up being ignored. A simple classification of various types of water scarcity and of their causes showed a range of water-related scarcities that are not easily captured by aggregate numbers.

Not surprisingly, the most interesting indicators would be the ones that are the hardest to develop. For example, the ratio between the current diverted water and the potential (itself a percentage of renewable water) would indicate the degree of “closure” of the basin. This, however, necessitates elaborate water accounting and runs, again, into antagonistic viewpoints on, for example, whether more dams are needed or what is a “good” environmental reserve. Another example is that of the adaptive capacity of societies. While there is little doubt that the responses of societies to water scarcity differ, the reasons for such differences may be more easily elucidated through an in-depth qualitative analysis than by plotting a few indicators.

One may contrast two opposite views on quantification and indicators. One considers that refining the definition of indicators, increasing their number, improving data quality and building expert consensus on them will progressively afford us a good grip on the real world, informing decision and policy-making. In this view, weaknesses tend to be seen as transient, as an inevitability of science in the making, and are compensated for by improved communication and raised awareness. The other view refutes the claims for objectivity, emphasizes reductionism of indicators, how their choice is pervaded by ideology and particular worldviews, how they lend themselves to manipulation and depoliticize problems, how they compare what is not comparable, and ignore (or at best quantify) qualitative and deep realities. In other words, they are dismissed as poor science and “smoke screens” serving political ends.

To sum up, we may identify a continuum from local in-depth studies to macro-aggregate indicators. On the left range of the spectrum, analyses address complexity and diversity, with the risk that they may confound decision-makers and provide no clear road map for action. They can capture reality in much more depth, may allow one to flag “mined fields” and to avoid severe misunderstandings, but they tend to be influenced by personal viewpoints and their conclusions tend to be hard to communicate. At the other extreme of the spectrum, indicators give way to gross simplification but their quantitative nature and alleged simplicity of definition cloak them in the respectability of openness and objectivity. Their scientific content and value are limited, sometimes drastically, but their main role is to convey messages, convince the public and decision-makers and support discourses, at the risk of manipulation.

The middle ground consists of an explicit recognition that indicators are socially constructed tools, “loaded” with particular development objectives and interests. Instead of looking for a general “best indicator”, it would perhaps be possible to make the design of water indicators part of the water-resources development planning process. In this way, it becomes a tool or instrument for negotiation and alignment of the different objectives and interests of the participants. Each planning process would generate its own indicator that would evolve over time, feeding on both “heavy research” and on the societal values with regard to water of the different interest groups. The two virtues that indicators seem to have would be used productively and systematically in this manner. The first, paradoxical, virtue is that the very weaknesses of indicators invite criticism and contribute to a more lively debate and richer conceptual development. In other words, they may play a heuristic role, just as models do. Secondly, their “eye-catching” dimension can mediate some flow of information between researchers and the rest of the society and contribute to raising public awareness on crucial societal issues.

These roles are beneficial and become problematic only when indicators become hegemonic and when the world they describe tends to be remade in their image (Porter, 1995; Scott, 1998): when they undercut local knowledge, manipulate discourse to the benefit of certain constituencies, perpetuate narratives that straightjacket understanding or foster the worldview of armchair analysts. A pitfall is avoided if assumptions, biases, viewpoints, simplifications and practices remain under constant public scrutiny – which happens when they are made an explicit element of participatory development planning. Combining this exigency and the use of indicators as communicating tools conveying simple messages is, however, likely to remain hard to achieve. The real use and impact of indicators on policymaking also remain a subject on which little is known and which deserves further investigation.

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