Socio-economic issues and options for improved management of irrigation system

Billi A.

in

Lamaddalena N. (ed.), Lebdi F. (ed.), Todorovic M. (ed.), Bogliotti C. (ed.).
Irrigation systems performance

Bari : CIHEAM
Options Méditerranéennes : Série B. Etudes et Recherches; n. 52

2005
pages 243-250

OTHER CONTRIBUTIONS

SOCIO-ECONOMIC ISSUES AND OPTIONS FOR IMPROVED MANAGEMENT OF IRRIGATION SYSTEM

A. Billi[*] and A. Quarto[*]
[*]CIDEM –University of Rome, Italy

SUMMARY – This work presents various beneficial impacts of irrigation development and treats a variety of valuation techniques that may be used to quantify socio-economic and environmental impacts of water use. Valuation techniques of “non-demand” and “demand” curve are analyzed considering different approaches and valuation methods.

Key words: irrigation impact, economic valuation, valuation techniques.

INTRODUCTION

Water is an extremely complex resource. It is both a public and a private good. It has multiple uses. The hydrology and externalities require that we examine potential productivity gains at the farm, system and basin levels. Both quantity and quality are important in measuring availability and scarcity, and the institutions and policies that govern the use of water are typically flawed.

In the areas that are already facing a water crisis the unmet needs are due basically to the scarcity of resources available. Water scarcity results from natural conditions (dryness) or connected extreme events (drought), which create difficulties with normal water supply. But water deficit can be caused also by man through:

- An increase in use;
- A reduction of availability;
- An inefficient utilization of water.

The increase in use is connected mainly with demographic growth and to social and economic development. The reduction in availability is a consequence of the deterioration of water quality, while inefficient utilization is due is to leaks in the water systems, as well as to consumptions that exceed actual requirements, that is to say, wastes. When it is a case of identifying possible interventions to implement to alleviate problems connected with the scarcity of water resources, there are two possible types of operations.

On the one hand it is possible to increase the supply of available water; on the other, it is, rather, possible to reduce the demand and at the same time bring about a better distribution among the various productive sectors.

During the 1980s and the beginning of the 1990s, following the guidelines of the previous decade, actions were concentrated mainly on a single type of intervention: the implementation of great multifunctional infrastructures through which, on the basis of available resources, it was attempted to increase the quantity of water. Nevetheless, during the last decade, the possibility of further investments in the programs that exclusively aim to increase supply has appeared rather restricted. This is not only due to limited water resources especially in arid and semi-arid regions but also due to the fact that the costs involved in building new systems, such as dams and large delivery networks, tend to grow enormously owing not only to problems of placing these infrastructures, but also to the environmental impact and the social costs connected to the realization of such works.

Nowadays, there is a widespread opinion that the actual water problems can only be resolved through a suitable combination of interventions aimed at diversifying supply and controlling demand. Therefore, on the one hand we have to promote the use of non-conventional water resources and, on the other, the development of economic policy tools capable of affecting the choices of allocation by consumers and increasing savings and the conservation of resources. Consequently, the focus of policy-makers in the irrigation sector has now shifted to issues like irrigation water management, participatory decision-making and institutional reform in the irrigation sector, environment management for system sustainability and more equitable distribution across irrigation system and across agro-environments.

IRRIGATION IMPACTS

Historically, irrigation originated as a method for improving natural production by increasing the productivity of available land and thereby expanding total agricultural production, especially in the arid and semi-arid regions of the world. In addition to increasing crop production and farm and family incomes, improved irrigation access significantly contributes to rural poverty reduction through improved employment and livelihoods within a region.

Indirect benefits, such as more stable rural employment as well as higher rural wage rates, help landless farm laborers obtain a significant share of the improved agricultural production. In addition to yield improvement and intensive production practices, better irrigation infrastructure and reliable water supply also enhance uses of other inputs like fertilizers and high yielding varieties. This intensification of agricultural practices generates additional employment opportunities in the rural sector.

The irrigation induced benefits are not limited to farming households but also affect broader sectors of the economy by providing increased opportunities to growing rural service sectors and other off farm employment activities. Examples of such opportunities are, additional employment creation for landless laborers in agro-industries, rural marketing and other off farm activities like house construction and basic infra-structural building. In turn, this feedback process increases the demand for employment manifold and generates additional wealth creation and/or capital accumulation in the rural sector.

All of these benefit processes create transformation within rural and urban sectors, and their feedback mechanism in an economy has significant importance in designing location-specific poverty reduction strategies.

The total beneficial impacts of irrigation development, both direct and indirect, can be summarized under the following categories:

1. Increased crop production (yield improvement) and increased farm income;
2. Increased cropping intensity and crop diversification opportunities and the feasibility of year round crop production activities;
3. Increased farm employment, more employment opportunities for farming families as well as for hired laborers in the locality;
4. Increased farm consumption and increased permanent wealth (permanent asset accumulation due to irrigation). This has significant implications for reducing intrinsic food insecurity in a region;
5. Reduced food (crop) prices allowing access to food for all, which is more beneficial to landless and subsistence families and provides better nutrition intake. This is also equally beneficial to urban poor and city dwellers, since they spend more than 50 percent of their daily income on food items;
6. Reduced friction in the rural economy and reduced transaction costs including reduced farm marketing costs due to increased access to farm link roads and to other improved farm and non-farm related services in the region;
7. Multiple uses of water for bathing, washing, livestock and home gardens;
8. Increased recharge of groundwater, easy access to groundwater and less drudgery for women in fetching water for daily household needs;

9. Aesthetic and recreational benefits accrue out of irrigation facilities;
10. Increased farm income (for farmers) and increased farm and off farm employment opportunities for rural landless laborers result in better school attendance of children of farm laborers and improved social capital in society. This is due to the *income effects* of irrigation, since education is still a luxury compared to other basic needs: foods, clothes, shelter, health, etc.

Improved rural infrastructure always coincides with irrigation facilities. This greatly reduces transaction costs and rural marketing costs and other frictions associated with the farming sector. The benefits generated by these activities are also called indirect benefits of irrigation investments. These indirect irrigation benefits, usually intangible, are not *fully* captured by farming communities alone. Rather, they are shared by larger sections of society. For example, lower food grain prices benefit poor urban and rural landless communities more by enabling them to purchase required food items at affordable prices. Keeping food prices at relatively low levels also greatly assists the industrial sector to avoid the pressure of increasing the real wage rate. In this process, improved agriculture indirectly subsidizes the industrial sector of the economy as well.

The *full* benefits of irrigation are not only captured by farmers, but are also spread to wider sections of society, also called positive externality effects of irrigation access to society. These externality effects are the unintended income (also employment) equivalent of welfare changes brought about by the irrigation project. The extent of such irrigation induced positive externalities, or spillover impacts of irrigation benefits, is much wider in scope in large scale irrigation projects contributing significantly to the regional and national development pace of a country. The farming sector alone cannot capture all the benefits of external effects of reduced friction and transaction costs in the rural economy, as they are economy wide impacts. In addition, these reduced transaction costs have other feedback chain effects on the development of new institutions and the emergence of new socio-political orders in the rural economy.

All of these direct and indirect benefits achieved through irrigation access are difficult to quantify and value in monetary terms. Many of them are even harder to pin down and they also depend upon several other underlying institutional and structural factors and the benefits vary from system to system. This creates difficulties in identifying and delineating irrigation costs to the actual project beneficiaries or the service users.

This high exclusion cost (costs to exclude members from service use once it is there) is the underlying factor for treating irrigation services as a typical public good type of resource. These indirect and intangible benefits have a large implication for management, and investment and financing decisions in the irrigation system. The level of complexity involved in identifying (and valuing) these intangible impacts of irrigation access and high exclusion costs prohibit private sector provision of the service, which are some of the reasons for societal involvement in provision of irrigation infrastructure almost everywhere in the world throughout history

TECHNIQUES FOR ECONOMIC VALUATION OF IMPACTS

A variety of valuation techniques may be used to quantify socioeconomic and environmental impacts of water use, classified essentially into market-based and, non-market-based techniques.

Tools of conventional cost benefit analysis can be used for decision making when the inputs and outputs of alternative projects, policies or programs can be bought and sold in the market, i.e., costs and benefits can be evaluated in monetary units. However, when the project inputs and outputs are not traded in the market, conventional cost benefit analysis needs to be modified. This is particularly true in the case of programs with environmental dimensions, such as water irrigation, because environmental goods and services are not sold in the market place. They possess attributes of public goods such as non-rivalry and non-excludability and as such, market prices do not exist for these goods and services.

In the case of projects or programs with environmental externalities, economists have developed other non-market-based techniques for evaluating the costs and benefits of such projects. These techniques evaluate the change in consumer welfare, under "with" and "without" project scenarios. If the project leads to a positive change in consumer or community welfare, the consumers should be willing to pay for the project. Thus, the consumer willingness to pay for an environmental resource or service [1] becomes the basis for judging the economic feasibility of the project in the absence of market prices and marketable outputs.

All economic and environmental valuation techniques, whether market-based or non-market based, measure the change in consumer/producer welfare, using "with" and "without" project scenarios to evaluate socioeconomic and environmental feasibility. Table 1 gives an overview of environmental valuation techniques. The valuation methods can be categorized according to: (a) the type of market they rely upon; and (b) how they make use of actual or potential behavior of economic agents.

The valuation method has been categorized into two broad groups:

1. Surveys of willingness to pay, like the Contingent Valuation Method;
2. Production function-based approaches. The second category is further divided into two subcategories:
   (2a) Output measurable in markets (corresponding to second column-conventional markets-in table 1);
   (2b) Output not measurable in markets (corresponding to column two and three-other techniques in table 1).

Some environmental valuation techniques are generally applicable while others are potentially applicable and still others may be selectively applicable. As stated several times, environmental goods and services, among them water, since they have the same features as public goods and services, do not have a market in which they can be traded and in which therefore a price is attached to them (commercial value). However, it is still possible to give them an economic value.

Generally, there are two different approaches for monetary appraisal defined in the Anglo-Saxon economic literature in the following way:

- non-demand curve (Market Valuation Techniques);
- demand-curve approach (Non Market Valuation Techniques).

Supporters of the first approach think that it is possible to give environmental goods and services a monetary value (price), referring to alternative goods and services that have a definite price on the market. For example, the monetary extent of an environmental service for waste disposal can be compared to the market value of the costs required to set up an appropriate center for the collection and disposal of waste, in case disposal into the environment is forbidden.

Below we will examine briefly various valuation techniques connected with such an approach, which attempts to attribute to the environment and to natural resources a value equivalent to the price (commercial value) of alternative goods that have a market. However, as is shown by economic theory, prices do not always reflect the total value, that is, the amount of overall utility that derives from the environmental good or service. It is therefore necessary to estimate the demand curve of the same good, at the same time remembering that the area below such a curve is representative of the entire value of the good being examined. The demand-curve evaluation approach aims to estimate the demand curve of environmental goods and services, as well as of the natural resources, resorting to various techniques.

[1] Measuring the demand for conventional goods and services is rarely easy, and the problems are even more complex in the case of environmental goods. An environmental good is defined as having at least one of the two characteristics: either it is negative good - a "bad" which carries no price and thus is inefficiently allocated by the market; or it is public good endowed upon the society (rather than purchased).such as biodiversity. In these cases, the aggregate quantity of good or bad supplied is observable but the individual or aggregate expenditures or valuation of the good are not. Thus in general, the researcher knows the cost of supply of public goods and trade off monetary costs with benefits, but they don't know the cost of environmental goods. In these *cases environmental goods all* that can be. observed is how the consumption of private goods change with the level of the environmental goods. Thus the challenge is to recover the underlying demand for the environmental good. Alternatively, artificial or hypothetical markets may be

constructed to elicit implicit prices or values for environmental goods and services. In the latter, demand estimation is easier although eliciting preferences becomes harder.

Table 1 – Taxonomy of economic valuation techniques

Conventional Market Based on Revealed Preferences	Implicit Market	Constructed Market
Private goods sold in the market	Public goods/Government services	Artificial Market
(conventional price and quality analysis)	(collective choice analysis)	
	• Hedonic Pricing	
• The Productivity Approach	• Travel Cost Analysis	
• Effect on Health or Earnings	• Hedonic Property Values Approach	
• Defensive Expenditures	• Proxy Marketed Goods or	
• Averting Expenditures	Supply and Demand Analysis	
	of Related Goods	
Based on Stated Preferences		• *Contingent Valuation*
Potential Market Goods	Indirect or Passive Use of	Method,
(experimental economics,	Environmental Resources	Bidding Games
conjoint analysis)	• Contingent Valuation Method	Trade off Games
• Repair / Replacement Cost	Conjoint Analysis	
• Shadow Project Analysis	• Habitat Equivalency Analysis	
	Direct Use of Environmental Resources	
	• Contingent Valuation Method,	
	Conjoint Analysis	
	• Habitat Equivalency Analysis	

Valuation techniques of "non-demand curve"

Opportunity Costs

This valuation technique aims to estimate the value of the environmental good or service, comparing it to the fair market value (price) of that to which one must give up to safeguard that good or in order to give life to set up that environmental service.

Costs of alternative goods or services

The value of environmental goods or services can be compared to the well-defined value of expenses needed to purchase goods or to establish alternative services that allow the enjoyment of the same benefits in their absence.

Shadow projects

Based on this approach the value of an environmental good that could be damaged or destroyed by a a development project, can be estimated through the appraisal of expenses needed to replace the destroyed good, or to restore its quality. The example that is usually made is that of the destruction of a humid zone. In the calculation of the costs for implementing the development project one must comprise, within a shadow project, also the costs foreseen for reconstituting the threatened humid zone. The reconstruction of the good can happen also in a different place from the original position. Therefore, every development project with a negative impact on the environment must also contain a shadow project aimed at replacing the damaged environmental good, or at restoring its quality. The valuation techniques briefly examined are based on a market approach. They try to give to a price (commercial value) to the environment, using as a reference the goods and services that have a well-defined value on the market.

Valuation techniques of "demand curve"

Figure 1 indicates two methods of demand-curve valuation. The first approach is based on the valuation of the preferences directly expressed by the economic subject in relation to the environmental good, through the constitution of hypothetical markets (method of expressed preferences). The second, on the other hand, avails itself of some weak complementarities between the environmental good without a market and market goods with a well-defined market price (method of revealed preferences).

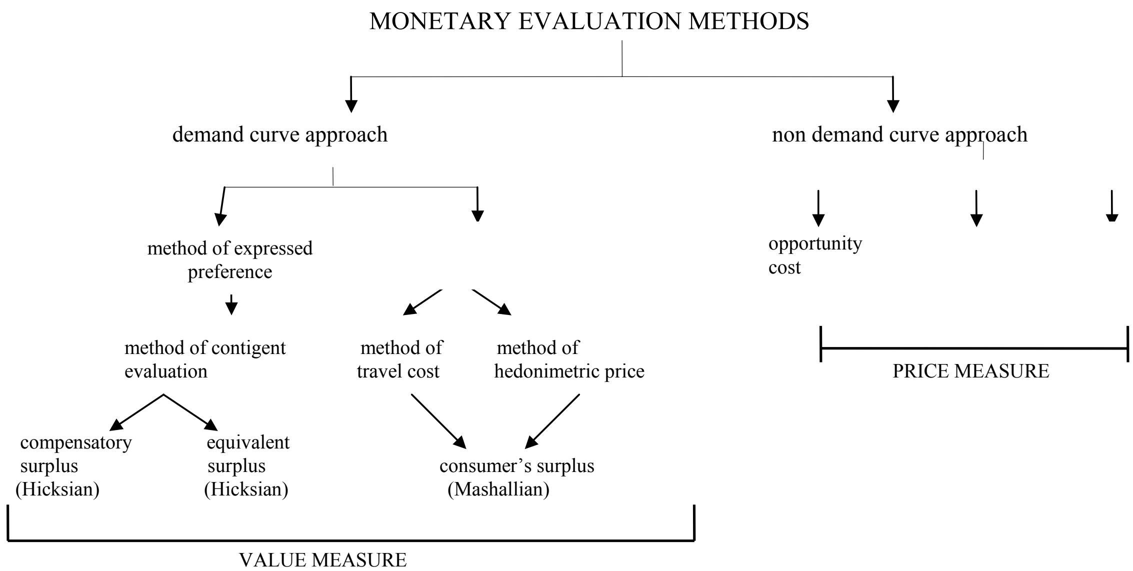

Fig. 1 Monetary evaluation methods (Source: Bateman 1993)

This typology can further be expanded, by making reference to the study by Mitchell and Carson (1989), in which valuation techniques are divided into four groups according to whether:

- real or hypothetical behaviors are analyzed;
- they aim at directly estimating the value of the environmental good or they do it by observing private consumption of a good connected by weak complementary relationships with the environmental good to be valued.

Therefore, there are four types of approaches:

1. DIRECTED HYPOTHETICAL (Contingent Valuation);
2. INDIRECT HYPOTHETICAL (willingness to travel; identification of indifference maps; contingent ordering);
3. DIRECTED HYPOTHETICAL (referendum; market simulations; private market parallels);
4. INDIRECT REAL (Travel Cost; Hedonimetric Price).

Travel Cost

The method of shipping charges, or more generally of expenses faced by users, belongs to the category of indirect real methods. Indirect methods avail themselves of some existing relations among the environmental goods that do not have a market and other goods for which there is a market and it is therefore possible to ascertain their trade value. The TCM, as the other revealed preference methods, are based, therefore, on the purchase of market goods that are connected by weak complementary relationships with the environmental good to be valued. When there is this type of relationship between the two, a combined analysis of the consumption of the environmental good and of the cost of the complementary good can allow an estimation of the demand function of the environmental good.

Therefore, by definition, through the Method of shipping charges, it is possible to estimate the economic value total of the environmental good. Indeed, the TCM aims to estimate the recreational value of an environmental good thanks to the existing relation between the number of trips taken in a determined period and the costs faced to reach the place where the good is located.

The Method of hedonimetric price

This method also belongs to the category of indirect real methods. It attempts to estimate the environmental good by examining the existing relation between the environmental good without a market value and property connected to it. For example, a beautiful landscape, a pleasant and calm atmosphere can increase the value of the property which is the object of exchange in a given market. Therefore, observing the behavior of the economic agents on the real estate market, it is possible to estimate the individual appreciation of an environmental good or service that is spatially located.

It is possible to estimate an ordinary demand curve, and therefore of the surplus of the consumer, by comparing the quantity of the environmental good with the difference of price between a pieces of real estate A, situated in a zone characterized by the presence of the environmental good, and a B, which differs from A only in its location in a zone in which that good is absent.

The method of the hedonimetric price is however based on two somewhat restrictive assumptions:

- the existence of perfect information on the prices of real estate,
- exact perception of the environmental benefits on the part of those who purchase real estate.

Contingent valuation techniques

Contingent valuation, contrary to the previously illustrated techniques, belongs to the category of the hypothetical direct methods. The stated preference methodologies, commonly called contingent valuation techniques, are based on surveys where humans are directly questioned by the researchers' to place monetary values on goods and services normally not sold in the common market place. Thus, contingent valuation method seeks to replicate hypothetical market conditions to elicit consumer preferences about non marketed goods: that is, how would they behave if the goods in question *were* actually sold in market.

The consumer preferences are sought either in terms of willingness to pay (WTP) or willingness to accept (WTA). Sometimes, a variant of the contingent valuation method, such as Delphi technique, is used for valuation purposes where experts, instead of consumers, are approached to seek their opinion about a particular environmental resource or issue .

Contingent valuation techniques can be used to evaluate a number on non marketed public or environmental goods such as water quality and quantity improvement projects, natural resource conservation projects, assessment of natural resource injuries such as water pollution due to hazardous waste or oil spills, enhancement of environmental quality, ecosystem change, and endangered species conservation etc.

REFERENCES

Bhattarai M., Sakthivadivel R., and Hussain I. (2002). *Irrigation Impact on Income Inequality and Poverty Alleviation: Policy Issues and Options for Improved Management of Irrigation Systems*. International Water Management Institute: Colombo, Sri Lanka

Fan S., Hazel P, and Sukhadeo T., (1999). *Linkages between Government Spending, Growth, and Poverty in Rural India.* Research Report No 110. International Food Policy Research Institute: Washington D.C., USA., Washington DC.

Gittinger, J. P. (1982). *Economic analysis of agricultural projects*. EDI series on Economic Development. Washington, DC : The World Bank.

Young, R. (1996). *Measuring economic benefits for valuing water investments and policies*. World Bank Technical paper No. 338. Washington D.C. USA: The World Bank.

Mitchell, R. C. and R. T. Carson. (1989). *Using surveys to value public goods: The contingent valuation method*. Washington DC, USA: Resources for the Future.

Pearce, D. (1993). *Economic values and the natural world*. Cambridges, Massachusetts, USA: MIT press.

Turner, R.K., Pearce, D., Bateman, I. (1993) *Environmental Economics: an Elementary Introduction*. Johns Hopkins.

World Commission on Dams, (2000). *Dams and Development: A New Framework for Decision-Making*, Earthscan Publishers, London, UK.