# CHAPTER 9
# DISTRIBUTION ANALYSIS
# AND IMPACT ON POVERTY

## CONTENTS



## Tables

## 9.1 Concept and Rationale

1. The cost and benefits of a water supply project (WSP) are shared among different groups. Based on the results from the financial and economic benefit-cost analysis, an assessment of the distribution of project benefits and costs can be given to show which participant will gain from the project or incur a loss.

2. For example, consumers might gain due to the project if they can obtain water with the project at a lower price than without the project. Meanwhile, farmers might loose with the project when less irrigation water is available, and the government might loose when it subsidises the utility if it does not generate sufficient financial funds.

3. In general, distribution analysis is useful:

i) to assess whether the expected distribution of project effects corresponds with the objectives of the project (e.g., increased well-being) ;

ii) to assess the likely impact of policy changes on the distribution of project benefits (e.g., pricing and exchange rate policy); and

iii) to provide the basis for the poverty impact assessment (Section 9.5). This assessment evaluates which portion of the net gains of the project will ultimately benefit the poor.

4. The distribution analysis depends on data from both the financial and economic benefit-cost analyses. As financial benefit-cost analysis is done using the domestic price level numeraire, the latter will be used in the examples throughout this chapter.

## 9.2 Distribution of Project Benefits and Costs

5. The following is an example of a statement on the distribution of project benefits and costs in a WSP. The assumptions used to derive the economic benefits and costs are presented in Table 9.1.

Table 9.1 **Basic data**

| | | | |
|---|---|---|---|
| Demand without-project | | 200 | ‘000m³/year |
| Price of water without-project | | 2.50 | Rs/m³ |
| Price of water with-project (tariff) | | 1.50 | Rs/m³ |
| Price elasticity of demand | | -0.5 | |
| | Demand with-project | 240 | ‘000m³/year |
| | Incremental water | 40 | ‘000m³/year |
| | Nonincremental water | 200 | ‘000m³/year |
| | Average demand price with-& without- project | 2.00 | Rs/m³ |
| Economic supply price of water without-project | | 2.25 | Rs/m³ |
| | | | |
| Unaccounted for water | | 30% | |
| | non-technical losses | 10% | |
| | and technical losses | 20% | |
| | | | |
| **Investment costs (financial)** | | | |
| Equipment | | 1,37 | Rs‘000 |
| | | 1 | |
| Installation (labor) | | 171 | Rs‘000 |
| | | | |
| **Operation and Maintenance** | | | |
| Operating labor (% investment) | | 1.0% | |
| Electricity (% investment) | | 1.5% | |
| Other operating costs (% investment) | | 0.5% | |
| | | | |
| **Conversion factors (domestic price numeraire)** | | | |
| Equipment (traded component) | | 1.11 | SERF |
| Installation (labor) | | 0.90 | SWR |
| Operating (labor) | | 0.90 | SWR |
| Electricity (subsidized) | | 1.20 | CF |
| Other operating costs | | 1.00 | CF |
| | | | |
| **Opportunity cost of water** | | | |
| Opportunity cost of water | | 0.10 | Rs/m³ prod. |

6. The with-project demand forecast for year 2002, the time horizon for this project, has been assessed on the basis of the following assumptions:

(i) the project is expected to replace a demand from alternative sources of 200,000 m³/year (nonincremental demand);

(ii) the average financial price of water without the project is Rs2.50 per m³;

(iii) the average financial price or tariff with the project will be Rs1.50 per m³;

(iv) the price elasticity of demand is -0.50.

7. As a result of a 40 percent price decrease [(2.50-1.50)/2.50] x 100, the demand with the project is expected to increase by 20 percent [(-0.50 x -0.40) x 100], from 200,000 m³ to 240,000 m³ per year.

8. This demand would build up during five years, from 50 percent of the ultimate demand forecast in 1997, 60 percent in 1998 until full supply capacity is reached in 2002. On the basis of an unaccounted-for-water (UFW) of 30 percent, the project water production would be [240,000/(1 - 0.30)] or 343,000 m³ (rounded). The demand and production of piped water with the project is shown in the table below.

Table 9.2 **Piped Water Demand and Production**

| **Piped Water Demand and Production** | **Unit** | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| - Demand/Capacity build- up with-project | | | 50% | 60% | 70% | 80% | 90% | 100% | 100% | 100% | 100% |
| - Piped water demand | '000 m³ | | 120 | 144 | 168 | 192 | 216 | 240 | 240 | 240 | 240 |
| -UFW (30% of production) | '000 m³ | | 51 | 62 | 72 | 82 | 93 | 103 | 103 | 103 | 103 |
| Piped water production | '000 m³ | | 171 | 206 | 240 | 274 | 309 | 343 | 343 | 343 | 343 |

9. The financial cash flow statement of the project during the project life is presented in Table 9.3. The project lifetime is for presentational purposes, assumed to be ten years.

10. The revenues are calculated on the basis of the forecasted demand and tariffs. For example, in 1997, revenues are equal to (50% x 240,000 x 1.5) or Rs180,000. The investment cost of the project is Rs1,371,000 for equipment and Rs171,000 for installation labor. Operating labor is estimated at 1 percent of the total investment of Rs1.543 mn, electricity at 1.5 percent and other O&M at 0.5 percent. At the projected tariff level, the water utility will not recover the full incremental cost of the project at financial prices, discounted at 12 percent which is the assumed WACC. At this rate, the utility will have a loss of Rs259,000 in present value. So, the project is only viable if subsidized.

Table 9.3 **Project Financial Benefits and Costs**
*(Rs'000, 1996 prices)*

| **Financial statement** | **PV @12%** | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Benefits: | | | | | | | | | | | |
| - Revenue | 1,339 | | 180 | 216 | 252 | 288 | 324 | 360 | 360 | 360 | 360 |
| Total | 1,339 | | 180 | 216 | 252 | 288 | 324 | 360 | 360 | 360 | 360 |
| Costs: | | | | | | | | | | | |
| - Equipment | 1,224 | 1,371 | | | | | | | | | |
| - Installation (labor) | 153 | 171 | | | | | | | | | |
| - Operating labor | 73 | | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 |
| - Electricity | 110 | | 23 | 23 | 23 | 23 | 23 | 23 | 23 | 23 | 23 |
| - Other operating costs | 37 | | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 |
| Total | 1,598 | 1,543 | 46 | 46 | 46 | 46 | 46 | 46 | 46 | 46 | 46 |
| Net cash flow | -259 | -1,543 | 134 | 170 | 206 | 242 | 278 | 314 | 314 | 314 | 314 |

11. The economic analysis of the project introduces the following considerations:

(i) with the project, increased quantities of water will be available at a lower cost, representing an economic benefit to the user. Nonincremental water (200,000 $m^3$/year) has been valued by its economic supply price without the project of Rs2.25 per $m^3$ and incremental water (40,000 $m^3$/year) by its average demand price of Rs2.00 per $m^3$ [(1.50 + 2.50)/2].

(ii) water consumed but not sold (non-technical losses) does not generate revenues for the utility. It, however, does benefit the consumer. At full capacity, the volume of the non-technical losses is 10 percent of water produced, or 34,300 $m^3$ per year (10% of 343,000). Valued at the weighted average economic value of incremental and nonincremental water of Rs2.21 per $m^3$ (5/6 x 2.25 + 1/6 x 2), the worth of NTL is Rs76,000 (rounded) per annum, as of year 2002. From Table 9.4, it can be seen that the weights 5/6 and 1/6 are constant during 1997-2005.

Volumes of incremental and nonincremental water demand, and of nontechnical losses are shown in the table below. The economic benefits derived from this water consumed are comprised in Table 9.5.

Table 9.4 **Volumes of Water from which Economic Benefits are Derived**

| | **Unit** | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Demand/Capacity build- up with-project | | | 50% | 60% | 70% | 80% | 90% | 100% | 100% | 100% | 100% |
| Water demand with-project [1/] | '000 $m^3$ | | 120 | 144 | 168 | 192 | 216 | 240 | 240 | 240 | 240 |
| Water demand without-project [2/] | '000 $m^3$ | | 100 | 120 | 140 | 160 | 180 | 200 | 200 | 200 | 200 |
| Nonincremental water | '000 $m^3$ | | 100 | 120 | 140 | 160 | 180 | 200 | 200 | 200 | 200 |
| Incremental water | '000 $m^3$ | | 20 | 24 | 28 | 32 | 36 | 40 | 40 | 40 | 40 |
| Nontechnical losses (10% of production) | '000 $m^3$ | | 17 | 21 | 24 | 27 | 31 | 34 | 34 | 34 | 34 |

[1/] Piped water demand, ultimately reaching 240,000 $m^3$ per year, building up according to percentages given.
[2/] Water from alternative sources, to be replaced by the project, ultimately reaching 200,000 $m^3$, building up according to percentages given.

(iii) there is a difference between the economic price of foreign exchange and the official exchange rate. A SERF of 1.11 has been estimated for the country, implying that foreign exchange components have a higher economic than financial cost to the country. All equipment has to be imported;

(iv) the economic cost of labor is below the financial cost. The SWRF has been estimated at 0.90 and is applied to the installation labor and to operating labor;

(v) electricity is subsidized by the government. The economic cost of electricity is 20 percent higher than the financial cost;

(vi) the benefit foregone in agricultural production (opportunity cost of water) has been estimated at Rs0.10 per $m^3$ of water produced (343,000 $m^3$ at full capacity).

12. The financial project statement has been adjusted taking into account the above considerations to arrive at the project economic statement, as given in Table 9.5. This Table also shows the annual flow of benefits, other than revenue. The discounted economic benefits are now larger than the discounted economic costs. The economy will benefit as the project has a positive present value of Rs392,000. The project is economically justified.

Table 9.5 **Project Economic Benefits and Costs**
*(Rs'000, 1995 prices)*

| **Economic statement** | **PV@ 12%** | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Benefits: | | | | | | | | | | | |
| - Nonincremental water | 1,674 | | 225 | 270 | 315 | 360 | 405 | 450 | 450 | 450 | 450 |
| - Incremental water | 298 | | 40 | 48 | 56 | 64 | 72 | 80 | 80 | 80 | 80 |
| - Non-technical losses | 282 | | 38 | 45 | 53 | 61 | 68 | 76 | 76 | 76 | 76 |
| Total | 2,253 | | 303 | 363 | 424 | 485 | 545 | 606 | 606 | 606 | 606 |
| Costs: | | | | | | | | | | | |
| - Equipment | 1,361 | 1,524 | | | | | | | | | |
| - Installation | 138 | 154 | | | | | | | | | |
| - Operating labor | 66 | | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 |
| - Electricity | 132 | | 28 | 28 | 28 | 28 | 28 | 28 | 28 | 28 | 28 |
| - Other operating costs | 37 | | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 |
| -Opportunity cost of water | 128 | | 17 | 21 | 24 | 27 | 31 | 34 | 34 | 34 | 34 |
| Total | 1,861 | 1,678 | 67 | 70 | 73 | 77 | 80 | 84 | 84 | 84 | 84 |
| Net cash flow | 392 | -1,678 | 236 | 293 | 351 | 408 | 465 | 522 | 522 | 522 | 522 |

## 9.3 Analysis of Beneficiaries

13. In the example, the following beneficiaries of the project have been identified:

(i) Consumers. These will benefit from the project because of the lower cost of water and the accompanied induced increase in consumption. They also reap economic benefits because of the economic value of non-technical losses;

(ii) Government/economy. Because of the overvaluation of the domestic currency at the official exchange rate, the economic cost of the equipment exceeds its financial cost by the extent of the SERF. The loss is borne by the government and economy; the government is providing a subsidy on electricity, this represents a cost (loss) to the government.

14. The diverted water is assumed to result in a lower agricultural production value, as expressed by the opportunity cost of water. This loss is borne by the government or by the farmers who are treated as a part of the economy.

(i) Labor. The financial cost of labor exceeds its opportunity cost; the difference accrues as a gain to the laborers;

(ii) Utility. There is a loss to the utility because not all of the full financial costs including capital costs, are recovered.

## 9.4 Distribution Analysis

15. The financial and economic statements are shown in Table 9.6. The gains and losses to different participants in the project (distribution of project effects) are also indicated. The gains and losses to the different participants are determined by the difference between financial and economic benefits and costs.

16. The overall results are a negative financial net present value (FNPV) of Rs 259,000 and a positive economic net present value (ENPV) of Rs392,000. The ENPV exceeds the FNPV by Rs651,000.

17. Two participants lose from the project. The utility will suffer a loss of Rs259,000. The rest of the economy will suffer a loss of:

(i) Rs136,000, because foreign exchange is available at a price lower than its economic price;

(ii) Rs22,000, because the financial price of electricity is below the economic cost; and

(iii) Rs128,000, because water previously used in irrigated agriculture will be diverted to household use.

The result is a total loss of Rs286,000.

18. On the other hand, two participants are expected to gain. Labor will gain by Rs23,000 at the projected wages, and consumers will gain by Rs914,000. These gains and losses in part compensate for each other; the net gain is positive and equal to the ENPV of Rs392,000.

Table 9.6 **Distribution of Net Economic Benefits**

*(Rs'000, present values at 12% discount rate)*

| | | | | Difference | Distribution of Project Effects | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Financial Present Values | Conversion Factor | Economic Present Values | Economic minus Financial | Utility | Gov't/ Economy | Labor | Consumers | Total |
| Benefits: | | | | | | | | | |
| Total benefits | 1,339 | | 2,253 | 914 | | | | 914 | 914 |
| Costs: | | | | | | | | | |
| - Equipment | 1,224 | 1.11 | 1,361 | 136 | | -136 | | | -136 |
| - Installation (labor) | 153 | 0.90 | 138 | -15 | | | 15 | | 15 |
| - Operating labor | 73 | 0.90 | 66 | -7 | | | 7 | | 7 |
| - Electricity | 110 | 1.20 | 132 | 22 | | -22 | | | -22 |
| - Other operating costs | 37 | 1.00 | 37 | 0 | | | | | 0 |
| - Opportunity cost of water | | | 128 | 128 | | -128 | | | -128 |
| Total costs | 1,598 | | 1,861 | 263 | | | | | |
| Net benefits | -259 | | 392 | 651 | -259 | | | | -259 |
| Gains and Losses | | | | | -259 | -286 | 23 | 914 | 392 |

## 9.5 Poverty Impact Analysis

19. The initial step required to trace the poverty reduction impact of a project is to evaluate the expected distribution of net economic benefits to different groups as summarized in Table 9.6. The next step is to assign the economic benefits to the poor and to the non-poor. The **poor** are defined as those living below the country specific poverty line. An example of a calculation of a poverty impact ratio is given in Table 9.7 and discussed below.

20. The first line in Table 9.7 repeats the gains and losses for the government/economy, consumers and laborers from the last line in Table 9.6. In the second line, it has been assumed that the negative financial return to the utility of Rs259,000 is subsidized by the government, resulting in an additional loss to the government. This represents a loss of potential fiscal resources which could be used, for instance, in poverty alleviation programs.

21. The proportion of benefits accruing to the poor are estimated as follows for losses and gains to:

(i) Government/economy. An assessment of the targeting of government expenditures shows that on average, 50 percent of all government expenditures reach the poor. Losses/gains to the government/economy are decreasing/increasing the available government funds, therewith decreasing/increasing government expenditures directly targeted to the needs of the poor;

(ii) Labor. Thirty-three percent of the operating and installation labor needed for the project is carried out by poor people;

(iii) Consumers. A socioeconomic survey has been conducted in the project service area and it was found that 40 percent of the new consumers are below the poverty line.

22. A poverty impact ratio (PIR), expressing the proportion of net economic benefits accruing to the poor, can be calculated by comparing net economic benefits to the poor with the net economic benefits to the economy as a whole. In this case, as shown in Table 9.7, the PIR is 0.26 (= 101/392), which indicates that 26 percent of the economic benefits (present value) of the project will reach the poor.

**Definition of Poverty Impact Ratio (PIR)**

$$PIR = \frac{\text{Benefits to the poor}}{\text{Total economic benefits}}$$

23. The PIR should be assessed in relation to the population, which is poor in the project area. For example, if 20 percent of the population in the area is poor, and the PIR amounts to 0.26, the project would have a positive poverty reducing impact.

Table 9.7 **Poverty Impact Ratio**

*(Rs'000, present values at 12% discount rate)*

| | Gov't/ Economy | Labor | Consumers | Total |
|---|---|---|---|---|
| Gains and Losses (NEB-NFB) | -286 | 23 | 914 | 651 |
| Financial return utility | -259 | | | -259 |
| Benefits | -544 | 23 | 914 | 392 |
| Proportion of poor | 0.50 | 0.33 | 0.40 | |
| Benefits to poor | -272 | 7 | 366 | 101 |

*Poverty impact ratio: 101 / 392 = 0.26*

## 9.6 Limitations of the PIR

24. The distribution analysis and PIR calculation consider the economic benefits of the project. A part of this benefit is the economic cost of water replaced by the project, such as the cost of water sold by vendors, households' wells and kerosene. The PIR does not take into account the question whether this replacement affects poor or non-poor people. For example, if vendors will loose their jobs as a result of the project, the expressed PIR does not take this into account.

25. The proportion of benefits going to the poor is difficult to estimate. For the consumer benefits, the estimate is usually based on survey data. The portion of the economic benefits to the economy affecting the poor, or cost that the project imposes on the government or economy, can be estimated on the basis of the existing budgetary policy of the government. The portion of project labor that is

carried out by poor people has to be based on some broad assumptions but may be easier to estimate.

26. Note that the distribution analysis and the PIR calculation can only be done if the same discount rate is used in both financial and economic benefit-costs analysis. In the example a discount rate of 12 percent has been used in both the economic and financial analysis. Sensitivity analysis using other discount rates might be appropriate. Such an analysis is presented in Table 9.8.

Table 9.8 **Sensitivity of the PIR**
*(at different discount rates)*

| Discount rate | PIR |
|---|---|
| 12% | 0.26 |
| 10% | 0.32 |
| 7% | 0.37 |

27. Different discount rates result in different PIRs. In this example, it appears that the higher the discount rate, the lower the PIR and vice versa. A relative high discount rate (e.g., 12 percent) gives relatively high weight to costs and benefits in the early project years, and relatively low weight to costs and benefits that accrue in later years. On the other hand, a relatively low discount rate (e.g., 7 percent) gives relatively low weight to costs and benefits in the early project years, and relatively high weight to costs and benefits that accrue in later years.