केन्द्रीय जल आयोग
CENTRAL WATER COMMISSION

METHODOLOGY OF COMPUTATION OF BENEFIT COST RATIO FOR MAJOR AND MEDIUM IRRIGATION PROJECTS

PLANNING COMMISSION
APRIL 2014

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REPORT OF THE EXPERT COMMITTEE ON METHODOLOGY OF COMPUTATION OF BENEFIT COST RATIO FOR MAJOR AND MEDIUM IRRIGATION PROJECTS

GOVERNMENT OF INDIA
PLANNING COMMISSION
NEW DELHI
APRIL, 2014

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CENTRAL WATER COMMISSION

WE, THE MEMBERS OF THE "EXPERT COMMITTEE ON COMPUTATION OF BENEFIT COST RATIO FOR MAJOR AND MEDIUM IRRIGATION PROJECTS" HEREBY SUBMIT OUR FINAL REPORT

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FOREWORD

Although meeting the water requirement for sustenance of life and development, including irrigation, over time is a challenge, it is not because nature has been too niggardly in bestowing this valuable resource on us but more because we have been wanting in using this resource with care and vision. So far we have been a bit slow in our programmes and projects for the development of this precious resource. The earlier we construct our irrigation structures the lesser would be the cost. Besides, every project involving country's financial outlays has to be examined from the angle of economic viability before it is accepted for implementation. The methodology for justifying or otherwise, the financial viability of irrigation projects, recommended by Prof. D.R.Gadgil in 1964 is still in vogue by the Government of India. Now, time has come for taking a close view on the details of the procedure as also for modifying the yardstick evolved by Prof. Gadgil for computation of economic viability of Benefit Cost Ration for irrigation projects. A uniformity of procedure can be expected only if standardized procedures are evolved after studying all related aspects.

The setting up of the committee on "Methodology of Computation of Benefit Cost Ratio for Irrigation Projects" under the aegis of the Planning Commission, though a little late, it has now achieved its objective and suggested corrective steps which were earlier missing in Prof. Gadgil yardstick in computation of Benefit Cost Ratio. The report has suggested an approach for new methodology for computation of BC Ratio which would be now adopted by all the Irrigation Departments of the country, and Central Government for techno-economic approval of the projects.

I extend my appreciation to Chairman, Dr. Saumitra Chaudhuriand all the Members of the Committee who put time and efforts with sincerity and contributed substantially in finalization of this report by the Planning Commission.

(Montek Singh Ahluwalia)
Deputy Chairman, Planning Commission

Dated:

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PREFACE

Since independence, irrigation sector has the pivotal role in the economy of our country which is not only ensuring food security to the people of our nation but also helping in the overall development and employment generation to majority of persons. There are large numbers of Major & Medium irrigation project coming up in the country. The construction of the irrigation projects requires several pre-calculations in which the Benefit Cost Ratio calculation is very much necessary. The computation of Benefit Cost Ratio enables the project planners/engineers/economists/State and Central Governments to understand the viability of the project as well as enables them to foresee the comparison of the cost involved in the project and expected benefit to accrue which must be higher than the cost involved in order to optimize the benefit from the investment made.

Earlier, the methodology for calculation of Benefit Cost Ratio accepted in 1964 for sanctioning irrigation projects was based on the recommendation of the Research Committee set up under Prof. D.R.Gadgil. The Government accepted this recommendation and since then the benefit cost criteria has been adopted. Now, as per the need of the shifting phase of the irrigation sector, the time has come that we should relook into the criteria of Benefit Cost Ratio earlier adopted by the Government of India.

I am sure that the strategies suggested in this report of the Expert Committee on methodology of Computation of **"Benefit Cost Ratio for Irrigation Projects"** would enable the decision makers and the project authorities in adopting appropriate measures and techniques required for irrigation project formulation in our country.

It is my pleasure and privilege to thank all the Members of the Expert Committee for their many important suggestions and for sparing their valuable time towards the finalization of this report. This report would also enable the Planning Commission to take appropriate basis in according investment clearance to the irrigation projects in the country.

(Dr. Saumitra Chaudhuri)
Member, Planning Commission &
Chairman, Expert Committee
on methodology of Computation of
Benefit Cost Ratio for
Major and Medium Irrigation Projects

Dated:

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ACKNOWLEDGEMENT

I would like to pay my sincere gratitude to Deputy Chairman, Planning Commission who initiated the idea of constitution of the Expert Committee on Methodology of computation of Benefit Cost Ratio for Irrigation Projects and under the guidance of Dr. Soumitra Chaudhuri, Member, Planning Commission, the report has been finalized.

I would extend my sincere regards to Dr. Saumitra Chaudhuri, Member, Planning Commission & Chairman of the Expert Committee, without his kind guidance and support this mammoth task of taking all the Experts on board and finalization of report could not be completed.

I would also extend my regards and thanks to Dr. Mihir Shah, Member (WR&RD), Planning Commission, who finalized the experts of the Committee and thereafter guided in finalization of this report.

Further, I would also like to acknowledge all the Members of the Expert Committee who have spared their valuable time and provided inputs with full contents and knowledge which made this report possible. I would also mention that a delay has occurred in finalization of this report is partly due to time constraint. I would personally extend my regards to Shri O.P. Rawat, Former Vice Chairman, Narmada Vally Development Authority and Additional Chief Secretary, Government of Madhya Pradesh who provided kind guidance and support. I would also pay my gratitude to Dr. Yudhvir Uppal, Senior Adviser (Retd.), Water Resources who in his tenure supported the task.I record my personal regards and appreciation to Dr. Tushar Shah (IWMI) and Prof. Kanchan Chopra (President, Indian Society of Ecological Economics) who have provided substantial inputs to this task.

I would also thank to Central Water Commission, Ministry of Water Resources for providing the valuable inputs and material which were needed at the time of preparation of this report.

Further, I would acknowledge the efforts made by Shri M.M.N Saxena, Consultant (WR) without which it was very difficult to finalize this report. i also thank Shri A.Muralidharan, Senior Research Officer (WR) andShri Rahul Dubey, Young Professional (WR) who have immensely contributed in the effort of finalization of this report.

Lastly I am submitting this report acknowledging all the people who are directly or indirectly contributed in preparation of this report and made this report possible.

(Avinash Mishra)
Joint Adviser (WR)
&
Member Secretary

Dated:

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TIME VALUE OF MONEY

Money has time value. A Rupee today is more valuable than a rupee a year hence. Why? There are several reasons:

- *Individuals, in general, prefer current consumption to futur consumption.*
- *Capital can be employed productively to generate positiv returns. An investment of one rupee today would grow t (1+r) a year hence (r is the rate of interest earned on th investment).*
- *In an inflationary period a rupee today represents a greate real purchasing power than a rupee hence.*
- *Most of the financial problems involve cash flows occurrin at different points of time. For evaluating such cash flows a explicit consideration of the time value of money is required*
- *The criteria "time value of money" has applications in variou areas of financial analysis.*

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CHAPTER 1

INTRODUCTION

1.1 Water is for the sustenance of life a human need and prime natural resource. While the endowment of water resources in the country may appear abundant, there is a great variation in the availability of fresh water over space & time.

1.2 With the growth in the population and also economy, the need for water will grow, while planning for water resources projects it is essential to plan in such a way that the availability of utilizable water grows. The demand for Water is projected to grow to about 1447 BCM in 2050, wherein utilizable quantum of water in the country is just 1123 BCM implying that all irrigation projects be constructed for achieving benefits commensurate with actual expenditure involved in their construction. Here lies the concept of Benefit Cost Ratio. The irrigation potential (created and utilized) was of the order of 22.6 Mha (Comprising of 9.7C Mha by Major and Medium Irrigation Projects (MMI) and 12.9 MHa by Minor project) in the preplan period which has risen to 112.53 Mha potential created (Comprising of 47.41 Mha by MMI & 65.12 Mha by Minor Project) by the XI Plan but utilization is mere 90 Mha which does not seem to be judicious from engineering and economic aspects.

1.3 The economic viability or economic effectiveness of various alternates of the projects where benefits cannot be fully transformed into monetary terms, is one of the criteria fo taking up any irrigation project. It is invariably observed that the irrigation projects ar sanctioned on the basis of BC Ratio exceeding 1.5:1 (or 1:1 for special category States) bu none of the project is evaluated after it. The Planning Commission while accordin investment clearance to irrigation projects considers, amongst others, economic viability i the form of BC Ratio, on the recommendations of the Ministry of Water Resources (M/oWR as one of the parameter. Presently, the M/o WR does not consider the effect of cost/tim overrun or effect of deferred irrigation benefits in their methodology for calculation of B Ratio. Thus, a need was felt to relook the present Methodology of Benefit Cost Rati calculations.

1.4 The Deputy Chairman Planning Commission while approving the Investment Clearanc of the revised estimate for Teesta Barrage Project (1st Sub Stage of Stage I of Phase I), ha observed that there is 40 folds cost escalation at revised stage and remarked that despi huge cost increase the Benefit Cost Ratio (BCR/ BC Ratio) is practically the same ar expressed his worry about cost increase which does not affect the BCR and finally desire for studying such issues by some experts and suggest more appropriate Methodology whi can reflect the cost and benefit variation on time scale. In view of this an Expert Committe on Methodology of Computation of Benefit Cost Ratio for Major and Medium Irrigati Projects was proposed by the Water Resources Division to have a relook into t methodology adopted for calculation of BC Ratio and to suggest remedial measure corrective steps for establishing the economic viability of Major and Medium Irrigati Projects.

1.5 The Planning Commission vide order no. 2(3)/2007-WR dated 17-01-2011 constitut an expert group under the Chairmanship of Dr. Soumitra Choudhury Member, Planni Commission with Shri Avinash Mishra, Joint Adviser (WR), Planning Commission as Mem

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Secretary. The constitution of the expert committee and its terms of reference are at Annex.-I. The committee was initially to submit its report in two months. Subsequently vide order dated 28th September, 2011 the time for submission of report was extended by six months further i.e. up to 30th November, 2011 (Annex.-II) but due to the works of 12th Plan the report could not be submitted in time.

1.6 The committee was required to address the following issues:

I. To have a thorough relook into the methodology adopted for calculation of the Benefit Cost Ratio for Major and Medium Irrigation projects by test checking of about 20 projects selected on the basis of random/stratified sampling.

II. Suggest corrective steps in the Methodology for establishing the economic viability of Major and Medium Irrigation projects.

III. Any other important issue relating to BC Ratio which the group may wish to consider.

1.7 Despite best efforts, the committee could hold only one meeting on 09-08-2011 (Annexure–VIII) since many meetings were continuously postponed because of unavailability of the members of the committee. Based on the deliberations in the meeting and inputs provided by the Members of the committee, the findings & recommendations of the committee were finalized and presented in the ensuing sections of this report.

1.8 For finalizing this report BC Ratio computations of numerous irrigation projects of the country were studied. Simultaneously, data was also collected from Central Water Commission who provided requisite data for 15 irrigation projects of the country viz:

(i) Khadak Purna River Project (Major), Maharashtra

(ii) Kanhar Irrigation Project (Major), Uttar Pradesh

(iii) Bilgaon Irrigation Project (Medium), Madhya Pradesh

(iv) Mahuar Medium Irrigation Project, Madhya Pradesh

(v) Halon Major Irrigation Project, Madhya Pradesh

(vi) Relining of Indira Gandhi Main Canal (Stage-I), Rajasthan

(vii) Imphal Barrage Project (Medium), Manipur

(viii) Rehabilitation of 1st Patiala Feeder and Kotla Canal, Punjab.

(ix) Restoration of Western Gandak Canal System, Bihar

(x) Hardoi Branch, Canal, Uttar Pradesh

(xi) Minimata (Hasdeo) Bango Project, Chhatisgarh.

(xii) Gumani Barrage (Major), Jharkhand

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(xiii) Champamati Irrigation Project (Major), Assam

(xiv) Teesta Barrage (1st Sub Stage of Stage I of Phase 1), West Bengal; and

(xv) Gumti Medium Irrigation Project, Tripura.

However, for finalizing the new/ suggested methodology for computation of BC Ratio, the B Ratio calculations for following 5 projects (representative projects of the eastern, westerı southern and northern regions of the country) were studied in detail:

(i) Kanhar Irrigation Project (Major), Uttar Pradesh.

(ii) Teesta Barrage, West Bengal

(iii) Tembhu Irrigation Project (Major), Maharashtra

(iv) Rajgarh Medium Irrigation Project, Rajasthan; and

(v) Sri Rameshwara Lift Irrigation Scheme (Major), Karnataka.

Accordingly, BC Ratio computations for these five projects have been carried out based (discounted rate method (10%) i.e., by suggested methodology along with corresponding IR calculations as well as computations of BC Ratio with discounted rate method considerir cost overrun of 25%, time overrun of 3 years and benefits overrun of 3 years along wi corresponding IRR and the same are compared with BC Ratio computations based (present methodology i.e., calculation without any discount rate and comparing Annual Cc with Annual benefits. These details are tabulated in Table 1 of the report.

Chapter 2

HISTORY OF Benefit Cost RATIO

2.1 Cost-Benefit Analysis (CBA) estimates the equivalent money value of the benefits and costs to the community of projects to establish whether they are worthwhile. These projects may be dams and highways or can be training programs and health care systems.

2.2 The idea of this economic accounting originated with Jules Dupuit, a French engineer whose 1848 article is still worth reading. The British economist, Alfred Marshall, formulated some of the formal concepts that are at the foundation of CBA. But the practical development of CBA came as a result of the impetus provided by the Federal Navigation Act of 1936. This act required that the U.S. Corps of Engineers carry out projects for the improvement of the waterway system when the total benefits of a project to whomsoever they accrue exceed the costs of that project. Thus, the Corps of Engineers had created systematic methods for measuring such benefits and costs. The engineers of the Corps did this without much, of any, assistance from the economics profession. It wasn't until about twenty years later in the 1950's that economists tried to provide a rigorous, consistent set of methods for measuring benefits and costs and deciding whether a project is worthwhile. Some technical issues of CBA have not been wholly resolved even now but the fundamental presented in the following are well established.

2.3 Principles of Cost Benefit Analysis:

One of the problems of CBA is that the computation of many components of benefits and costs is intuitively obvious but that there are others for which intuition fails to suggest methods of measurement. Therefore some basic principles are needed as a guide.

2.4 There Must Be a Common Unit of Measurement:

In order to reach a conclusion as to the desirability of a project all aspects of the project, positive and negative, must be expressed in terms of a common unit; i.e., there must be a "bottom line." The most convenient common unit is money. This means that all benefits and costs of a project should be measured in terms of their equivalent money value. A program may provide benefits which are not directly expressed in terms of Rupees but there is some amount of money the recipients of the benefits would consider just as good as the project's benefits.

Not only do the benefits and costs of a project have to be expressed in terms of equivalent money value, but they have to be expressed in terms of Rupees of a particular time. This is not just due to the differences in the value of Rupee at different times because of inflation. A rupee available five years from now is not as good as a rupee available now. This is because a rupee available now can be invested and earn interest for five years and would be worth more than a rupee in five years. If the interest rate is r then a rupee invested for t years will grow to be $(1+r)^t$. Therefore the amount of money that would have to be deposited now so that it would grow to be one rupee t years in the future is $(1+r)^{-t}$. This is called the discounted value or present value of a rupee available t years in the future.

When the rupee value of benefits at some time in the future is multiplied by the discounted value of one rupee at that time in the future the result is discounted present value of that benefit of the project. The same thing applies to costs. The net benefit of the projects is just the sum of the present value of the benefits less the present value of the costs.

The choice of the appropriate interest rate to use for the discounting is an issue that needs to be decided considering the local condition.

2.5 CBA Valuations Should Represent Consumers or Producers Valuations As Revealed by Their Actual Behavior

The valuation of benefits and costs should reflect preferences revealed by choices which have been made. For example, improvements in transportation frequently involve saving time. The question is how to measure the money value of that time saved. The value should not be merely what transportation planners think time should be worth or even what people say their time is worth. The value of time should be that which the public reveals their time is worth through choices involving tradeoffs between time and money. If people have a choice of parking close to their destination for a fee of Rs. 50 or parking farther away and spending 5 minutes more walking and they always choose to spend the money and save the time and effort then they have revealed that their time is more valuable to them than Rs. 10 per minute. If they were indifferent between the two choices they would have revealed that the value of their time to them was exactly Rs. 10 per minute.

The most challenging part of CBA is finding past choices which reveal the tradeoffs and equivalencies in preferences. For example, the valuation of the benefit of cleaner air could be established by finding how much less people paid for housing in more polluted areas which otherwise was identical in characteristics and location to housing in less polluted areas. Generally the value of cleaner air to people as revealed by the hard market choices seems to be less than their rhetorical valuation of clean air.

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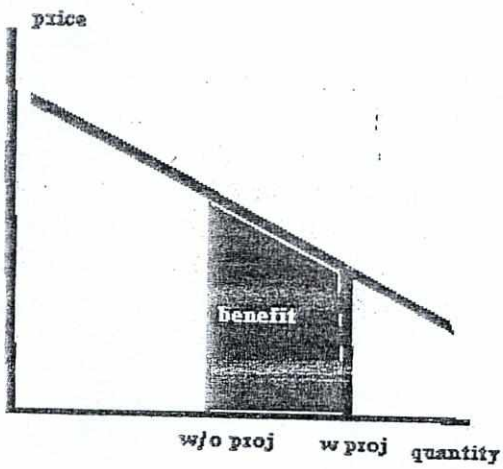
2.6 Benefits Are Usually Measured by Market Choices

When consumers make purchases at market prices they reveal that the things they buy are at least as beneficial to them as the money they relinquish. Consumers will increase their consumption of any commodity up to the point where the benefit of an additional unit (marginal benefit) is equal to the marginal cost to them of that unit, the market price. Therefore for any consumer buying some of a commodity, the marginal benefit is equal to the market price. The marginal benefit will decline with the amount consumed just as the market price has to decline to get consumers to consume a greater quantity of the commodity. The relationship between the market price and the quantity consumed is called the demand schedule. Thus the demand schedule provides the information about marginal benefit that is needed to place a money value on an increase in consumption.

2.7 Gross Benefits of an Increase in Consumption is an Area Under the Demand Curve

The increase in benefits resulting from an increase in consumption is the sum of the marginal benefit times each incremental increase in consumption. As the incremental increases considered are taken as smaller and smaller the sum goes to the area under the marginal benefit curve. But the marginal benefit curve is the same as the demand curve so the increase in benefits is the area under the demand curve. As shown in Figure 1 the area is over the range from the lower limit of consumption before the increase to consumption after the increase.



When the increase in consumption is small compared to the total consumption the gross benefit is adequately approximated, as is shown in a welfare analysis,

by the market value of the increased consumption; i.e., market price times the increase in consumption.

2.8 Some Measurements of Benefits Require the Valuation of Human Life

It is sometimes necessary in CBA to evaluate the benefit of saving human lives. There is considerable antipathy in the general public to the idea of placing a Rupee value on human life. Economists recognize that it is impossible to fund every project which promises to save a human life and that some rational basis is needed to select which projects are approved and which are turned down. The controversy is defused when it is recognized that the benefit of such projects are in reducing the risk of death. There are many cases in which people voluntarily accept increased risks in return for higher pay, such as in the oil fields or mining, or for time savings in higher speed in automobile travel. These choices can be used to estimate the personal cost people place on increased risk and thus the value to them of reduced risk. This computation is equivalent to placing an economic value on the expected number of lives saved.

2.9 The Analysis of a Project Should Involve a With Versus Without Comparison

The impact of a project is the difference between what the situation in the study area would be with and without the project. This that when a project is being evaluated the analysis must estimate not only what the situation would be with the project but also what it would be without the project. For example, in determining the impact of a Metro transit system such as the Delhi Metro Rail Corporation (DMRC) in the San Francisco Bay Area the number of rides that would have been taken on an expansion of the bus system should be deducted from the rides provided by DMRC and likewise the additional costs of such an expanded bus system would be deducted from the costs of DMRC. In other words, the alternative to the project must be explicitly specified and considered in the evaluation of the project. Note that the with-and-without comparison is not the same as a before-and-after comparison.

Another example shows the importance of considering the impacts of a project and a with-and-without comparison. Suppose an irrigation project proposes to increase cotton production in Maharashtra. If the Government of India limits the cotton production in the country by a system of quotas, then there might be reduction in the cotton production quota for the country implying that the impact of the project on cotton production could be minimized thereby giving an indication that the benefits even with the project would not be worthwhile.

2.10 Cost Benefit Analysis Involves a Particular Study Area

The impacts of a project are defined for a particular study area, be it a city, region, state, nation or the world. In the above example concerning cotton the impact of the project might be zero for the nation but still be a positive amount for Arizona.

The nature of the study area is usually specified by the organization sponsoring the analysis. Many effects of a project may "net out" over one study area but not over a smaller one. The specification of the study area may be arbitrary but it may significantly affect the conclusions of the analysis.

2.11 Double Counting of Benefits or Costs Must be Avoided

Sometimes an impact of a project can be measured in two or more ways. For example, when an improved highway reduces travel time and the risk of injury the value of property in areas served by the highway will be enhanced. The increase in property values due to the project is a very good way, at least in principle, to measure the benefits of a project. But if the increased property values are included then it is unnecessary to include the value of the time and lives saved by the improvement in the highway. The property value went up because of the benefits of the time saving and the reduced risks. To include both the increase in property values and the time saving and risk reduction would involve double counting.

2.12 Decision Criteria for Projects

If the discounted present value of the benefits exceeds the discounted present value of the costs then the project is worthwhile. This is equivalent to the condition that the net benefit must be positive. Another equivalent condition is that the ratio of the present value of the benefits to the present value of the costs must be greater than one.

If there are more than one mutually exclusive project that have positive net present value then there has to be further analysis. From the set of mutually exclusive projects the one that should be selected is the one with the highest net present value.

If the funds required for carrying out all of the projects with positive net present value are less than the funds available this means the discount rate used in computing the present values is too low and does not reflect the true cost of capital. The present values must be recomputed using a higher discount rate. It may take some trial and error to find a discount rate such that the funds required for the projects with a positive net present value is no more than the funds available. Sometimes as an alternative to this procedure people try to select the best projects on the basis of some measure of goodness such as the internal rate of return or the benefit/cost ratio. This is not valid for several reasons.

The magnitude of the ratio of benefits to costs is to a degree arbitrary because some costs such as operating costs may be deducted from benefits and thus not be included in the cost figure. This is called netting out of operating costs. This netting out may be done for some projects and not for others. This manipulation of the benefits and costs will not affect the net benefits but it may change the benefit/cost ratio. However it will not raise the benefit cost ratio which is less than one to above one. For more on this topic see Benefit/ cost Ratio Magnitude.

CHAPTER 3

PRESENT METHODOLOGY OF CALCULATION OF BC RATIO ADOPTED BY THE MINISTRY OF WATER RESOURCES

3.1 In 1958, the Planning Commission initiated studies of some of the major projects to assess the overall benefits and to find a better criterion. These studies showed large benefits accrued from irrigation in terms of double cropping, diversification, better quality of crops, higher yields, larger income and greater employment opportunities for hired labour. Indirect benefits included establishment of processing industries, retail trade, transport and communication. The total benefit was thus far larger than financial returns accruing to the Government. It was therefore recommended that benefit-cost ratio should be used for assessing the feasibility of new projects instead of traditional criterion of the direct financial return.

3.2 The benefit was to be worked out as the difference between the value of the total annual agricultural production and the cost of cultivation before and after the introduction of the irrigation. The cost would comprise the annual interest on capital, depreciation, and expenditure on the operation and maintenance. For simplicity, it was also considered that indirect or secondary benefits need not be taken into account. This methodology was formally accepted in 1964 for sanctioning irrigation projects based on the recommendation of the Research Committee set up under Prof. D.R.Gadgil. The Government accepted this recommendation and since then the benefit cost criteria has been adopted.

3.3In November 1980 the Fifth Conference of Irrigation Ministers adopted a resolution calling for review by a High Level Committee of the current criteria based on actual performance of irrigation systems necessitated on account of rising cost of irrigation projects due to cheaper sites having already been exhausted. The Planning Commission accordingly set up the Nitin Desai Committee in 1982 to review the current criterion for working out the benefit cost ratio based on actual performance of irrigation projects and to review the norms for evaluation of direct and indirect benefits to be considered in the analysis. The Committee in its report has covered a wide range of issues viz. realistic data on crop yields, valuation of outputs, adjustment for social cost of agricultural inputs, non-agriculture benefits estimation, project cost covering on farm development works, employment effects etc. The committee did not however apply recommended methodology to any specific project data as an example and for this reason no action was taken to implement its recommendation, also it became difficult to monetize the indirect benefits, so the methodology remained as theoretical suggestion away from practical considerations.

3.4 In 2001 MoWR adopted the single window clearance to recommend the project for investment approval of the Planning Commission and also accepted the recommendation of the Nitin Desai Committee. However no change in the calculation of

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the BC Ratio methodology was adopted by the MoWR because of absence of re data and absence of standardization of related benefits including projection o employment effect and non-agriculture benefits. The Nitin Desai Committee Report also indicated valuation of out puts i.e. wheat production should be valued at the cost of imports (adjusted for a foreign exchange premium) since a short fall will lead to higher imports. Other cereals should be valued at the opportunity cost of wheat plus any premium or discount implicit in the prices which domestic consumers are prepared to pay. Similarly variety of cereals i.e. basmati rice which are exported to a significant extent should be valued at the relevant export price.

3.5 Subsequently there are various indicators for the cost calculation; data consideration was indicated in the report of Nitin Desai Committee. In brief the methodology suggested by Shri Desai was complicated and theoretical. The BC Ratio calculation as suggested by Prof. D.R.Gadgil is still being followed, however these calculations ignore the direct benefits like Rural & Urban Drinking Water, industrial water, and hydro power (the general international Practice is to include the cost of the alternative (thermal) as the benefit of the project) and also the flood control benefits.

3.6 In short the existing Methodology for BC. Ratio Computation of Irrigation Projects can be summarized as under:

A. ESTIMATION OF NET ANNUAL COST PART:

i) Annual interest @ 10% of the Total Cost of the Project.
Total Cost of the Project also includes cost of land development which is presently as Rs. 20,000 per ha as decided by the Advisory Committee of Ministry of Water Resources.

ii) Annual Depreciation of the project based on assumed life of the project. (@ 1% if life is 100 years & 2% if life is 50 years) on cost of the project only i.e. excluding cost of land development, the life is decided with the rate of siltation in Reservoir.

iii) Annual Maintenance of head works @ 1% of its cost

iv) Annual Operation & Maintenance @ Rs. 1175/- per ha of CCA or annually irrigated area whichever is more (as per the recommendations of 13th Finance Commission)

v) In case of Lift Irrigation Schemes, annual cost also includes:

a) Depreciation of the pumping system @ 8.33% of its cost (Life being 12 years).
b) Depreciation of the raising mains @ 3.33% of its cost (Life being 30 years).
c) Energy Charges for lifting water at prevailing market rates

B. ESTIMATION OF ANNUAL NET BENEFIT PART:

i) Monetary increase in net agricultural produce value "after" introduction of irrigation over the net agricultural produce value 'before' irrigation

ii) Net agricultural produce value is Gross produce value minus Cultivation charges.

iii) The cost of cultivation and other expenses are deducted from the gross receipts to compute the net benefits in pre and post project conditions.

iv) The net procedure value of increased dung and husk because of irrigation is also added in net annual benefits.

The State Agriculture Department furnishes the crop wise yields / ha under pre and post project conditions and rates of the produce to be adopted The cost of cultivation and other expenses are also furnished by the State Agriculture Department .

BC. Ratio = Annual Net Benefits / Annual Net Cost

Criteria of acceptable BC. Ratio-

3.7 BC Ratio considered acceptable is of the order of 1.5:1.0 for project in General category States and 1.0:1.0 for the projects benefiting drought prone areas and / or special category States.

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CHAPTER 4

EFFICACY OF THE PRESENT METHODOLOGY:

4.1 Investment in irrigation, like any other investment, produces economic benefits and social impact, an assessment of which is required to determine the usefulness of any particular project from the point of view of the society as a whole. In India the criteria of BC Ratio is in use since 1964 for determining the economic viability of projects. Benefits are calculated in terms of net increase in agricultural productivity due to irrigation as per the methodology mentioned in Chapter 3 which is presently approved by the Government. This methodology in present era is considered preliminary/obsolete as it does not permit a comprehensive and realistic appraisal and accordingly the deficiencies should be removed requiring modification in the present methodology. Some of the discrepancies along with their preventive measures are listed below-

4.2 Accuracy of Benefit Cost Estimates:

The criteria of BCR is sometimes applied in a ritualistic manner without realizing that its purpose is to ensure the selection of the projects which make a net contribution to the growth of economy. The data and assumptions used in the computations often turn out to be unrealistic resulting in substantial cost and time overruns of projects under execution. Sometimes, even deliberate attempts are made to overestimate the benefit part and under estimate the cost part. At other time, requisite investigations are not done properly or done in a haste, data collection and analyses are inadequate for determining hydrology which drastically affect water availability/planning. Soil survey are frequently not carried out properly which lead to defective cropping pattern. Uniform figures of delta / duty are used over wide areas which are not in harmony with local conditions and consequently an element of unrealism enters into the estimate of irrigation potential itself. Other unrealistic assumptions relate to the estimates of utilization of irrigation potential and of increase in agriculture productivity due to irrigation. Unless adequate care is observed, it is easy to make mistakes in estimating cropping pattern, crop yield, and quantity and costs of inputs. There is no mechanism to ensure that correct data are in appraisal reports. Evaluation studies which provide one such source of data are seldom carried out.

4.3 Therefore there is need for post facto evaluation of projects so as to get a feed back for their formulation and appraisal. Problem related to inadequate investigations and deliberate manipulations of costs benefits would become less acute if a sample of projects are appraised by an independent agency outside the close fraternity of the project formulating departments at the Centre and the States.

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4.4 Assessing the Benefits:

Rise in agriculture productivity is the most important benefit from the irrigation which is determined as the difference between value of agriculture products' net costs after irrigation and a similar value before irrigation incorporating related all other inputs like cost of fertilizers, pesticides, better farming practices etc.

4.5 Time Value of Money:

The evaluation of benefits and costs of projects which spread over number of years ignores completely the consideration related to time value of money as reflected through the rate of interest. It is therefore essential that all the figures of cost and benefits of products having life span of more than one year are presented on a time scale and added by discounting them with prescribed interest rate. Such an arrangement would also result in an in-built mechanism for penalizing delays in construction of projects which are so chronic in the field of irrigation. Hence use of discounted cash flow method need to be used for evaluating BCR. The rate of interest to be used for this purpose should be social rate of discount or rate prescribed by the Government for this purpose.

4.6 Price Factor:

The appraisal of socio economic impacts of irrigation is carried on in money terms. This requires evaluation of inputs required by a project and outputs produced by it in monetary terms. The price factor is, therefore, is an important element in the appraisal of economic impacts of irrigation projects. There are two aspects. One relates to price changes over a period of time and other being the selection of appropriate prices at any point of time.

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CHAPTER 5

SENSITIVITY AND RISK ANALYSIS

5.1 The purpose of these analyses is useful in improving understanding of the nature and working of the project, increasing NPV by improving design of the project, reducing risks by suggesting precautions to be taken, evaluating the effect of uncertainty elements in computing BCR by considering parameters like output price, crop-yield rates, construction costs, and development of irrigation. The economics of the project are very sensitive to delay in construction and consequent delay in the development, increase in the construction cost and deferred benefits (in short cost, time and benefits overrun). Any change in these parameters would change the BCR to switching value. By NPV analysis method the future performance of the scheme could be visualized by changing any of the parameter. The discounted cash flow method and corresponding NPV analysis would give a transparent evaluation of the project as against conventional version of BC Ratio calculation being followed now. By this methodology one can also forecast the situation when there is cost overrun, time overrun or deferred benefits and take requisite remedial measures since all projects are sanctioned on the basis of BC Ratio. Annualizing the benefits and costs and use Net Present Value (NPV) method for ascertaining the economics of the projects give a sense of of project benefits over the life of the project, since the irrigation projects have long gestation period.

CHAPTER 6

SOCIAL IMPACTS

6.1 India is a land of villages and agriculture is predominant economic activity in a village. Irrigation, which has emerged as the most important factor in improvement of agriculture, is, therefore bound to have a significant impact on social conditions in the country. The advent of irrigation increases economic prosperity and raises marketable surplus which results in increasing urban contact of the rural people with the consequent change in their life style. The consumption pattern gets diversified, the level of education goes up and modes of entertainment affected. These in turn lead to changes in ideas and attitudes. Irrigation leads to double or multiple cropping as a result of which the farmer becomes more busy during the so called off season. This reduces his leisure which in turn affects his centuries old social and cultural life. Sometimes, the sharing of irrigation water results in formation of farmers' cooperative societies like the pani panchayats in Orissa and other parts of the country with various names.

6.2 Irrigation however increases social economic inequality and social tensions. The construction of dam's results in uprooting of poor tribal's in the upper reaches of the river. They become homeless ad landless while the benefits of irrigation go primarily to the landed peasantry in the plains. The alignment of canals is decided inter-alia by pressures from influential farmers who try to get the lion's share of irrigation and minimize the possibilities of acquisitions of their land for canal constructions. In many areas, it is the rich and politically powerful farmers who get canal water on priority basis. Finally, the benefit of irrigation goes in direct proportion to those who have the land. The bigger farmers benefit more than the smaller farmers. And farmers as a whole get benefit more than the landless labourers and others who have no land. Moreover the irrigation based modern farming is a highly capital intensive. As a result, it is the rich farmers who derive the maximum benefits from irrigation. Apart from using their own funds, they are in better position to get credit from financial institution because they are more credit worthy. It is, however, admitted that the poor, specially the landless farm workers also get miniscule benefit from irrigation. The increases in agricultural activity consequent to irrigation raises the demand for labour and the level of wage rate both of which tend to raise the earnings of the workers families. As a result, the intensity of poverty is less in well irrigated areas like Punjab, Haryana and western UP. But the income of those who have farms, increases more rapidly which results in widening disparities.

6.3 Social impacts of the project have other indirect benefits also i.e benefits steaming out of the system as well as induced by the system. For example, if cotton is produced in plenty lot of workers who make clothes / quilts etc. get earnings steaming out of the system. Induced benefit is in the form of increased earning of people who sell fertilizers/ pesticides, since more the irrigation more would be the need of fertilizers/ pesticides

etc. Others indirect losses could be sentimental. In case of displacement of persc (PAP or DP) the situation would be more complex. Invariably displacement impoverishes and marginalizes most persons who are deprived of their sustenance without physical relocation. The situation further deteriorates since displacing agency is itself in charge of rehabilitation. It is true for persons from weaker section. Even among them women and children pay a higher price. Most DP's are voiceless. In addition the project authorities attends mainly to the financial aspect and ignores the related social aspects such as alienation from there community and as a result many DP's are unable to deal with the work culture and economy they are forced into and fall into bondage or bad activities as a coping mechanism. In short compensation and resettlement are not the main issues rather beginning life in a new environment with no preparation for it is more complex than it appears at the first sight. This is not feasible to convert into monetary terms. Conversion of indirect loses in monetary values is not feasible by any mathematical tool.

6.4 These social implications of irrigation are usually ignored. The prescribed appraisal methodology does not include these aspects. It is therefore needed that the distributional implications of an irrigation project may be brought out in the appraisal report so that suitable changes in alignment of canals and their management may be brought about as to have a better distributional impact. This can be done by giving details about people in different categories who are affected (either favorably or adversely) by irrigation.

CHAPTER 7

SUGGESTED NEW METHODOLOGY

7.1 At the outset the committee noted the deficiencies in the conventional method (being adopted by MoWR) for computation of BCR i.e. the conventional method. The day lightening deficiency is that the present procedure works out cost and benefit at rates collected at the time of project formulation. In actual practice the construction cost would have been raised by the time the project is completed. The full benefit assumed in the analysis would accrue only after a few years after the project got into operation and then value would be, therefore considerably different from what has been assumed in the project report. In short, in present practice, interest @ 10% of capital cost and other related cost part like depreciation, O&M charges for CCA/AI, O&M charges of head works are considered uniformly throughout the project life. Similarly for benefit part Net Annual Benefit after deducting or adding other related receipts or expenditure like dung receipt, expenditure on seeds, manures, labour, fodder, land revenue etc. are also consider uniform. In view of this the committee lay emphasis on discounted cost and benefit criteria over the life of the project followed by NPV analysis and sensitivity/risk analysis to take care and evaluation of uncertainties' associated with basic financial/production like cost/time/benefits overrun, deferred maintenance costs. So as to assess future performance of the irrigation project including viability of investment even after cost/time/benefit overruns as also to assess the potential of the project with optimum input. The procedure has been explained in detail in Annexure 3-7 and can be followed as new methodology.

7.2 The deliberations of the meeting virtually amount to that there is a necessity for annualizing the benefits and costs and use Net Present Value (NPV) method for ascertaining the economics of the projects as it gives a sense of project benefits over the life of the project. NPV analysis would give a transplant evaluation of the project instead of the simplified version of the BC ratio now being used, since the irrigation projects have long gestation period. This would also take care of the interest cost of capital. Members of the committee also opined that social impacts of the project need to be considered instead of mere agricultural production, indirect benefits, factored cost of the land, indirect losses/benefits to ecosystem, loss of livelihood etc. Hon'ble Chairman of the Expert Group Dr. Soumitra Choudhury, Member, Planning Commission, emphasized for modifying the methodology and correct deficiencies.

7.3 As regard consideration of social impacts, both, positive and negative, in computations of BCR, the positive and negative social impacts may balance each other, however, to what extent, could be difficult to elaborate here. Adverse effects are specially considered by the planners. For DP's/PAP, there is R&R policy, while the forest, environment and ecological aspects are considered by Ministry of Environment and Forest and the project authorities have to take all safeguards for mitigating environmental hazards etc. as directed by the Ministry of Environment and Forests. As

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already indicated earlier social impacts, both, positive and negative, could not b transformed into monetary terms, and hence some leverage, in the form of lesser BC Ratio, would be proper as compensation to the areas who have considerable indirect losses. The Planning Commission has already defined the values of minimum BC Ratio which should be more than1.5:1 for general category states and 1:1 for special category states, DPAP and Tribal area.

7.4There are few volatile parameters, not directly related to methodology, but have switching value, for calculating both, cost part as well as benefit part of the project, which could affect BC Ratio calculations (calculated by any available method) if these parameters are not adopted uniformly. For example, from the data of 5 projects referred above it is noted that for computing cost part of Teesta Barrage rate of land development and rate of annual O&M charges for CCA/Annual Irrigation are Rs. 2000 and Rs. 600 per ha respect. while those for Kanhar Project are Rs. 6000 and Rs. 800 per ha as against existing rate of Rs. 20.000 (approved by the TAC of the M/o WR) and Rs. 1175 per ha. approved by the 13th Finance Commission It is further noted that different Chief Engineers of the States are adopting different parameters (referred above) for the reason known to them only and surprisingly CWC/ TAC of the M/oWR has been accepting such nonuniform parameters while approving BCR. Similar is the fate of crop rates for computing benefit part, which is to be finalized by the States' Agriculture Department. Need of the hour is that these parameters are to be standardized by the Central Govt. so that BC Ratio calculations may lead to logical end. This standardization is from engineering considerations only and for calculating BC Ratio only and may not be taken in other way like infringement in the powers of the States. For purposes other than BC Ratio States should have free hand.

7.5Lastly, for modification of the present methodology for calculation of BCR, the committee lay emphasis that there is a necessity for annualizing on discounted rate the net benefits and costs and use Net Present Value (NPV) method for ascertaining the economics of the projects as it gives a sense of project benefits over the life of the project. NPV analysis would give a transplant evaluation of the project instead of the simplified version of the BC ratio now being used. This would also take care of the interest cost of capital.

7.6 The committee also noted the BCR calculations of five nos. of irrigation projects, Tembhu Major Lift Irrigation Scheme (Maharashtra), Rajgarh Irrigation Project (Medium), Rajasthan, Kanhar Major Irrigation Project (UP), Sri Rameshwara Major Lift Irrigation project (Karnataka) besides, Teesta Barrage, recently examined in the M/o WR and accorded investment clearance by the Planning Commission. The tabular details giving BCR computations by discounted rate method, IRR, effect of cost/time /benefit overrun and corresponding BCR computed by the conventional method being used presently for aforesaid five projects can be seen in Table - 1. For detailed calculations relevant Annexure III to VII attached with the report may be seen. The BCR computations calculated by annual discounted rate method are more or less in

agreement of BCR calculated by conventional method of M/o WR considering interest rate as 10% but in discounted rate method additional details of cost/time/benefits overrun are also included. Clearly, this method i.e. annual discounted rate method gives a picture of future performance which is not feasible while computing BCR by conventional method. In view of this committee recommends discounted rate method for computing the BCR as explained in the Annexure III-VII.

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CHAPTER 8

SUMMARY AND RECOMMENDATIONS

The elements for successful computations of BC Ratio can be as follows -

8.1. There is a necessity for annualizing on discounted rate, the net benefits and costs and use Net Present Value (NPV) method for ascertaining the economics of the projects as it gives a sense of project benefits over the life of the project. NPV analysis would give a transplant evaluation of the project instead of the simplified version of the BC ratio now being used. This would also take care of the interest cost of capital. This method i.e. annual discounted rate method gives a picture of future performance which is not feasible while computing BCR by conventional method. The methodology explained in annexure 3-7 can be followed. The rate of interest to be used for this purpose should be social rate of discount or rate prescribed by the Government for this purpose.

8.2 The parameters, particularly, rate of land development, yearly O&M charges of CCA/ AI for computing project cost and yearly yield and crop rates for computing benefit part, are to be standardized by the Central Govt. so that BC Ratio calculations may lead to logical end. This standardization is from engineering considerations only and for calculating BC Ratio only and may not be taken in other way like infringement in the powers of the States.

8.3. Transformation of social impacts, both, positive and negative, in monetary terms is not feasible for arriving at BCR. Practically, it may be prudent to consider that they balance each other as explained in earlier paragraphs. Accordingly, some leverage, in the form of lesser BC Ratio, would be proper as compensation to the areas who have considerable indirect losses. The Planning Commission has already defined the values of minimum BC Ratio which should be more than1.5:1 for general category states and 1:1 for special category states, DPAP and Tribal area.

8.4 Sensitivity and Risk analysis is useful in improving understanding of the nature and working of the project. The economics of the project are very sensitive to cost, time and benefits overrun. Any change in these parameters would change the BCR to switching value. By NPV analysis method the future performance of the scheme could be visualized by changing any of the parameter.

8.5 There is need for post facto evaluation of projects so as to get a feedback for their formulation and appraisal.

8.6 Problem related to inadequate investigations and deliberate manipulations of costs benefits would become less acute if samples of projects are appraised by an

independent agency outside the close fraternity of the project formulating departments at the Centre and the States.

8.7 These recommendations should be considered for implementation at the earliest since delay in the matter could spell crisis of a much larger scale than has been experienced so far.

8.8 The Committee lays special emphasis on the fact that since investment in irrigation projects are substantial, it would be worthwhile to spend some money on research and other related activities so that the planners may get reflection of all other aspects either positive or negative connected with the economy of the country.

Brief details of computation of Benefit Cost Ratio by new Methodology

S.No.	Name Of the project	BC Ratio at 10% interest rate/ IRR & no cost/ time over run using NPV	BC Ratio@ 10%/ IRR with 25% cost overrun/ 3 year time/benefit over run using NPV	BC Ratio by CWC Method (Conventional method)	Remarks
1	Tembhu Lift Irrigation Scheme (Maharashtra) Major Project	BCR=1.161 NPV=Rs. 764.69 Cr. IRR=12.1 % NPV=Zero(app.)	BCR=0.973 NPV=(-)141.7 Cr. IRR=NA Since Project failed 10% rate	1.22 accepted by CWC	1. Discount factor =10% 2.Land development @ Rs. 20000/=per ha 3. O&M charge @ Rs. 1175/ha of CCA or AI 4.Life=100 years
2	Rajgarh Irrigation Scheme (Raj) (Medium)	BCR=1.820 NPV= Rs.128.23 Cr. IRR=26 % NPV=Zero(app.)	BCR=1.432 NPV= Rs.77.42 Cr. IRR=17% NPV=Zero(app.)	1.557 accepted by CWC	1.Discount factor=10% 2.Life=100 Years 3 land development @ Rs. 20,000/ha 4. O&M charge @ Rs. 1175/ha of CCA or AI
3	Kanhar Irrigation Project(Major, UP)	BCR=1.16 NPV= Rs. 96.975Cr. IRR=12 % NPV=Zero(app.)	BCR=0.985 NPV=(-)Rs. 10.067 Cr. IRR=NA Since Project Failed at	1.17 accepted by CWC	1.Discount factor=10% 2.Life=100 Years 3 land

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			10% interst.		developmen @ Rs. 6,000/ha 4. . O&M charge @ Rs. 1175/ha of CCA or AI
4	Sri Rameshwara Lift Irrig. Scheme, Karnataka (Major)	BCR=1.28 NPV= Rs.144.59Cr. IRR=16 % NPV=Zero(app.)	BCR=1.24 NPV=Rs.127.069 IRR=15.5% NPV=Zero(app.)	1.11 accepted by CWC	1.Discount factor=10% 2.Life=100 Years 3 land development @ Rs. 20,000/ha 4. . O&M charge @ Rs. 1175/ha of CCA or AI
5	Teesta Barrage Major , West Bengal, Life=100 years	BCR=2.758 NPV=Rs.2878Cr. IRR=37 % NPV=Zero(app.)	BCR=2.444 NPV=2611 Cr. IRR=35% NPV=Zero(app.)	2.55 accepted by CWC	1.Discount factor=10% 2.Life=100 Years 3 Land Development @ Rs. 20,000/ha 4. O&M charge @ Rs. 600/ha of CCA or AI

Source: Notes of the Technical Advisory Committee (TAC) of Ministry of Water Resources

Notes:

BCR – Benefit Cost Ratio
NPV – Net Present Value
IRR – Internal Rate of Return
CCA – Cultural Command Area
AI – Annual Irrigation
O&M – Operation and Management