Economy of Water and Its Management

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Abstract

Water management is undergoing significant and important economic and financial changes. Small scale industry once dominated by public bureaucracies is rapidly transforming into a global business that is driven by shareholder interests and profit and loss statements. In fact, the water industry is already a booming business. Worldwide, annual industry revenues are estimated at $300 billion, the capacity to control water supplies for human purposes has increased markedly during the 20th century. But as water development has expanded, the opportunities for adding to aggregate water supplies have declined, the economic costs of new supplies will increase and the threats to supplies from pollution and groundwater depletion will continue to escalate. The growth in global population and incomes has meant that the demand for water has continued to grow and supplies are therefore becoming increasingly scarce. At present in India numbers of regions are facing major water problems, as has been referred in many research publications. These problems are due to policy and, human resources development and socio-cultural reasons.

The aim of this paper is to reflect the wide variety of water related topics with their inherent complexity and identify water resources research. The paper includes reviewing the nature of new economy of water and problems that are emerging in water resources management. It then suggests what water resources strategies and options will be important in research and policy in order to respond successfully to these challenges. Finally the paper suggests new economy of **w**ater and its management.

KEYWORDS: Water management, Water policy, Economic scarcity, Sustainable water resource

1. Introduction

Water is problematic in the following context: It is generally non-substitutable (although at the limit there is an almost infinite supply of sea water, which can be converted into fresh water at a cost of energy and some pollution);It faces rising overall demand and use intensification; and It has limits to use - there are physical limits, for example, the rate of recharge of groundwater, but at the aggregate level the notion of an absolute physical limit is less valid because adjustment mechanisms (recycling etc.) should mean that water will for the foreseeable future be available at reasonably practicable prices; relative cost limits, in the sense that as usage of existing supplies intensifies and new supplies are sought costs of extraction and usage will escalate; finally there are social limits, set by the social acceptability of the effects of certain uses, for example, water quality and flow conditions for recreational activities. The capacity (via scientific and technological advances) to control water supplies for human purposes has increased markedly during the 20th century. But as water development has expanded, the opportunities for adding to aggregate water supplies have declined, the economic costs (including environmental costs) of new supplies have increased and the threats to supplies from pollution and groundwater depletion have also mounted. While demand for water has continued to grow, with increases in populations and incomes, supplies are becoming increasingly scarce. Despite this position, fresh water is still commonly treated as an almost free resource (with consequent inefficient use and potential over-use problems) rather than as a scarce resource requiring greater efficiency in usage, re-usage and proper economic pricing. The price mechanism is capable of bringing both the demand for water (i.e. the schedule of quantities of water that consumers are willing to purchase at various prices) and the available supply (a schedule depicting in ascending order of cost, the amount of water available to consumers) into balance at some market level. As population and income levels have risen the demand for water has simultaneously increased. The most efficient economic level of water provision is at the point (Qe) where consumer willingness to pay is just equal to the marginal cost of supply (Pe), see figure 1.

2. Water as "critical natural capital"

Fresh water has been identified as an example of "critical capital" (Dubourg, 1992). As a result, aggregate sustainability requires that the value of the fresh water capital stock should not decline over time. More generally, we can interpret this requirement as saying that current usage of the stock of fresh water should not impose costs upon future generations. This might refer to direct costs, such as reductions in health standards, which might result from increases in pollution or indirect costs, in terms of the benefits foregone by future users as a result of the water stock becoming unsuitable for economically valuable uses. Hence current water use should not impose direct costs upon future users, and it should also not foreclose the use options of those future users either. Fresh water can be identified as an example of "critical capital" essentially because its availability is self-evidently a prerequisite for human life. Even further, fresh water underpins the operation of the planet's biosphere ecosystem. It is quite clearly an ethical imperative that current use of fresh water should not undermine the global ecosystem, as this is likely to have catastrophic consequences for future generations. However, it is also clear that current water use in many countries is far in excess of the levels necessary for the simple sustenance of human life. As a result, can water used for everyday domestic and industrial processes really be regarded as "critical"? Firstly, it can be argued that, in some sense, uses which might appear "luxurious" at low income levels can become "necessary" at higher levels of income and industrialisation. This is not only consistent with concepts of relative poverty (e.g., 1979; 1985) but also with the technological relationships which are the foundations of a modern industrial society. Hence, a lack of water for cooling in power generation might cause severe hardship, at least in the short to medium term, such is the economy's reliance upon electricity. Secondly, even if we assume that water does have capital substitutes over some restricted range, it is not obvious that we can guarantee sufficient investment in these substitutes to offset any reductions in the water sector. This appears especially true given the extent to which water services are unpriced in many countries. Therefore, adopting a sectoral approach can, in this case, be viewed as an attempt to ensure sustainability in the absence of the institutional arrangements adequate to produce such an outcome without intervention.

3. The concept of economic scarcity

At a fundamental level, economics is concerned with the concept of scarcity and with the mitigation of scarcity-related problems. Economics is the study of the allocation of scarce means (total resources, man-made and natural) towards the satisfaction of the maximum number of human ends (wants and needs) as is feasible with prevailing technology and knowledge. Given this fundamental preoccupation with scarcity, economics defines the conditions required to secure the most efficient allocation of scarce resources in a variety of contexts. Applied economists operate with the principle and method of cost-benefit analysis. Under the -benefit principle and the criterion of economic efficiency no project, policy or course of action is chosen unless social benefits exceed social costs. Social costs and benefits include items called externalities (valuable or damaging side-effects) as well as private (financial) costs and benefits. The optimal scale of a project or activity is the point where the difference between benefits and costs is maximised. In certain situations some level of an activity, e.g. waste water disposal, is unavoidable and in these cases efficiency is increased when the net social costs of that activity (financial costs plus pollution externality effects) are reduced (perhaps minimised) by a project, policy or course of action which reallocates resources. Rapid population and economic growth has led to an intensification of competition involving limited supplies of water and increasing quantitative demands from alternative water user's agriculture, urban populations and industrial users. But there is also a quality dimension to the water scarcity problem. Declining quality standards impose costs in terms of losses of recreation and amenity use, human health and overall ambient environmental quality. Demand and supply imbalance is most evident in urban areas, especially those in developing countries. Water quantity/quality imbalance is causing rapid increases in the costs of water services (supply and wastewater treatment) for urban populations. Significant health damage costs are also being imposed on poorer people in developing countries. According to the World Bank the provision of services has not kept pace with urban populationgrowth. Thus, while the number of people with access to adequate water supply increased by 80% in the 1980s, and those with adequate sanitation increased by 50% over the same period, the number of urban dwellers without adequate water services has not fallen and those without adequate sanitation increased by 70 million (World Bank, 1992). It has been estimated that in 1990 some 1.7 billion people lack proper sanitation and 1 billion lack an adequate water supply (Briscoe, 1993). The water imbalance problem has led inexorably to environmental degradation in the form of surface water pollution and groundwater contamination and/or depletion. Taking dissolved oxygen as a proxy for overall water quality, average river quality during the 1980s declined in low-income countries, was static in middle-income countries and rose only slightly in high income countries (World Bank, 1992). Surface water pollution is the result of inappropriate disposal of a variety of wastes (household and industrial) into the water medium, causing the assimilative capacity to be breached. But groundwater loss is more the result of compensatory behavior exhibited by individuals suffering from an under-provision of water services. The proliferation of private wells in Northern Jakarta, for example, has lowered the water table to such an extent that saline intrusion now affects a 10 kilometer-wide zone along the coastal plain. Over-pumping of groundwater has also led to land subsidence and asset damage in many cities. Clearly without more efficient and effective management of water resources, the social costs (private financial costs plus externality costs of pollution etc) of providing sufficient quantities of clean water and related environmental services will continue to escalate significantly. Economic thinking (e.g. the application of economic pricing regimes, valuation methods and economic incentive instruments) can play an important role in the formulation and operation of a better water management strategy. Such a strategy needs to treat water as a scarce good with increasing conservation requirements. All this is not, however, meant to suggest that economics is some sort of panacea. Across the globe, the allocation of water is a complex issue enmeshed in both legal and cultural traditions. Existing water users typically have well established rights and have become used to paying low charges for the use of water or its related services. Further, institutional failures often compound the allocation problem, with sectorally differentiated government ministries operating in an uncoordinated way. Economists have spent much time and effort studying measures designed to increase the overall rate of economic activity in an economic system. Government policy in all countries has been, and continues to be, dominated by the goal of maximum economic growth (conventionally defined in terms of gross domestic product (GDP) or gross national product (GNP) generated per annum). The rationale for this policy objective has been that increased economic growth brings increased material standards of living and increased consumer choice. Environmental economists have more recently (since the late 1960s) emphasised the fact that economic systems depend on ecological systems and not vice versa. The laws of thermodynamics lay down that production and consumption activities do not result in the complete destruction of matter and energy, merely its transformation. This so-called "materials balance view" of an economy demonstrates that during the growth process more and more useful (low entropy) matter and energy is drawn into the system (e.g. mining and harvesting activities) only to be discharged/emitted from the system at a variety of locations, and over a period of time, as useless matter and energy (high entropy residuals and wastes). This has led some economists to study not just the efficiency of existing economic activity but potential future limits on the growth and overall scale of economic activity.

4. The sustainable development concept

The term sustainable economic development has now become fashionable in the face of mounting concern over pollution pressures on the assimilative capacity of ecosystems and the depletion of the natural resource base provided by the biosphere. 'Sustainable development' has been broadly interpreted at the macro level. Sustainable development' typically refers to some acceptable measure of national development (e.g. per capita welfare - rising per capita incomes, and quality of life) which is at least constant and preferably rising over time. Sustainable development' needs to be distinguished from sustainable resource use which refers to the ability to sustain the use of the aggregate resource base over long periods of time. Sustainable resource use can be applied to single renewable resources - e.g. fish stocks can be sustainably managed so that the overall stock does not decline. Freshwater is also a renewable resource provided it is managed accordingly. Sustainable resource use for the aggregate of resources is a condition for SD, but sustainable resource use for single resources is not a condition for Sustainable development' provided:

a) The resource in question has substitutes; and/or

b) Capital and labour can substitute for the resource; and/or

c) Stocks of the resource are very large. On this "weak sustainability" basis it is the aggregate capital stock which is important, so that reductions in environmental capital can be substituted for by increases in the stock of manmade capital. Stronger definitions of sustainability stress the life-supporting functions of the environment, and assert that man-made capital is an imperfect substitute for natural capital over a wide range (Pearce et al 1989; Pearce & Turner, 1990). This argument is supplemented by references to irreversibility in environmental degradation, uncertainty and loss aversion. Accordingly, the stock of natural capital should itself be non-declining over time within a non declining aggregate capital stock. Hence, this stance assumes that certain types of natural capital can substitute for other types. However, some commentators have gone even further than this in arguing that certain types of natural capital underpin the very functioning of the environment in some fundamental way. These types of capital, termed "critical capital" have no effective substitutes, whether manmade or natural. This implies that no amount of decline in the stocks of critical capital can be consistent with a non-declining welfare stream (Mäler 1986; Turner, 1993). Therefore, aggregate sustainability requires policies which will not only ensure the maintenance of the aggregate capital stock, but also the maintenance of certain types of capital at the sectoral level. Clearly, adoption of these stronger positions will involve a rather more precautionary and' hands-on' approach to environmental management.

Water management is undergoing significant and important economic and financial changes. This sleepy little industry once dominated by public bureaucracies is rapidly transforming into a global business that is driven by shareholder interests and profit and loss statements. In fact, the water industry is already a booming business. Worldwide, annual industry revenues are estimated at $300 billion, with the United States accounting for more than half that amount, and this number is expected to double as water becomes scarce and the industry matures. This issue of IMPACT is devoted to understanding the new global economy of water. It looks at how policy changes are stimulating this new economy. As Terry Anderson points out in the first article, the development of a global market for water is emerging because water is rapidly moving from a publicly managed resource to an economic commodity. He points out that these policy changes are driven by the simple need to improve water management. Water remains the only critical utility service that has not yet undergone broad restructuring. The new economy of water, however, is ushering in consolidation, privatization, and market competition changes similar to those that have occurred in the gas, electricity, and telecom industries the past decade. New pricing policies are another key factor in the evolution of the new economy of water. As a society, we are rethinking the way we price water. For years, water has been highly subsidized and provided at little or no cost. The rationale for these policies was that water is a basic service of life and should be free to all. While a noble goal, the legacy of subsidized water has created an infrastructure crisis and has left many of the poorest of society without access to good clean water. New pricing policies are moving toward real cost pricing to address water scarcity, encourage conservation, provide infrastructure funding, and most importantly, attract private sector investment. Private companies are far more interested in funding water projects now that revenues can be generated. Historically, investors have shied away from the water industry because of its reputation of being highly regulated with little opportunity for growth. That attitude is changing. Finally, I have taken editorial privilege by including an article with my own thoughts and observations on water markets and pricing. Certainly there will be winners and losers in the evolution of the new economy of water. Without significant changes, however, the industry simply will not be able to meet the growing global thirst for clean water, nor will it be able to raise hundreds of billions of dollars needed to upgrade and expand a woefully neglected water infrastructure. The new economy offers a great deal of promise for meeting those financial needs. It also provides a way of enlisting the private sector to help solve the looming global water crisis. Reform of water pricing policy in developing countries faces many technical, administrative, and political constraints, but with increasing water scarcity and declining financial resources available for irrigation and water resource development, reform of water pricing is essential. For both urban and agricultural water, innovative and pragmatic water pricing reform that introduces incentives for efficient use and enhances cost recovery while improving equity in water allocation is feasible. Agricultural water pricing reform that establishes water rights for users, such as suggested above, would be particularly beneficial, protecting farmers against capricious changes in water allocation, ensuring that farmers benefit from more efficient water use, and providing a basis for trading of water among farmers and across sectors that would further enhance efficiency.

5. Principles for water resource management

Three primary principles should underpin future water resource management, and together form a powerful case for the wider adoption of economic analysis:

5.1 The principle of cost-benefit analysis, i.e. the need to balance explicitly, on a consistent (monetary) basis, the costs of a project, policy or course of action against the benefits provided. This economic approach to water allocation is most valid once the basic needs levels of water provision (e.g. 20-40 liters per capita per day) to a population have been satisfied. It is based on the willingness to pay behavior trait of water consumers and the fact that the marginal costs of water supply increase as less and less accessible supply sources are exploited. So far it has proved difficult to assign unambiguous economic values to all water uses and therefore some may be implicitly undervalued or overvalued. As population and income levels rise the likelihood that use of water by one agent will interfere with the use by another increases. In economic terms water now has an 'opportunity cost' with a value equivalent to the willingness to pay of the user who is losing the water. In cost benefit investment appraisal terms, the value of the water to a user is the cost of obtaining the water plus the opportunity cost. If there were well-established markets for all water-related functions and services then the market price itself would reflect the opportunity cost of water. In reality, many functions and services are not priced at all, or are only nominally priced. Economists have developed a number of proxy methods and techniques in order to estimate monetary values for the amenity and environmental services provided by water bodies. This so-called 'benefits estimation' literature covers both use and non-use value components of total economic value (Pearce and Turner, 1990). To take just a few selected examples, the recreation value of a lake or river (use value) can be estimated via the travel cost method which utilises recreation trip cost data as a proxy for the missing price data. The value that individuals might derive from the mere knowledge that pristine mountain lakes still exist and flourish (non-use value) can be estimated by the contingent valuation method, which utilises social survey techniques to generate willingness to pay values.

5.2 The principle of integrated planning and management. Catchment-wide management is essential because all the water resources within a basin are interrelated. The evaluation of a water project or water use must encompass impacts on the entire hydrologic system and on the ecological system of which it is an integral part. Water resource use conflicts are best mitigated within this integrated approach to resource management. However, water pricing is and will continue to be a complex process. There will be a need for a 'political economy' of water pricing because of the existing complex set of legal, institutional and cultural constrains that condition the supply and demand for water in all countries. The objective of greater economic efficiency will have to be traded off against other decision criteria, but will gain increased significance as the full social costs of water services provision escalate;

5.3 The **principle of long term planning and precaution**. The criterion of quantity/quality - sustainable water use should supplant short term expediency. From the quantity perspective, sustainability requires that current water abstractions should not impose costs upon future generations. The quantity of water that is available for use in any particular period is equal to "effective runoff" i.e. a flow equivalent to the difference between total precipitation and the amount lost through evapo-transpiration, plus the stock of fresh water, i.e. any water held in surface or underground storage. The sustainability rule becomes: water demand should be met out of effective runoff only (Dubourg, 1992). In the UK, the implied intertemporal tradeoff is limited to a 50 year period because reliable yield water flow is based on a 1 in 50 year drought situation. From the quality perspective, the sustainability rule becomes: water quality should be non declining over time. Hence, except in cases where effluent levels exceed critical loads, sustainability arguments as such cannot be used to justify improving water quality.

6. Water Resources Management

Drinking water supply and sanitation is based on the need to provide, on a sustainable basis, access to safe water in sufficient quantities and proper sanitation to all (adopted at the Global Consultation on Safe Water and Sanitation in New Delhi from 10-14 September 1990) emphaasising the “some for all rather than more for some” approach. This includes community management of services backed by measures to strengthen local institutions, and sound financial practices achieved through better management of existing assets and widespread use of appropriate technology, in implementing and sustaining water and sanitation programmes. The recent recommendation of World Water Commission (Hague 2000) further emphasise that “every human being, now and in the future, should have enough clean water, appropriate sanitation, enough food and energy at reasonable cost.” Providing adequate water to meet these basic needs must be done in a manner that works in harmony with nature.

Water and sustainable urban development is the identification and implementation of strategies and actions to ensure the continued supply of affordable water for present and future needs in urban environments and to reverse current trends of resource degradation and depletion. The development objective of this program is to support local and central government’s efforts through environmentally sound management of water resources for urban use. The development activities include protection of water resources, efficient and equitable allocation of water resources, promotion of public participation, support to local capacity building and enhanced access to sanitary services.

Water for sustainable food production and rural development depends on sound and efficient water use and conservation practices consisting primarily of irrigation development and management, water management for rainfed areas, water for aquatic and terrestrial ecosystems. Due to rising water demand in the agriculture sector, multiple use of water should be given priority.

Impact of climate change on regional water resources remains an uncertainty with respect to the prediction of climate change at global and/or at regional scale. It is assumed that average higher temperature and a more erratic precipitation of higher intensity would lead to decreased water supplies and demands, putting strain on already fragile balance between water supply and demand in many tropical countries.

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