ECONOMIC FEASIBILITY OF IRRIGATION PROJECTS AND THE MULTI-OBJECTIVE PLANNING APPROACH

by Palitha Manchanayake

Traditional Approach

Generally, in planning of small scale irrigation projects, it was the practice to evaluate them on the basis of pro-rata costs. In this methodology, the total cost of the project was evaluated and a ratio of Cost/Acre of cultivation was considered the criterion. The benefits of the project were not valued as it was felt that generally irrigation projects were beneficial, and these pro-rata costs provided a means of assessing the better project to be given priority and taken up for construction.

Subsequently, the Benefit/Cost ratios came into prominence, where the benefits of the project and its costs are evaluated, and a ratio is found. This ratio indicates the economic worthiness of the project, and it should essentially be higher than unity for it to be considered for implementation. In the case of benefits, only the primary benefits of an irrigation reservoir such as the intended agricultural produce are considered for evaluation. The intangibles or secondary benefits such as inland fishing, growth of secondary industries, the increase in land values of the area etc. are generally not being evaluated. The cost stream comprises the cost of construction of Headworks, the water conveyance system, the land development works, the provision of irrigation facilities, the replacement cost of some components after a certain period, the operation and maintenance cost of the system, and the recurrent cultivation cost. As most of the costs are concentrated towards the construction period of the project, and the benefits are being reaped over the scatter of the period of operation, both the cost and benefit streams need to be brought to a common time base, and as such the Benefit/Cost ratios were found out either by Present Worth or the Equivalent Annual Values. In defining the B/C ratios, one could adopt different methods such as taking the Opportunity Costs/Shadow Prices into account, and also the Guaranteed Price/Market Prices. Higher the Benefit/Cost ratios, higher would be the economic worthiness of the project.

Internal Rate of Return is one other way of assessing the economic worthiness, where it could be referred to as the interest rate at which the total present worth of benefits equals the total present worth of costs over its economic life span.

Thus, in the above traditional approach, one could notice that the national economic efficiency objective is the prime concern, and it is generally the deciding factor for the project to be implemented or not.

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Fig (1)

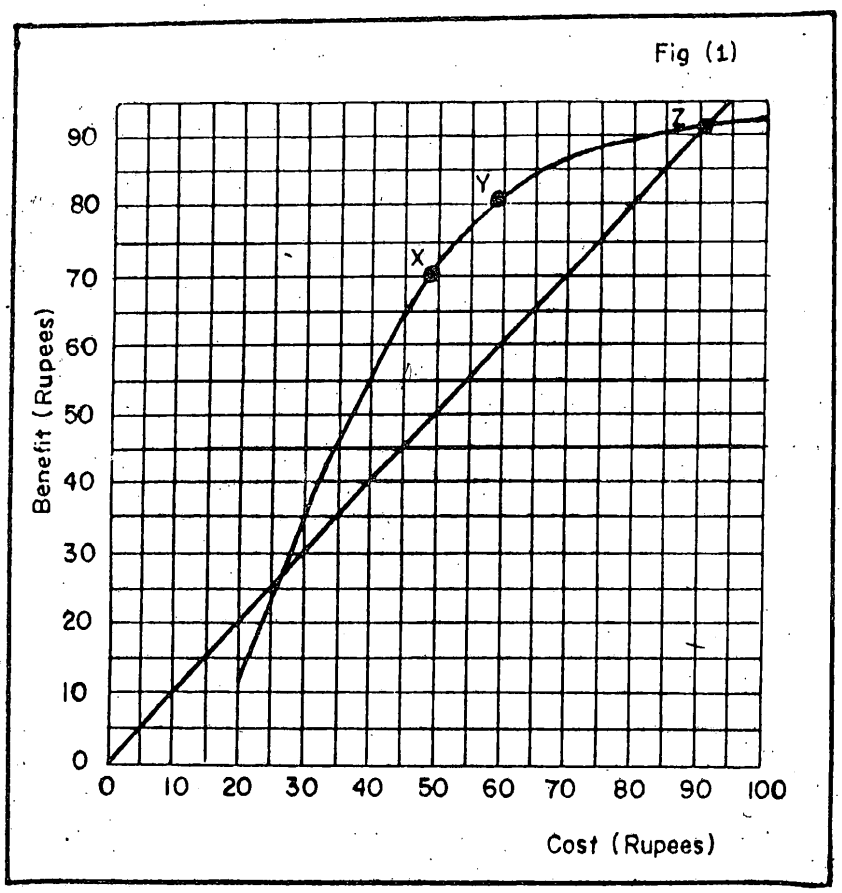
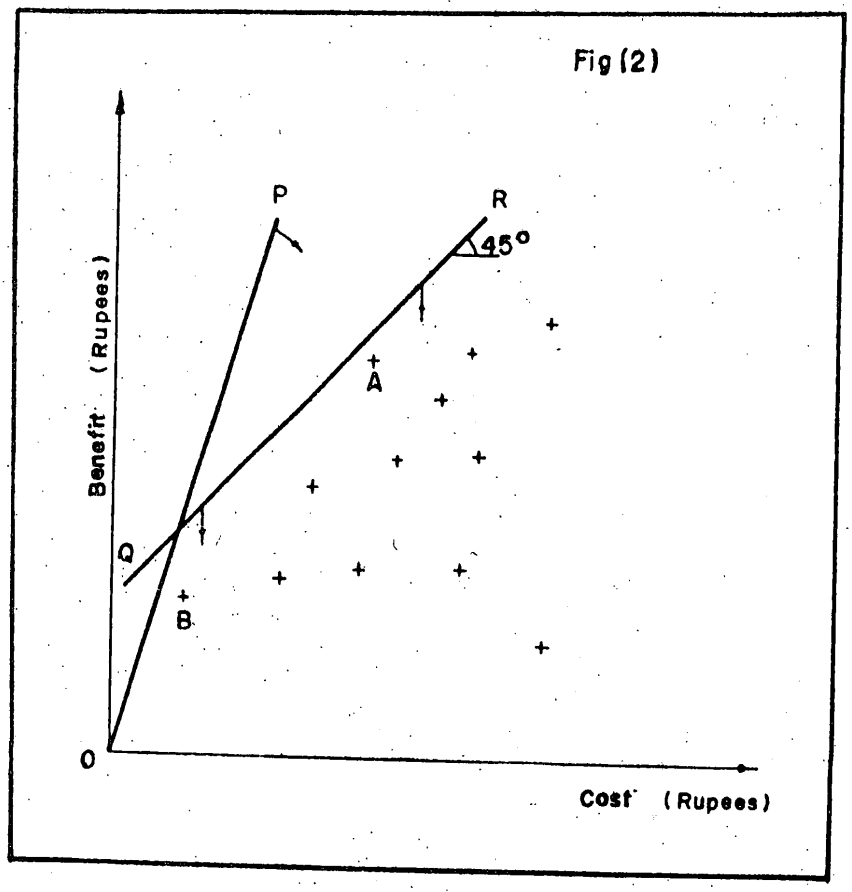

Benefit (Rupees)
90
80
70
60
50
40
30
20
10
0
0 10 20 30 40 50 60 70 80 90 100
Cost (Rupees)
X
Y
Z

Fig (2)


P
R
45°
A
Q
B
0
Benefit (Rupees)
Cost (Rupees)

Scale of work

At a particular dam site, for a particular size of the dam, the project costs and its benefits could be evaluated. These calculations could be repeated for different sizes of the dam at the same dam site, and for dams of various sizes at different sites. The object is to find the best size of the dam and also the best location for it economically. A series of values of benefits and the corresponding costs (either present worth or annual values) could be plotted as shown in Fig. (1). There are three important points X,Y,Z on the benefit-cost curve that are worthwhile discussing. At point X, even though the benefit/cost ratio is a maximum, the curve still continues to rise, which implies that for an additional increment of development, the incremental benefits would be higher than the incremental costs. It could thus be emphasised that the full economic benefits will not be achieved in the region of curve from X to Y. Similarly it could be argued that the incremental benefits would be lesser than the incremental costs in the range Y to Z. At the point Z, the total benefits of the project equal the total costs, and that for any scale of development larger than that of Z, the total costs will exceed the benefits. At the point Y, the excess of benefits over the costs would be the maximum, and also the incremental benefits would equal the incremental costs, thus giving the economic limit of the scale of work. It could be generally accepted that purely on economic grounds, the scale of the project or the size of the dam should be fixed at point Y.

Decision criteria in the economic comparison of competing projects

In making economic comparisons, it is worthwhile to note that they may be made only of similar or alike projects. It would be erroneous and misleading to compare unlike competing projects on the basis of their benefit/cost ratios in the case of national funding.

If we have a number of projects or dams on different rivers each corresponding to the size giving the maximum excess of benefits over costs, and if it is decided to rank them, one has to use the following criteria. Figure (2) gives a plot of benefits versus costs (present worth or annual values). If a radial line OP is made to rotate about the origin O in the clockwise direction starting from vertical, the very first point it would meet is the point B, as it is the project with the highest gradient in the plot corresponding to the highest benefit/cost ratio, and it could be accepted as the first dam to be built under government investments. In considering the national economic efficiency objective, if this point B has a benefit/cost ratio less than unity, no dam could be recommended for construction at any site.

Other than the highest benefit/cost ratio criterion, there is also the maximum benefit minus cost criterion in the comparison of competing projects. In dealing with the above, actual values of benefits and costs would also govern the decision on priorities. If we take two competing projects, one having a cost of Rs. 1 million and a benefit of Rs. 4 million against another project of cost Rs. 10 million and benefit Rs. 18 million, then even though the benefit/cost ratio of the former is 4 and that of the latter is 1.8, opting for the former would result in foregoing a Rs. 8 million gain for a mere Rs. 3 million. In fig. (2), if we assume a line QR at 45° to the horizontal to descend vertically, on to the cloud of points, the very first point to cross the line would be the point A which corresponds to the project of highest benefit minus cost value and it could be ranked as No. 1 and given the priority for construction.

Choice of Discount Rate

The choice of appropriate discount rate is a vital factor in the economic analysis of projects and it could be illustrated by citing different examples. If there are two competing projects with equal costs and of equal economic lives, but one has most of its benefits being drawn at the early stages of the project, while the other has most of it at the latter stage, then the former would prove to be having a higher B/C ratio at high discount rates, and the latter proves it to be at lower discount rates. Taking another example, if there are two competing projects with equal annual benefits and equal annual capital and operational costs, but one having an economic life span of 100 years while the other has only 50 years, then at higher discount rates the B/C ratios of both the projects would more or less be the same. But at a zero discount rate, the former would be double that of the latter.

In connection with the choice of discount rate, there was much controversy after the publication of "Proposed Practices for economic analysis of river basin projects" (Green Book) by the U.S. Inter Agency River Basin committee (1950), whose object was to set down standard procedures that are to be used by all agencies. Since then, a lot of literature has been written criticising some aspects of the report and suggesting improvements. Among various view points on the choice of discount rates, some were advocating that the rate should be that of risk free investments in private enterprise, as governments generally do not compete with private enterprise in highly profitable investments, but provide the essentials such as dams, roads, railways, harbours, hospitals and schools, which are not attractive to private enterprises. Many seem to agree with Marglin (1963) who suggests a "social rate of discount" where he states that the discount rate used for public investment projects such as dams, schools, Universities and harbours, should express the value which the present generation places upon the future development of the nation. That is the value placed by this generation upon the welfare of its children and grand children. If this generation does not have concern for its descendants, it could fix a high discount rate for government projects such as irrigation schemes, which will not be economical in the short run, and instead they can channel the available capital into the private enterprise development such as tourism, hotel industry, import of new cars, air-conditioners and other luxuries which would yield immediate benefits to the present generation. Because an irrigation project is generally assumed to last for at least 75 to 100 years, and that the benefits are drawn throughout the duration except for the small period of construction at the start, it is found to be beneficial in the long run, if a small discount rate is used.

Marglin (1963) argues that it is impossible to assess scientifically what value the present generation places upon the welfare of the future generation, and therefore the decision must rest on the parliamentary representatives of the present generation. Eckstein (1958) argues that because the water projects are long lasting and provide benefits to future generations, it is not correct to assume that a correct evaluation of the value of money is provided by the cost of capital to the present generation. He advocates a "social rate of time preference" which he defines as that rate at which majority of the population would choose as a guide to long term investment projects whose income streams would go to large masses of population at a later date.

The recommendations of Commonwealth Treasury, Canberra, Australia (1966), are either to (i) carry out the benefit

cost analysis using a range of rates, and to allow the decision maker responsible for the final choice to decide on the issue or to (ii) choose a rate and give reasons. In Sri Lanka, both the Ministry of Finance & Planning, the Central Bank of Ceylon, as well as the World Bank have used a discount rate of 10% for project evaluations in the past. For agricultural projects and settlement schemes which are of long term nature, where many of them have a lot of social benefits which are difficult to be quantified, a discount rate of 10% was considered appropriate. An advisor on Project evaluations to Ministry of Finance and Planning, Deepak Lal in 1978 has suggested a rate of 13% to be used in project evaluations. Nedeco in September 1979 has indicated that, because of the long term characteristics of the Mahaweli Programme, a lower rate of around 12% be chosen for economic analysis.

In Australia 3%, 5% and 7% discount rates have been used for Keepit Dam Feasibility Study in 1969, and 8.5% has been used for Dartmouth Project in April 1974. In Sri Lanka, 6% and 10% rates were used for Muthukandiya and Rambukkan Oya Irrigation Projects in 1974, 10%, 12% and 14% have been used for Kotmale Project in January 1978; 10% for Maduru Oya Project in November 1979; and 8% and 10% being used for the base case in Randenigala Project in February 1980.

Effects of inflation on Benefit-Cost analysis

The effect of inflation on benefits and costs could be ignored, as long as both are expressed at present day price levels. This is on the assumption that all benefits and costs are affected equally by inflation in future.

Period of Analysis

U.S. Inter-Agency River Basin committee (1950) in their "Green Book" recommended the period of analysis to be (i) the expected economic life, or (ii) 100 years which ever is shorter. The special Task Force of U.S. Water Resources Council, Washington (1969), specifies the period of analysis to be the lesser of (i) the period of time over which the plan can reasonably be expected to serve a useful purpose, or (ii) the period of time when further discounting of benefits and costs will have no appreciable effects on the design.

It could be noted that the period of analysis relates much to the discounting rate chosen, as the project would have no present worth of benefits after a certain period, even though the dam and the project would function physically for more than 100 years. For the economic study of Keepit Dam in 1969, a period of analysis of 75 years was used for the range of discount rates 3%, 5% and 7%, and for the Dartmouth Project, a period of 50 years at the discount rate of 8.5%. For the Muthukandiya and Rambukkan Oya Projects too, a period of 50 years was used for the rates 6% and 10%, while for Maduru Oya Project, a 40 year period has been considered at 10% rate, and for Randenigala, it has been 50 years at 8% and 10% discount rates.

Multi-objective planning approach (M.O.P.A.)

The Special Task Force of U.S. Water Resources Council, Washington (1970), introduced the basic principles of the new multi-objective approach to water and Land Resources.

The overall purpose of water and Land Resources Planning should reflect society's preferences for attainment of objectives defined below:

1. To enhance national economic development by increasing the value of the Nation's output of goods and services and improving national economic efficiency.

2. To enhance the quality of the environment by the management, conservation, preservation, creation, restoration, or improvement of the quality of certain natural and cultural resources and ecological systems.

3. To enhance social well-being by the equitable distribution of real income, employment, and population, with special concern for the incidence of the consequences of a plan on affected persons or groups; by contributing to the security of life and health; by providing educational, cultural and recreational opportunities; and by contributing to national security.

4. To enhance regional development through increases in a region's income, increases in employment, and improvements of its economic base, environment, social well-being, and other specified components of the regional objective.

Applicability of M.O.P.A.

The multi-objective approach covers a wider spectrum of planning area and gives a methodology of optimising the use of available water and land resources by considering not only the national and regional perspectives of economic efficiencies, but also looks into the environmental and the social well-being aspects.

In the Sri Lankan context, this multi-objective planning approach would be very much relevant and applicable. This would be more appropriate as most of the projects, with pure irrigation benefits would fail to prove its worthiness at higher discount rates and also as the country needs a lot of development in other aspects as well, being one of the poorer countries in the world. The general uplift-ment of living conditions, in undeveloped areas, a good road network in place of foot paths and cart tracks, the availability of basic human needs such as hospital facilities, shopping centres, market places, schools, play grounds, post offices etc., and the regional development would certainly account for, and fill up the deficits if at all, of the national economic efficiency objective. The concept of Benefit/Cost ratio, naturally leads itself to a neat mathematical calculation, merging to a definite answer. This normally dominates the decision to the detriment of several factors which are in reality more important to the human race, but cannot be quantified so neatly and definitely. The Benefit-Cost Analysis is undoubtedly a useful tool, but it should be used only as an aid to decision making and not as the final answer. This broader perspective would generally enhance the convincing of decision makers and the financial agencies who would opt to fund the project. Further, the project costs could even be shared by the local government bodies and the District Development councils of the region concerned, and the social service organisations such as the Social Services Department etc., alongwith the Central Government, in the case of budgetting the project.

The Sri Lankan parliamentarians can be stated to have followed this multi-objective approach in their decision to dredge and build a lake around the island on which the new parliament was built at Jayawardenapura. On the basis of national economic efficiency objective only, the Benefit/Cost ratio of it would be practically zero, as the national export income would not be affected by the lake, except for few tourists from overseas who would visit it. But it enhances the beauty of the newly built city Jayawardenapura, and people would agree that it has a national value, even though it cannot be quantified in Rupees and cents. If the equivalent annual capital and operating costs of the lake is so many* Rupees per annum, then the parliamentarians in effect would have assessed the environmental

IMPACT - INCIDENCE MATRIX

GROUPS IMPACTED	IMPACTS			
	DIRECTLY ESTIMATED (IN Rs.)	INDIRECTLY ESTIMATED (IN Rs.)	ESTIMATED QUANTITATIVELY (NOT IN Rs.)	ESTIMATED QUALITATIVELY (BY DESCRIPTION
NATIONAL				
REGIONAL				
SOCIAL WELL-BEING				
ENVIRON-MENTAL				

FIGURE 3

benefits as equal to that sum, which illustrates a form of environmental objective concept.

Impact-Incidence Matrix

The Impact-Incidence Matrix could be referred to as a tabular form presenting the decision maker with information on the distribution of benefits and costs of the system (Fig. 3).

The matrix could have columns pertaining to benefits and costs of different categories such as those which could be computed in Rupee terms as direct and indirect impacts, those which could be quantified but not in Rupee terms, and those which could be described qualitatively. In an irrigation project, the direct benefits would be the agricultural production while the indirect would be growth of secondary industries, inland fishing etc. which could be evaluated in Rupees. The quantifiable amounts (not in Rupees) would be the number of people affected, the acreages getting submerged, the number of lives and property lost by recurrent flooding etc. The qualitative aspects could

be referred to in the environmental and the living conditions. In connection with the environmental aspects, the disturbance to an elephant corridor in the area, the places of historical and cultural interest that are being innundated by the formation of a reservoir, the number of tourists that could be expected annually to visit the beauty of the site could come in.

Thus the Impact Incidence Matrix would permit the analyst to summarize different measures of effectiveness of a project on a simple table. It also would give a broader view of the entire project which would make the decision makers, to go for a better decision in these public investment projects.

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