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METHODOLOGY FOR THE USE OF COST-BENEFIT ANALYSIS IN ENVIRONMENTAL INVESTMENT PROJECTS A REVIEW OF THE IZMIR BAY ANALYSIS

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1. ENVIRONMENT AND COST-BENEFIT ANALYSIS

General observations

Environment policies are developed in response to public demand and they produce partly private and partly public goods. Public goods have various characteristics which they possess to differing degrees. For example a beautiful landscape can be enjoyed by everybody; it is a pure public good; sewerage services are available only to those who pay for them but they also contribute to public health in general even those who are not in the sewerage system benefit from them.

The important point about environmental public goods is that they are similar to public goods produced by health and educational expenditures and are difficult to evaluate in economic terms. Economic evaluation is however important because the allocation of public funds is based partly on the benefits these funds can produce; at the same time governments also take into account public demand for environmental goods and services as it is expressed through the political process.

Consequently requests for better evaluation of environmental expenditures are becoming more and more frequent both at the national and at the international level. Such assessments are needed between environmental and other public projects and also between environmental projects to define priorities. As available funds are always limited, choices have to made and such choices can be made rationally only with the assistance of cost-benefit or similar techniques. The results of such evaluation techniques are only one of the factors that need to be considered, but certainly the most important one for economic efficiency.

The obvious necessity for evaluation of environmental effects in public and private projects has been evident for sometime - in fact at least since the early 1960's this was a widespread concern - when they produced significant environmental benefits or costs together with main output of the project. To illustrate this point an irrigation project is a good example. A purely economic evaluation required positive net benefits based on agricultural benefits (output) less cost of production including the cost of a dam and delivery cost of water, calculated over a sufficiently long period; often some other macro-economic benefits, such as job creation, were also taken into account.

Such public/private irrigation agriculture projects usually produced significant environmental effects: loss of land and landscape due to the construction of dams, soil erosion and salination were examples of environmental losses; recreational benefits of the dam, and ecosystems created were examples of environmental benefits. These losses and gains were not included in the assessment and this could have led to incorrect results and therefore wrong decisions.

Today it is widely accepted that environmental costs and benefits should be taken into account in both private and public investments and associated expenditures. In the case of private projects Environmental Impact Assessments are required and the shape and the execution of the project are adapted to conform with those requirements. If after these changes the financial analysis, a 'cost-benefit' for private projects, shows that the project is not profitable then it is abandoned or often the environmental requirements softened. Investments undertaken to reduce pollution are treated as costs and their benefits are not taken into account by business except if they simultaneously contribute also directly to output of the enterprise.

The situation with public projects is different. In most countries large investment projects proposals need to be submitted for approval with a cost-benefit analysis, which in principle should take environmental costs and benefits into account either by quantifying and valuing them or in less specific forms. If the objective of the project is a marketable commodity, such as water, electricity, wood products then environment appears as a byproduct. In other cases better environment is the major output of the project such as with sewerage systems, land conservation, and protection of wetlands. There are still other cases where government policies aiming at environmental improvements, particularly pollution control, need to be evaluated. Such a policy might require that all cars should have catalytic converters for pollution control and in this case the government might wish to evaluate to nationwide costs and benefits of the policy over the longer term.

This short discussion indicates that there is a considerable scope for cost-benefit analysis in the environment field. The environmental community is divided on this issue. Environmental economists have been arguing for a wider use of cost-benefit analysis for environmental and natural resource systems suggesting that this would lead to more rational environmental and resource management policies. Others argued that environment is either too difficult or too precious to be expressed in monetary terms., and such an approach would lead to a relative undervaluation of the environment. It has been also argued that cost-benefit evaluation can not be applied in its conventional form in countries where a large section of population live in a subsistence economy.

Cost-benefit analysis technique

The most general way of expressing cost-benefit analysis that takes into account also the environment is by the following simple equation:

$$NVP = Bd + Be - Cd - Cp - Ce$$

where NVP = net present value
Bd = direct project benefits
Be = external (and/or environmental) benefits
Cd = direct project costs
Cp = environmental protection costs
Ce = external (and/or environmental) costs

The traditional development project evaluation takes into account only the direct project benefits and direct project costs. The expanded approach above includes the external and environmental benefits, including those from environmental protection, and the cost of external and/or environmental damages and of environmental protection measures. There are three steps involved in this process: identification of costs and benefits; their quantification; and their valuation. Each of steps require careful analysis and some relatively new and untried methodologies and assessments. Extreme care is needed that all effects are identified and that double counting is avoided.

All items on the right hand side of the equation are to be discounted in present values. The process of discounting is simply compound interest worked backwards. In general the present value of any future receipt or expenditure is calculated by multiplying it by $1/(1 + d)t$ where 100d is the percentage rate of discount and t is the number of years ahead. By this process of discounting expenditures and receipts, costs and benefits, which occur at different times throughout the construction and operation of the project are all revalued to make them comparable to present expenditures and receipts. Thus, the rate of discount becomes a crucial element in the evaluation.

2. THE CASE OF IZMIR

Objectives of this report

The main objective of this report is to review the methodology used in the "Preliminary Study on the Costs and Benefits of Measures for the Reduction of Degradation of the Environment from Land-Based Sources of Pollution and Activities in Coastal Areas of the Bay of Izmir" referred to hereafter as the 'Izmir Study'. That study was carried out at an extremely short notice and consequently subject to a number of qualifications and limitations. During the meeting, 9-13th December 1991, of government designated experts in Nairobi a number of suggestions have been put forward to be considered for inclusions in future cost-benefit analyses of similar type.

This review will describe the methodology used in the 'Izmir Study" and propose improvements concerning the qualifications and limitations specified and will put forward changes to take account of the suggestions at the Nairobi meeting particularly those concerning developing countries.

The 'Izmir Study'

The purpose of the preliminary 'Izmir Study' was twofold: firstly to demonstrate the feasibility of the application of cost-benefit analysis to the region of Izmir Bay; secondly to compare the costs and benefits that are likely to occur over the next 35 years from the restoration of the Bay.

From the viewpoint of economic and environmental analysis the Metropolitan Area and the Bay of Izmir are well definable regions. Even though certain activities contributing to the pollution of the Bay are outside the Metropolitan area and cannot be influenced by the proposed control measures these are of minor importance.

Three factors facilitated greatly the analysis:

i) for the major pollution control measure a single investment project could be identified; the construction of a sewerage system for the treatment of waste water for the whole of the Greater Metropolitan Area would restore and maintain the Bay well into next century;

ii) without the construction and operation of the sewerage system the Bay's ecology is likely to collapse in the near future with dramatic economic and environmental consequences for the region.

iii) considerable amount of physical and economic data were available for the Bay area combined with a great deal of ancillary information.

Identification of costs and benefits was the first and perhaps the most important phase of the analysis. This was only possible with the help of lot of additional information available through considerable amount of prior research. It was also possible to combine scientific and economic understanding of the area in such a way as to elicit the relationships that are likely to emerge under certain conditions in the future. This was fundamental for the identification of likely benefits that could emerge from the restoration of the Bay; or putting it the other way around for the recognition of potential losses from the collapse of the Bay.

Table 1. shows the process of identification used. The following steps were followed:

i) identification and listing of the main pollutants entering the waters of the Bay; the pollutants are listed in generic terms in the table but it was possible to identify them by individual pollutants and in quantitative terms; such detail is essential to the evaluation of effects and the subsequent quantification of losses.

ii) the second step was tracing the main sources of pollution, such as domestic, industrial, agricultural to be able to specify control action and evaluate cost; in this case the control action was in fact predetermined in the form of a sewerage system for the Greater Metropolitan Area.

iii) the most important element in the identification process was such definition of the effects that pointed the way to redefining the impacts in terms of losses/benefits; therefore these were described in some cases as quality changes in the environmental media, such as water quality of the Bay with reference to certain prescribed standards (bathing water quality); or residues in the fish population; or direct impact on human health; the assumption taken here was crucial to the whole analysis, namely that unless immediate reduction in discharges is taken the water quality in the Bay will turn critical and will collapse by 1995.

iv) the next step was to quantify actual and potential losses in physical terms today and over the whole life of the project, defined as up to 2025; given the crucial assumption about the collapse of the Bay this meant that increasing number of tourists were staying away, fish population would die, recreation activities would cease and salt production would be abandoned.

v) control actions to stop further discharge of effluents into the Bay were identified as construction of a sewerage system for the Greater Metropolitan Area including treatment facilities and possible deep sea outfalls; stream control; industrial waste treatment and low waste technology; it was feasible to cost all these control measures with considerable degree of accuracy and provide a time table for them.

The System to Save Izmir Bay

The Economic Costs

As explained above the principal measure for the protection of the Bay is the sewerage system for the Greater Metropolitan Area of Izmir. However as the specification for the project was "reduction of degradation of the environment from land based sources of pollution and activities" other pollution control measures also had to be considered. Many such additional measures are needed and only two were included in the calculation: stream control and industrial control. 'Stream control' measures are needed to minimise the inflow of pollutants and sediments brought down by the different water flows into the Bay. 'Industrial control' is treatment of pollutants at the plant level required before discharge into the sewerage system or directly into the Bay.

Table 2. presents the different pollution control costs, capital and operation and maintenance, for the whole life of the project. This table represents the methodology to be used for the presentation of all the costs involved for a cost-benefit evaluation of projects. A number elements are missing here and need to be included for a fully fledged analysis.

TABLE 1

PRIORITY POLLUTANTS IN THE IZMIR BAY

POLLUTANTS	SOURCE	EFFECTS	LOSSES DUE TO POLLUTION	CONTROL ACTION	BENEFITS DUE TO POLLUTION CONTROL
Sewage	Domestic and Industrial Effluent	Bathing water quality, fisheries, human health	Tourism, sea food, recreational amenities, salt production	Domestic and industrial treatment, outfalls	Increased recreation, improved health and quality
Nutrient (nitrate and phosphate)	Domestic and industrial effluent, streams and agriculture	Eutrophication, red tide, bathing water quality, human health	Tourism, recreation amenities, fisheries, salt production	Treatment, stream control, outfalls	Increased recreation, tourism, land quality
Sediments	Dredging, stream runoff industrial sewage	Bathing water quality, eutrophication, human health	Tourism, harbour activities, recreational amenities	Stream control	Increased recreation, tourism, health-food quality
Metals (Chromium, Mercury and cadmium)	Industry, e.g. tanneries, domestic effluent, streams	Food quality, effect on microorganisms	Food quality, tourism	Industrial waste treatment, low waste technology	Improved food quality and water quality

Source: Izmir Case Study

TABLE 2

IZMIR BAY: COST OF POLLUTION CONTROL

Year	Investment costs								Operating & maintenance	Total	Discount.
	Pump	Tunnels	Sewer	Treatment	Land	Stream control	Industrial control	Submarine outfall			
1988	13	21.6								34.6	40.4
1989	13	21.6								34.6	37.4
1990	13	21.6	10		38					82.6	82.6
1991	13	21.7	10	40			25			109.7	100.9
1992	13	21.7	10	40			25			109.7	92.8
1993		21.8	12	40		24	25			122.8	95.5
1994			12	40		24	25	30	75	206.0	147.5
1995			11	40		24	25	30	75	205.0	135.1
1996						24	25	30	75	154.0	93.3
1997						24	25	30	75	154.0	93.3
1998						24	25		75	124.0	67.7
1999									75	75.0	38.5
2000									75	75.0	35.5
2001									75	75.0	32.6
2002									75	75.0	30.0
2003									75	75.0	27.6
2004									75	75.0	25.4
2005									75	75.0	23.4
2006									75	75.0	21.5
2007									75	75.0	19.7
2008									75	75.0	18.2
2009									75	75.0	16.7
2010									75	75.0	15.4
2011									75	75.0	14.2
2012									75	75.0	13.0
2013									75	75.0	11.9
2014									75	75.0	11.0
2015									75	75.0	9.3
2016										75.0	8.6
2017										75.0	7.9
2018										75.0	7.3
2019										75.0	6.7
2020										75.0	6.2
2021										75.0	5.2
2022										75.0	4.8
2023										75.0	4.4
2024										75.0	4.1
2025										75.0	3.7
Total	65	130	65	200	38	144	200	120	1650	3362.0	1326.1

Source: Izmir Case Study

The Economic Benefits

The important advantage of the Izmir Study from the cost-benefit analysis viewpoint was that a proportion of the environmental benefits could be translated into economic benefits. In fact the economic benefits are the losses avoided by the restoration of the Bay. This is not always the case with environmental benefits, indeed in many cases the benefits are not at all market type benefits as is the case in Izmir.

In Table 3. a distinction is made between *economic (output) benefits* and *health benefits*. Economic benefits are valued with prices provided by the markets: tourist expenditures, prices of fish, salt and drinking water, cost of corrosion control and expenditure on recreation. Health benefits are calculated on the estimated value of human life based on life earnings over the period of a statistical life.

In contrast to the costs estimated, which can be regarded as relatively firm, the benefit estimates are based on a number of assumptions about relationships between environmental improvements and behaviour, future economic trends, stability of price relativities and future population growth in the area. In the case of health benefits other crucial assumptions were needed: the relation between health and pollution, valuation of human life and valuation of life time earnings. To indicate the range of uncertainties involved in this estimation process two scenarios were provided: a conservative and a progressive. Only a few assumptions were changed to take account of the possibility of larger growth in the number of tourists.

A number of additional possibilities should be explored to give decision makers a better understanding of the sensitivities of the various assumptions and perhaps to tailor the project accordingly: either to increase the benefits or to minimise the costs.

Environmental Costs and Benefits

The question of environmental damage associated with the construction of the sewerage system and other clean-up measured have not been evaluated. The only known possible environmental effect so far is the possibility of strong odor from the treatment plant which under certain climatic conditions could effect the built-up areas of Izmir. Further work is needed on this and possible other environmental costs.

Environmental benefits, apart from those which can be designated as economic benefits, are shown in Table 3. as ecosystem benefits: the value and enjoyment of living on the shores of a clean Bay and the value to the society as a whole of the existence of a bird sanctuary. A valuation has been put forward for the general value and enjoyment of the a clean Bay and its ecosystem based on similar coastal bays and estuaries in other parts of the world. One valuation technique available is land values suitable adjusted for differences in per capita incomes. This is a questionable technique because other factors apart from water quality and ecosystems enter into land values: business and employment opportunities, urban environment in general, political stability in the region to mention a few. Clearly many alternatives could explored for valuation techniques.

The valuation of the bird sanctuary, apart from its recreation value, has not been attempted here but again various techniques exists and can be attempted.

The more general question, whether to include purely ecosystem benefits into the cost-benefit results has not been answered either. In the final summing-up of the result they were excluded. This would not satisfy those who are looking at the problem mainly from the environmental point of view and leaves a major question open for further consideration. This is particularly important for cases where the benefits are mainly in terms of pure, ecosystem environmental benefits.

TABLE 3

BENEFITS/AVOIDED LOSSES FROM THE RESTORATION OF IZMIR BAY FOR 1990

ECONOMIC BENEFITS	($ million, 1990 prices)	
	Conservative scenario	Progressive scenario
1. Tourism	45	45
2. Dredging	2	2
3. Fishing-commercial	5	5
4. Salt Production	5	5
5. Underground water	2	4
6. Corrosion	0.5	0.5
7. Recreation		
-Bay	4	19
-Bird Sanctuary	0.5	0.5
HEALTH BENEFITS		
1. Water Use	0.5	1
2. Dredging	1	3
TOTAL (Economic + Health)	**65.5**	**85**
ECOSYSTEM BENEFITS (*)		
1. Bay of Izmir 2. Bird Sanctuary	10,000	

(*) Non-uses or existence values.

Source: Izmir Case Study

The Missing Elements from the Izmir

From the short discussion it is possible to list some of the elements which were, for shortage of time, not considered in the Izmir study. It is also possible to add other missing elements that emerge from either the cost-benefit methodology or from the special problems of environmental questions.

The missing elements are:

i) additional environmental measures needed to deal with all land based sources of pollution and activities;

ii) alternative ways of quantifying the economic benefits;

iii) alternative ways of valuing the economic benefits;

iv) further investigation of possible environmental damages;

v) alternative ways of valuing environmental damages.

Other elements generic to cost-benefit analysis to be explored for the Izmir study:

vi) macro-economic implications;

vii) the time horizon;

viii) discount rates;

ix) identification of costs and benefits;

x) treatment of costs;

xi) valuing benefits;

xii) treatment of risks;

xiii) distributional aspects.

A number of these questions are treated in some detail in the next section (III).

3. SPECIFIC ISSUES IN ENVIRONMENTAL COST-BENEFIT ANALYSIS

This section will concentrate some of the generic issues of cost-benefit analysis but will consider also certain issues specific to the environment: macro-economic context, time horizon, discount rates, treatment of risks and distributional aspects. These will be discussed with reference to the Izmir study.

Macro-economic context

Most projects, for which cost-benefit analysis are undertaken, are regional projects; that is they are situated in a certain region of a country. However they have to be placed in a macro-economic context; this implies two elements: the analysis has to be carried out in the national economic framework and secondly the project has certain macro-economic consequences.

The National Economic Framework

i) the Izmir case study considered only the regional benefits; the question, would the tourists come to Turkey anyway irrespective the clean Bay of Izmir, was not considered; this could be an important consideration for some projects and a comparison might have to be made from the economic point of view with other projects which might be undertaken in the public sector;

ii) the Izmir study was conducted in constant 1990 prices; are 1990 prices and inflation rate such that the constant price assumption is valid for the period in question? Everything was expressed in $US for costs and benefits, based largely on world market prices; the consistency of the assumptions underlying these figures has to be carefully examined to avoid inconsistencies in the assumptions; it is particularly important that the stability of relative prices, which is under great stress in Turkey over a long period of high inflation, is plausible or changes in these relativities need to be introduced; while these considerations are not highly relevant to Izmir they can be important for developing countries in the Mediterranean region.

Macro-economic Impacts

i) The project could be so large that it would have a major impact on the economy of the country. This is not the case of Izmir but has been the case in many developing countries, such as a multi-purpose development of a large river basin; in such a case the overall national economic effects would also have to be incorporated into the analysis.

Time Horizon

Time horizon of a project has also two aspects: when should the project be undertaken and how long should be the period of analysis?

i) the result of the cost-benefit analysis can depend on the starting date of the project; for example if the benefits start to accumulate to a significant extent only 5 or 10 years hence, it might be more beneficial, other things being equal, to postpone the starting date; in the case of Izmir a five years' postponement would have provided larger benefits but also greater losses to the ecosystem; this is one aspect that would require further analysis.

ii) the period of analysis depends partly on the life time (time horizon) of the project and partly on the discount rate used; the life of the project is the life of the capital equipment which can however be replaced gradually overtime and appears as further cost; in the case of Izmir the sewerage system has a very long life with some replacement cost involved and therefore this fails to provide a time horizon for the project; concerning the discount rate the larger is the rate the quicker will the benefits be reduced to zero or close to it; in the case of Izmir the 8 per cent discount rate used reduced the cost and benefits occurring in the 2025 (after 35 years) to 5 per cent in 1990 discounted values; it is clear that after that year any further addition would make little difference to the result; with 2 per cent discount rate the time horizon would be much longer.

Discounting

Discounting is the cohesive factor in cost-benefit analysis; the mechanism whereby benefits and costs that occur at different points of time can be compared and weighted.

There are certain preconditions to make this comparison through discounting a valid exercise. One of them is that all costs and benefits are expressed in common monetary units: in the case of the Izmir study in $ US. Unless this is done no valid comparison can be undertaken. To the extent that some costs and benefits cannot be quantified or valued the cost-benefit analysis is incomplete. However this will not necessary invalidate the result; for example in the Izmir case study ecosystem benefits (although partially assessed) were not included in the final result, but even without them the benefit/cost ratio was positive. The second precondition is the time preference of consumption: cost-benefit analysis is carried out in constant prices as was the case in Izmir. But there are people who argue that in future the relative price of environmental goods, because of their future scarcity will increase and therefore this should be incorporated in the analysis. Using this method still fails to resolve the issue of future generations. Intergeneration equity is important in environmental projects. In the case of Izmir the loss of the Bay would effect both present and future generations and it was possible to solve the issue to some extent by demonstrating the magnitude of the loss over a 35 years' period.

The question of the **discount rate** is a major unresolved issue but there is agreement on several factors and they have been incorporated in the Izmir study:

- only one discount rate was used in the whole analysis; however the exercise should have been repeated, sensitivity analysis carried out, with different discount rate each time;

- the discount rate should not reflect the rate of inflation.

A number of approaches have been used by economists to determine the discount rate for economic analysis. These are: **the opportunity cost of capital, the cost of borrowing money, the social rate of time preference.** In practice at any one time there might not be such significant differences between these rates that they would produce contradictory results. The view taken for the Izmir study was that the **opportunity cost of capital,** in Turkish situation and with a substantial proportion of the money to be provided by World Bank loans, is the appropriate rate. As mentioned above a sensitivity analysis, using different rates, should be undertaken to test the analysis and strengthen the results.

Presenting the Results

The so called cost-benefit approach is in fact a broad term covering various methods of calculations and presentations using the same time horizon. Table 4. provides a comparison between three measures of present value: **net present value, internal rate of return and benefit-cost ratio.** In the Izmir case study the third approach, the cost-benefit ratio, was used but with no alternatives to achieve the objectives that was specified as "Reduction of Degradation of the Environment from Land-Based Sources of Pollution and Activities in Coastal Areas of the Bay of Izmir". To complete the case study it might be necessary to consider additional approaches and extend the analysis.

Identification of Costs and Benefits

In an economic analysis the identification of the costs and benefits should be relatively simple: capital outlays, operating costs overtime, direct benefits and perhaps some indirect benefits. This can then be carried out for various alternative investment options for the same project. The identification of costs and benefits become more complex when environmental costs and benefits are taken into account, what should be the case in all major investment project today. Perhaps even more difficulties are encountered when purely environmental projects are analysed such as the Izmir study.

TABLE 4

COMPARISON OF THE THREE MEASURES OF PRESENT VALUE

	Net present value	Internal rate of return	Benefit-cost ratio
Selection or ranking rule for:			
Independent projects:			
No constraint on costs	Select all projects with NPV > 0; project ranking not required	Select all projects with IRR greater than cut-off rate of return; project ranking not required	Select all projects with B/C > 1; project ranking not required
Constraint on costs	Not suitable for ranking projects	Ranking all projects by IRR may give incorrect ranking	Ranking all projects by B/C where Ce is defined as constrained cost will always give correct ranking
Mutually exclusive projects (no constraint on costs)	Select alternative with largest NPV	Selection of alternative with highest IRR may give incorrect result	Selection of alternative with highest B/C may give incorrect result
Discount rate	Appropriate discount rate must be adopted	No discount rate required, but cut-off rate of return must be adopted	Appropriate discount rate must be adopted

Source: Adapted from Gittinger (1982) from Dixon and Hufshmidt

It was fortunate that two different disciplines and data bases could have been readily combined: the scientific data and understanding combined with good local knowledge allowed to apply readily economics, including environmental economics, to prepare the analysis. Neither disciplines alone would have sufficed. It was also fortunate that the intellectual climate created a mutual respects and the recognition for the need to combine knowledge and experience.

It is not always the case that such understanding exists and such integration of disciplines is today regarded as an essential part of the integrated management process that is needed for efficient environmental management. Such arrangements should be made prerequisite to cost-benefit analysis with any significant environmental content.

Treatment of Costs

All the costs estimated used in the Izmir analysis were taken or calculated on conventional accounting basis but in principle all in constant 1990 prices. There are various objections to the use of accounting prices but they are not easily overcome. The basic concept is that costs should represent economic not accounting or financial costs.

The reasons for the differences are: purchase taxes distort the prices of inputs and capital costs; import prices are not reflecting the real costs because of import duties and distorted exchange rates; wages costs used are not representing the cost of labor in the economy; costs of the project are in different ways subsidised by the state. In addition the costing might not be representative of the base year of the project and the different cost items have been prepared at different dates.

Depending on the circumstances these differences between accounting and economic costs could make significant changes to the results of the cost-benefit analysis. However in the Izmir study no adjustments were made to the cost estimates provided by the various contractors for the sewerage system and industrial treatment costs were based on international prices. This aspect of the Izmir study needs a serious reexamination. Similarly the possible environmental costs associated with sewerage system and other measures need to be assessed.

Treatment of Benefits

As referred to earlier, different types of benefits might be evaluated through cost-benefit analysis: economic benefits, as used in the Izmir study to justify environmental expenditures; and/or environmental benefits. Treatment and problems associated with these two types of benefits are different. In the case of economic benefits the same problem of differentiation between accounting prices and economic prices as exists for valuing costs. Particularly important are here the possible subsidies which affect benefits and overvalue them. On the whole the treatment of economic costs and benefits should be consistent. This is another aspect of the Izmir study which needs to be reexamined.

The quantification and valuation of purely environmental benefits is the major problem in the use of cost-benefit analysis and until recently it practically prohibited its use for environmental purposes. However in recent years considerable advances have been achieved in this field but international concensus is still lacking as to the full acceptability of the various valuation methods.

Table 5. presents a summary of the valuation techniques in use together with their main areas of application. Table 6. presents an assessment of the feasibility and usefulness of the techniques. Some of the methods rely on comparisons with prices or wages operating in the free markets or on cost of measures governments are prepared to take or individuals prepared to pay to avoid potential damages.

TABLE 5

A MATRIX OF BENEFIT TECHNIQUES BY ENVIRONMENTAL SECTOR

Pollution	Type of effect	Benefit impact	Benefit estimation technique						
			Hedonic property	Hedonic wages	Travel cost	Contingent valuation	Dose-response	Other techniques	Comment
AIR POLLUTION									
1. Conventional pollutants (TSP, SO_2, NO_2)	Respiratory illness	WLD, RAD, medical expenses, suffering	O	L	O	X	X	Health capital model	
	Respiratory death	Death	L	X	O	O	X		Some wage valuation
	Aesthetics	Visual, sensory	X	L	O	X	O		experience
	Recreation	Visits especially to forests	O	O	X	X	O		
	Materials	Maintenance/repair	O	O	(?)	(?)	X		For historic monuments
	Vegetation	Crop losses	O	O	O	O	X		Forest reclamation
WATER POLLUTION									
1. Conventional pollutants (BOD, etc.)	Recreation:fishing, boating, etc.	Visit behaviour	L	O	X	X	O		
	Commercial fisheries	Stock losses	O	O	O	O	X		
	Aesthetics	Turbidity, odor, unsightliness	X	O	L	X	O		
	Ecosystem	Habitat and species loss	O	O	O	X	X		
2. Trace concentrations	Drinking water	Illness, mortality	O	O	O	(?)	X		
	Fisheries	Stock	O	O	O	O	X		
TOXIC SUBSTANCES									
1. Air (benzene, PCB, pesticides)	Illness and mortality	WLD, RAD, medical expenses, suffering (?)	X	O	X	X			
2. Hazardous chemicals to land	Aesthetics	Unsightliness	X	O	O	X	O		
	Ecosystem	Health, anxiety, ecosystem losses	O	O	O	X	X		
RADIATION	Illness, mortality	WLD, RAD, lives lost	(?)	X	O	L	X		
MARINE POLLUTION									
Oil, radioactive substances, sewage	Aesthetics, swimming	Unsightliness, visit behaviour, illness, fish stock losses	(?)	O	X	X	X		
NOISE	Nuisance	Annoyance	X	O	O	X	L		

X = Used technique
O = Non-usable technique
L = Very limited application exists
(?) = Not developed but possible
WLD = Work loss days
RAD = Restricted activity days

Source: OECD

TABLE 6

ASSESSMENT OF BENEFIT ESTIMATION TECHNIQUES

	Technique				
	Hedonic property prices	Hedonic wages	Travel cost	Contingent valuation	Dose-response/ damage cost
"Physical" data problems	No	Yes	Yes	No	Yes
Benefit function?	Yes	Yes	Yes	Yes	Assumed
Sophistication	High	High	High	High	High
Relation to Behavioural Theory	Yes	Yes	Yes	Yes	No
Problems	Sensitivity to model-specification			Hypothetical bias	Sensitivity to model-specification
	Free markets important		Travel time cost measurement		
			Influence of site substitutes	WTP/WTA disparity	
Special features	Main technique for workplace		Use limited to recreation	Can cover existence	Only method for many issues
	Can be cross-checked with contingent valuation			Only method for many issues	Requires separate valuation technique

*WTP = Willingness to Pay
WTA = Willingness to Accept

Source: OECD

It is not the objective of this paper to describe and evaluate valuation techniques. However it is worthwhile to refer to the "hedonic property price" approach which was used in the Izmir study.

Hedonic property price valuation (a direct valuation) technique is based on the recognition that the value of a piece of land is related to the stream of benefits to be derived from that land. Access to workplace, environmental facilities and environmental quality of the neighborhood, a view on a landscape which accrue to the person who has the right to land, are the examples. With different environmental attributes there will be differences in property prices and the hedonic approach, by using different statistical techniques, allocates the differences. Firstly, it identifies how much of a property value differential is due to a particular environmental difference between properties; and secondly, it infers how much people are willing to pay for an improvement and what the social value of the improvement is. It is used extensively in aesthetic and nuisance valuation. The identification of a property price effect due to difference in pollution levels is usually done by means of multiple regression technique in which data are taken either on a small number od properties over a period of years (time series) or on a large number of properties at a point in time (cross section) or on both.

In the case of Izmir Bay the environmental effects of the Bay's pollution were a combination of aesthetic, nuisance and ecosystem degradation; for sake of simplicity they were labelled 'ecosystem values'. Property prices were used for valuation, adjusted for income differentials. However it was a highly simplified method in comparison to the hedonistic approach set out above. Further work is required to strengthen the property price valuation used in the case study in the form of time series or cross section analysis.

Treatment of Risks

All projects whether purely commercial, mixed or exclusively environmental have a certain degree of risk or uncertainties associated with them. Whether this becomes a problem in evaluations of projects and programmes depends very much on specific circumstances and the kind of decisions that must be undertaken.

The terms risk and uncertainty are often used loosely to indicate a failure to predict the occurrence or consequences of initiating actions or events. The processes may be of natural origin, as in the case of earthquakes, floods, cyclones and ecosystem behavior, or anthropogenic. Risk and uncertainty associated with human activity may involve impacts of technology, environmental pollution, transportation systems and ecosystem management. In project or programme appraisals any of these factors may be present, individually or in combination.

In economic analysis there is a distinction between risk and uncertainty. the risk of a particular type of effect or event can be defined in terms of its magnitude and probability of its occurrence. Where different levels of effect are possible, each with its own probability of occurrence, risk may be specified as probability distribution.

Uncertainty exists when the probability of an effect or event is unknown. This encompasses a lack of knowledge about the potential magnitude of effect, since even large values may occur at some probability, however small. If the probability cannot be specified, the range of possible values may be unbounded. The greenhouse effect is an example of this kind.

In the case of Izmir a very high level of risk (high probability) was assumed for the total breakdown of the Bay, if the sewerage system is not constructed by 1995. The probability of this risk was not calculated, not because of a great deal of uncertainty but, because of lack of time.

There are certain accepted techniques in 'risk management' approaches:

i) analysis of initiating events and pathways of effect;

ii) specification of the probability distribution surrounding each type of damage effect;

iii) estimation of the economic value of each impact;

iv) computation of the probability distribution of net benefits.

With some additional information on the physical aspects of the Bay the probabilities for various types of environmental degradation could be calculated.

The Distributional Aspects

Cost-benefit analyses are normally carried out with an 'aggregate-consumption objective' making no distinction among recipients of benefits or bearers of costs. Aggregate consumption is the present value of future consumption produced by the investment undertaken by the project.

Two elements are normally considered under distributional aspects. Firstly it is only seldom the case that beneficiaries of the project are the same group in the population which pays for the project; If the existing income distribution to be maintained, it is essential to establish the favoured groups. Secondly a project might be undertaken with a specific income distribution objective in mind. Again it is necessary to know the beneficiaries and those groups paying the major part of the cost.

Having identified the benefits, the appropriate groups in the population need to be identified both in terms of per capita income and also by region, in some cases by sub-regions such as suburbs. A similar analysis is needed also for costs. The distribution of costs could be difficult if the project is financed from taxes; easier if paid for from user charges. Consequently considerable understanding of the financing procedure is also required.

The calculation of the distributional aspects could be further complicated if there are regional employment effects or other national benefits in terms of foreign exchange earnings.

In the case of Izmir the distributional question is particularly complex: there are national benefits in the form of foreign exchange earnings from tourism: there are regional employment benefits; there are health benefits to the region at large; there are benefits particularly to the tourism industry, the salt industry, to fishery industry property owners around coast of the Bay. These distributional effects have not been assessed; neither have been the consequences of them for the financing of the project.

4. SUMMARY OF IMPROVEMENTS TO AND EXTENSION OF THE IZMIR CASE STUDY

This report reviewed in considerable detail the philosophy and technique of cost-benefit analysis as it is applied to mixed economic/environmental investment projects. In the process of this review attention has been drawn to several shortcomings in the recently completed Izmir case study and suggestions were made to possible extensions to the study which were also proposed during the meeting of "Government Appointed Experts" in Nairobi. The purpose of this section is to bring together these proposals in order to have a better overview of them.

Basically two types of proposals have been put forward:

i) to gather additional physical and economic data as inputs for the cost-benefit study;

ii) generate more information through the cost-benefit technique that would assist international, national and local decision makers in the implementation and financing of the project.

Additional Input Data

Although, relatively speaking, substantial amount of physical data were available concerning the characteristics of the Bay, effluent inflows, quality of the Bay's water, impacts of pollution on the surroundings and marine environment. Other environmental impacts, such as soil erosion and disappearance of green areas, were not well documented; loss of fish life and bird life and degradation of ecosystems are poorly assessed. The paper prepared by Professor Balkas develops these questions in more detail.

It is believed that the economic data used, such as prices, costs and expenditures, were realisticly estimated. They however need to be cross checked and re-examined. The projection of tourist numbers need to be realigned with national projections; and similar verification is needed for weekend travellers and excursionists.

Extension of the Cost-Benefit Analysis

Numerous elements in the present case study can be improved and extended:

i) Putting the study into a national framework and consider the macro-economic effects;

ii) Undertaking a sensitivity study with different discount rates;

iii) Presentation of the results in alternative formats: net present value, internal rate of return and cost-benefit ratios;

iv) Adjustment of financial or accounting costs and benefits to represent economic costs and benefits;

v) Exploring various valuation techniques for the assessment of ecosystems, aesthetic values and other conservation benefits;

vi) Introduction of risk assessment by attaching probabilities to certain occurrences, such as the collapse of the Bay;

vii) Calculation of the distributional effects and their implications on financing the project.

5. APPLICATION OF COST-BENEFIT ANALYSIS TO DEVELOPING COUNTRIES

Although cost-benefit analysis has been widely used in developing countries the concern is often expressed that under certain conditions cost-benefit analysis can lead to misleading results in these countries. This view was also voiced at the Nairobi meeting by a number of developing country representatives.

This concern is not new and has been the subject of debate over the last 20 years. It has been restarted and taken on new dimensions when evaluation of infrastructure projects and environmental benefits started to be subjected to cost-benefit assessment.

The major point in the debate is the presupposition that actual prices in developing countries, prices which are used also to value economic and environmental benefits, are much worse reflectors of social costs and benefits than in advanced economies. The reason is that certain economic factors are operating in such a disproportionate manner that they distort the operation of market prices. These are: inflation, currency overvaluation,
wage rates and unemployment, imperfect capital markets, large investment projects, inelastic export demand, protection, and income distribution.

Some of these issues have been touched upon in this paper, such as income distribution. In the Izmir context some of these factors, such as inflation, are also of importance and should be accounted for.

It is not feasible to treat these issue in any detail in this paper but some of the main concerns can be mentioned:

i) inflation is often rapid in developing countries and this could necessitate the control of some sectoral prices by the authorities; it could also mean that relative prices will move differently in the future: these factors need to be taken into account when current prices are used for valuing costs and benefits;

ii) wage rates should be in theory equal to the marginal product of labor; because of monopoly power of trade unions or employers and immobility of labor there are serious imperfections in the labor market even in the developed economies; in the developing countries to these must be added large scale of under- or unemployment; when wage costs are used for valuation in developing countries adjustments are needed to establish the social cost of employment or other alternative wage costs;

iii) imperfect capital markets in developing countries produce unrealistic interest rates, completely unsatisfactory for establishing discount rates; these imperfections due to government intervention, monopoly power and create a very wide band of interest rates:

iv) large projects with significant environmental costs and benefits are common in developing countries; such large projects can have major macro-economic impacts and can alter overall profitability, wage rates and other economic variables; in the valuation of future costs and benefits these potential changes should be incorporated;

v) inelastic export demand implies that the free market price is not measuring correctly the benefits if the country is the major supplier of the product in question; again for valuation purposes these prices need to be adjusted;

vi) protection, in the form of import quotas, tariffs and export disincentives, is used often for good economic reasons, such as to support industrialisation policy; but they can completely distort the price structure of the economy and its use for valuation is difficult unless adjustments are made;

vii) the income distributional effects of major projects could be drastic in developing countries; this issue has already been treated earlier in this paper and their impacts again need to be taken into account for future costs and benefits.

This brief survey of special factors in cost-benefit analysis in developing countries indicates that they are numerous and their impacts could be important for the results of the evaluation. It also suggests that these impacts are not basically different from other valuation problems already discussed in this paper and that they can be successfully solved.

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