PROCEEDINGS OF THE EXPERT GROUP MEETING ON WATER PRICING

WATER RESOURCES SERIES
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This publication contains the report and documents of the Expert Group Meeting on Water Pricing organized by ESCAP at Bangkok, Thailand, from 13 to 19 May 1980.

ECONOMIC AND SOCIAL COMMISSION
FOR ASIA AND THE PACIFIC
Bangkok, Thailand

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CONTENTS

Part One
REPORT OF THE MEETING

Part Two
WORKING PAPERS PRESENTED BY THE SECRETARIAT

Part Three
INFORMATION PAPERS SUBMITTED BY PARTICIPANTS

LIST OF TABLES

Part One

REPORT OF THE MEETING

I. ORGANIZATION OF THE MEETING

1. The Expert Working Group Meeting on Water Pricing was held at Bangkok, Thailand, from 13 to 19 May 1980.

Attendance

2. The Meeting was attended by experts from Bangladesh, India, Indonesia, the Philippines and Thailand.

3. The World Health Organization (WHO) was also represented.

Opening of the Meeting

4. In his opening statement, the Executive Secretary of ESCAP pointed out that water of suitable quality had become a scarce resource which must be conserved and paid for by users. In recent years it had become clear that most of the Governments of the region were unable to make sufficient funds available to meet the growing demand for irrigation and urban water supply. It seemed imperative, therefore, that the users of water should be required to pay for the actual cost of water. Charging customers a fair price for water would curtail wasteful use of water and contribute to its conservation. Furthermore, efficient pricing systems would increase the revenue for better operation and maintenance of the water supply systems and for the improvement and expansion of their services. He expressed confidence that the members of the Group, with their collective knowledge and experience, would make sound and practical recommendations which would lead to the implementation of useful water pricing policies in the region.

Election of officers

5. The Meeting elected Mr. H. R. Khan (Bangladesh) as Chairman and Mr. B. M. K. Mattoo (India) as Vice-Chairman.

6. Mr. Cesar E. Yniguez (Philippines) was elected Chairman of the Drafting Committee.

Adoption of the agenda

7. The Meeting adopted the following agenda:

1. Opening of the Meeting
2. Election of officers
3. Adoption of the agenda
4. Current policies in the pricing of water
5. Principles of water pricing and associated problems
6. Recommendations
7. Adoption of the report

II. CURRENT POLICIES IN THE PRICING OF WATER

Irrigation

8. The Meeting reviewed document NR/WP/3, which provided information on the current practices in the pricing of irrigation water in nine countries of the ESCAP region: Afghanistan, Bangladesh, India, Indonesia, Malaysia, Pakistan, the Philippines, the Republic of Korea and Thailand. It noted that it was only in the Republic of Korea that the farmers paid the full annual operation and maintenance costs and shared 30 per cent of the project capital cost, at 3.5 per cent interest. In Thailand, and Sabah and Sarawak in Malaysia, there were no official water charges either for operation and maintenance or for recovery of the capital cost of irrigation projects. In Afghanistan and Indonesia, the farmers were responsible for operation and maintenance of terminal facilities, while the Governments were responsible for the main system. In the other countries the water charges were assessed based on land productivity, area of irrigated land, season and kind of crop, which had no bearing on the actual operation and maintenance costs or the capital cost of the irrigation facilities.

9. It also noted that in five typical irrigation projects financed by the World Bank, the capital cost varied from $US 107 per ha for an improvement project in Pakistan to $US 5,092 per ha for a new project in the Republic of Korea. The water charge in the five projects varied from $US 2.6 to $US 157 per ha. Based on 10 per cent interest on capital investment, the project cost recovery index varied from 14 to 41 per cent.

10. In Bangladesh about 39 per cent of the total irrigated area (2,770,000 acres) was supplied with irrigation water by systems employing traditional manual methods. Those systems received no public funds or government subsidy. Large surface-water projects (irrigating 160,000 acres) were the most expensive and at the same time the most subsidized (about 98 per cent of the project cost) by the Government. For low-lift pump and deep tube-well irrigation covering 1,490,000 acres, the farmers repaid about 6 per cent of the capital cost and bore 85 per cent of direct operation and maintenance costs. For shallow tube-well irrigation (60,000 acres), about 50 per cent of the capital cost and 100 per cent of the direct operation and maintenance costs were borne by the farmers.

Since about 95 per cent of the direct operation and maintenance costs, but not the capital costs, were borne by the farmers, they were discouraged from extending the system to its full extent. Therefore, the current water charge policy encouraged capacity under-utilization of the pumping facilities.

11. In India, where water was a State subject, there was considerable diversity among the different States in the system of levying irrigation charges. The charges included one or more of the following:

(1) Water rate depending on the kind and the extent of crop irrigated.

(2) Increment in revenue from land tax based on increased benefit derived annually from providing irrigation facilities.

(3) Betterment levy representing the Government's share in the increase in land value accruing with the provision of irrigation facilities.

(4) Irrigation cess, being the annual charges per acre of the irrigable area, whether water was actually taken for irrigation or not.

(5) Maintenance cess.

In the northern States such as Uttar Pradesh, Punjab, Haryana and Rajasthan, the water rates were charged on the basis of actual area irrigated under different crops. In West Bengal, the deltaic region of Orissa, and parts of Bihar and Madhya Pradesh, the assessment was made on the areas and crops entered into an agreement for irrigation, irrespective of whether the areas covered were actually irrigated or not. In Maharashtra and Gujarat in western India, the crops to be grown on individual plots were decided in advance, taking into account the soil and other pertinent factors, and the water rates were charged accordingly on a "crop-rate" basis. In Tamil Nadu and other southern States, the water charges for a single crop were realized as a part of the land revenue. The irrigation charge usually varied for different categories or classes of works according to the adequacy or dependability of the irrigation supply. They were usually higher for storage works than for gravity schemes of the diversion type. The rates for lift irrigation were usually higher than for gravity-type irrigation projects.

12. In Indonesia, so far no water charge or water tax had been levied in the country. The Government collected only IPEDA, a form of land tax which was assessed based on the productivity of the land. After the completion of an irrigation project, the productivity of the land improved and IPEDA was also increased accordingly. Fifty per cent of the IPEDA revenue was used for agricultural development and maintenance of the irrigation networks. The operation and maintenance of the main facilities of the completed projects were the responsibility of the provincial government, while the operation and maintenance of the terminal facilities at the farm level were left to the farmers concerned. In 1979/80, for the total irrigated area of 4.47 million ha, the Government spent a total amount of Rp 18 billion ($US 28.6 million at the exchange rate of Rp 630 per $US) for its operation and maintenance, of which Rp 6 billion was funded by IPEDA; the remaining Rp 12 billion was financed by the central Government.

13. In the Philippines, there were three categories of irrigation projects: national irrigation projects, communal irrigation projects and pump irrigation projects.

14. There were two government agencies involved in irrigation: the National Irrigation Administration (NIA) undertook national irrigation projects and provided technical assistance for communal irrigation projects; the Farm Systems Development Corporation (FSDC) assisted farmers (irrigators' service associations (ISAs)) in small irrigation projects involving areas of less than 1,000 hectares.

15. The national irrigation projects were constructed, operated and maintained by NIA. The farmers were charged a fee equivalent to 2 cavans (one cavan equals 50 kg) of paddy per ha in the wet season and 3 cavans per ha in the dry season, which was sufficient to cover only the annual operation and maintenance costs of the irrigation systems. For some new projects financed by the World Bank, the water charges were higher to recover part of the capital cost.

16. FSDC assisted farmers in forming ISAs which would own, operate and maintain small irrigation systems. For the communal irrigation projects, NIA provided technical and financial assistance to the farmers' associations which were formed by FSDC. Operation and maintenance of the systems were done by the farmers. For the pump irrigation systems, FSDC provided loans for the pumps, and operation and maintenance were the farmers' responsibility. In those two categories of projects, the irrigators' association collected fees from the farmers to amortize the capital cost at 6 per cent interest and to cover the full operation and maintenance costs.

17. In Thailand, the Government had never charged a water fee to the farmers in major irrigation projects. However, the farmers were charged or would bear a substantial part of the project costs for the following: (a) in the traditional small irrigation projects in northern Thailand the farmers took full responsibility for the construction, operation and maintenance of the structures and canals (b) in a number of pumping projects in north-east Thailand implemented by the National Energy Authority, farmers paid a fixed charge

of B 60 per rai (or $US 18.8 per ha) for a dry-season paddy crop, which was adequate to cover the salary of the common irrigator, to provide a small part of the operating budget of the farmers' organization and to pay full energy costs; and (c) in the northern Chao Phya plain, where the Government was implementing a land consolidation project to irrigate 200,000 ha, the annual charge to the farmers in 1981 would be B 100-110 per rai ($US 31-34 per ha) for cost recovery in 12-15 years, to which B 40 per rai would be added for the maintenance of the terminal facilities and B 20 per rai for the ditch and dike programme.

Urban water supply

18. The Meeting had before it document NR/WP/1, which described the background of and provided information on water rate structures during 1976 to 1978 of seven urban water supply systems in seven countries of the ESCAP region: Afghanistan, Bangladesh, India, Indonesia, the Philippines, Nepal and Sri Lanka.

19. The Meeting noted and concurred with the following conclusions: (a) six of the seven systems had no surplus or a marginal surplus revenue. The rates of return for their net fixed assets ranged from negative to 1.5 per cent; (b) it would be very difficult for a water supply utility to raise its tariff if the supply of water was intermittent and inadequate; (c) the high percentage of water unaccounted for (about 50 per cent or more in many developing countries) not only reduced the quantity of available water for the use of the customer, but also increased significantly the unit cost of the water sold; (d) owing to the high percentage of unmetered customers, it might be inferred that wasteful consumption was inevitable and the cost of water was not distributed equally among the customers served; (e) sound financial management of a water utility included billing of customers in accordance with the quantity of water used and full collection of bills.

20. The Meeting noted that deficiencies in the management of urban water supply were prevalent in most water supply systems in the developing countries. It was pointed out, however, that many improvements had been made by some of the countries in the level of service and in tariff policies in recent years.

21. The Meeting heard with interest water pricing practices in some countries of the region. In India, urban water supply was within the jurisdiction of the State governments and the local bodies. In all 22 States, the details were differently organized, but in general, with the exception of Rajasthan, the State government provided only for planning, design and construction of urban (and rural) systems through public health engineering departments (PHED), some of which had recently been converted into semi-autonomous water supply (and sewerage) boards. The States supported construction fully or partly by loans and/or grants or not at all. Many urban projects were assisted by the Life Insurance Corporation, which might lend up to two thirds of the project cost. Operations were generally, except in Rajasthan, the responsibility of the local bodies. Many of them did not feel able to carry out the tasks and entrusted PHEDs or boards with those works, either against reimbursement of cost or against revenue collection. In any case, tariffs, charges and/or taxes were set by the local bodies.

22. Water rates for metered domestic connexions varied from Rs 0.02 to Rs 3.50 per cu m, the majority of tariffs lying in the range of Rs 0.30 to Rs 0.75. Consequently, the financial situation of water supplies showed very different results. In most places revenues did not cover costs. Owing to the lack of appropriate accounting systems, the local bodies were not even aware of their real losses. Many of them were satisfied if revenues were sufficient to cover recurrent expenditures. As a result, local bodies were normally not able to generate cash for system extensions, augmentation or rehabilitation. Some States had recently tried to adopt the Rajasthan system, where all levels of activities were centralized at the State level, with the following positive features:

(a) Economy in operation;

(b) Higher job satisfaction and better promotion chances for staff;

(c) Cross-subsidies between rural and urban subsectors and also among urban schemes;

(d) Rate setting at the State level for the whole of the population, keeping in mind the viability of the State's organization; and

(e) Allocation of funds for investments exclusively in line with priorities.

However, the resistance from the local bodies was everywhere so strong that so far no other State had been successful in concentrating responsibilities at the State level.

23. The Philippines also followed a socialized pricing policy by imposing a greater load on those who could afford to pay more for urban water. Water pricing was based on two premises: first, all water drawn from the water system must be accounted and paid for; and, second, water rates must be high enough to meet the financial requirements of the water utility. There were two agencies responsible for urban water supply. The Metropolitan Waterworks and Sewerage System (MWSS) was created in 1971 to take care of the Metropolitan Manila area. The Local Water Utilities Ad-

ministration (LWUA) was organized in 1973 to establish independent locally-controlled water districts in the provinces; water districts were established in cities with a population of at least 20,000. LWUA extended long-term loans which carried a 9 per cent interest and a 30-year repayment period, including a four-to-five-year grace period, and short-term loans, also at 9 per cent interest with a 5- to 15-year repayment period, including a one-to-two-year grace period. Under the LWUA Charter, water districts were authorized to formulate and adopt reasonable water rates to attain and maintain their financial viability. LWUA recommended two methods for determining water rates: (a) the revenue-oriented approach, which gave prime consideration to financial requirements and (b) the service-oriented approach, which was primarily designed to favour the low-income group.

24. The water facilities provided by MWSS were undergoing improvement and expansion to increase the current capacity of 330 million gallons per day (MGD or 1.25 million cu m per day) to the capacity of 570 MGD (or 2.16 MCM/day) in 1982. It was expected that 100 per cent of house-connexion customers would be metered in 1980. In order to reduce the amount of non-revenue water, all defective meters would be replaced by the end of 1981. With the new rate adjustment in May 1980, the rate of return on fixed assets would be expected to reach 5 per cent by the end of 1980. The rate of return would be raised again to 8 per cent in 1982.

25. The current MWSS water rates for residential purposes effective 15 May 1980 were as follows:

Consumption (cu m per month)	Rate (US dollars)
Less than 15	0.60 per month
16–20	0.99 per month
21–25	1.41 per month
26–30	2.01 per month
31–50	0.08 per cu m
51–70	0.11 per cu m
71–90	0.12 per cu m
91–100	0.15 per cu m
Above 100	0.17 per cu m

26. The Bangkok Metropolitan Water Works Authority of Thailand was responsible for an area of 3,100 sq km with a total population of 5.6 million. Owing to its limited production capacity, the system provided water to only 2.8 million people and served an area of 242 sq km in 1980. Since the completion of phase I development in November 1979, the production capacity of the system had been increased from 1.2 to 2.0 million cu m per day, which would be adequate to supply water to the customers in an expanded service area of 273 sq km. Since 1973 the tariff had been as follows:

Consumption block	Consumption per month (cu m)	Rate ($US per cu m)
1	0.6	0
2	6-12	0.025
3	12-25	0.05
4	25-50	0.075
5	50-200	0.10
6	Above 200	0.125

27. The average revenue per cubic metre of water sold was $US 0.075 (or B 1.50). According to the current rate, the revenue of the Authority was not sufficient to cover its full operating expenses. In 1979, the Government subsidized an amount of B 195 million (or $US 9.7 million). There were three major difficulties in raising water rates: (a) the traditional concept of the low price of water; (b) lack of authority of the Waterworks Board of Directors to approve the revision of the water rate; and (c) great diversity of income among the people.

28. The Meeting noted that in many water supply systems in the region the water unaccounted for amounted to 50 per cent of the total production, which was very high compared with the acceptable rates of 2 to 15 per cent for new systems and 10 to 15 per cent for old systems in developed countries. The water unaccounted for consisted not only of the losses in main pipelines and distribution networks, but also of wastage and illegal connexions.

III. PRINCIPLES AND PROBLEMS OF WATER PRICING

29. The Meeting considered documents NR/WP/2 and NR/WP/4. It recognized that there were two separate areas, namely, irrigation and municipal water supply, where pricing policies were at wide variance and it was not feasible to reconcile the two. Therefore a separate approach to each should be developed.

30. The Meeting considered the following principles of water pricing: marginal cost pricing (MCP); average cost pricing (ACP); benefit pricing (BP); and socio-political pricing (SP).

31. Under MCP, a price was set based on marginal cost for economic efficiency. Marginal cost referred to the cost of one additional unit of production, which could be measured by cubic meter, thousand gallons or million gallons in order to deal with quantities that were manageable. However, other than the fact that

MCP was economically efficient, it had no additional advantages. There were in fact many disadvantages to the use of purely marginal cost pricing. Those were: (a) price based upon marginal cost would be very unstable since marginal cost would vary from one consumer to another and would vary with any change in production cost. Such a system would be impossible to administer; (b) when a large investment required for additional capacity, marginal cost would rise and fall precipitously. The additional unit of production might cost several million dollars, but the following unit of production might cost very little. Therefore, means for smoothing those peaks had been developed by using alternative definitions of marginal cost. There were four alternative definitions, all of which provided some smoothing of the investment peaks, but the one most applicable to water supply was average incremental cost. The concept of AIC was a compromise between (1) efficiency of allocation in the short run; and (2) recovery of all investment in a future period, say, 10-15 years. It provided estimates of marginal cost which smoothed the "lumps" in the expenditure stream and also reflected the level and trend of future costs to be incurred to satisfy rising demands. The marginal cost-pricing principle had almost never been applied to the pricing of irrigation water. However, MCP might be useful in the pricing of municipal water.

32. Average cost pricing was intended to cover all costs, including depreciation, interest and operation and maintenance, and thus satisfied the requirement for financial viability. However, average cost might or might not be equal to AIC.

33. Unless average cost equalled or exceeded AIC, the goal of economic efficiency and financial viability could not be achieved.

34. The advantages of ACP were that cost was easy to calculate, whereas with AIC pricing many calculations were necessary. ACP also met all the financial requirements of the system. One disadvantage of ACP was that it did not encourage economic efficiency.

35. There should be no problem in the application of ACP to municipal supplies, but applying the principle to irrigation water might prove difficult since ACP was based upon accurate measurement.

36. Benefit pricing meant that users were charged for the actual benefits they received from an irrigation project in terms of increased income or increased land values, independent of their contribution to cost recovery. The funds recovered would enable the Government to pursue further development of the sector, and would prevent farmers from gaining windfall profits. The rationale was that the community paid for and implemented the project from which only a few benefited directly. The benefits they received should therefore be shared by the community.

37. The main disadvantage of that type of pricing was that it was unrelated to both the volume of water used and the actual cost of water. Furthermore, it was difficult to monitor increases in income and to overcome the problem of evasion.

38. Socio-political pricing (subsidies) meant that the Government financed most of the costs of the project, while the farmers were only expected to contribute to the operating costs of the system. Its objective was to recover only the operational costs of the system so as to provide maximum agricultural income for farmers and to redistribute income from the non-agricultural to the agricultural sector. The subsidy was meant to serve as an incentive to farmers to increase production by cutting down costs. The rationale behind that type of pricing was that the provision and disposal of water were integral parts of the infrastructure of the country and should be provided free.

39. The main disadvantage of the provision of subsidies was that it might discourage efficiency in allocation of resources and might lead to wastage, as users were not paying the full cost of water.

40. The costs of the project might be paid through general or specific taxation, rather than an assessment on the farmers directly. General taxation included income taxes, sales and production taxes which generally affected users and non-users equally. Specific taxes included those levied on certain crops and specific export commodities, as well as those levied on agricultural land.

41. One of the most common forms of socio-political pricing was the cross-subsidy. Generally for a large integrated water supply project, certain sectors (i.e. power) paid more than their share for the project and subsidized other sectors (i.e. irrigation).

42. Subsidies for agriculture might also be justified on the basis that production of certain crops enabled the Government to forego importation and therefore save foreign exchange.

43. Among the irrigation pricing policy alternatives brought out in document NR/WP/2 were the following:

(a) **Volumetric pricing** charged farmers according to the amount of water actually used. The volume might be measured by meters, time period of delivery, size of the outlet or proportional shares of water available. That method encouraged efficiency and led to cost recovery.

(b) **Payments per unit of land** were charges based on the number of hectares irrigated in the command area. That method was simple to apply and was used widely in developing countries. However, it discouraged efficient use of water.

(c) **Flat rates** were levies based on all land in the command area, regardless of whether water was used.

(d) **Payments per benefits received** were charges assessed on the basis of increased income or increased land values of farmers in the command area. They might take the form of commodity taxes or land betterment taxes. Those taxes redistributed benefits from the project, and prevent farmers from gaining windfall profits. However, they are unrelated to efficiency and costs.

(e) **Payment on the basis of crop** involved a cess which varied according to the crop grown. Its rationale was either that certain crops (i.e. paddy) used more water than others or that the Government wanted to encourage some crops over others.

(f) **Payment per season** was a cess which varied according to the abundance of water during that season. In the dry season, farmers were charged more per land unit than in the rainy season.

(g) Other payment methods mentioned included: payment according to distance from source; continuous flow fees; ability to pay contracts; and percolation rates.

44. Among the municipal water pricing policy alternatives discussed in the document were the following:

(a) **Flat rates** were charges unrelated to the volume of water used. They might include set installation charges and fixed service charges per billing period. They encouraged wasteful consumption.

(b) **Declining block rates** (promotional pricing) included a fixed charge for an initial volume of water, followed by progressively smaller unit prices within discrete ranges of quantities consumed. Such a policy was justified where systems were over-developed and capacity under-utilized, but generally discouraged conservation.

(c) **Rising block rates** (conservation pricing) included a nominal charge for a minimum quantity used, followed by increasing rates within discrete ranges. The minimum quantity was at a basic needs level and the approach favoured the poor. Its aims were income redistribution and conservation.

(d) **Uniform rates** referred to a constant charges per unit of water consumed, without regard to quantity. The same price would be charged to all users, regardless of location or time of year.

(e) **Differential pricing** meant that different categories of customers were charged different rates per unit of water. That was a very common feature of municipal water pricing systems (a sample of categories: (1) schools, churches (temples), hospitals, private houses; (2) government offices, international organizations; and (3) commercial uses).

(f) **Peak-demand pricing** meant that customers would be charged premium rates for using water during peak periods. Although ideally the peak period could apply to the peak hour of the day, the practice of applying peak rates had so far been limited to the peak season (i.e. summer in Europe and North America; the dry season in tropical areas).

(g) **Drought supply pricing** was the practice of using extra price increases during droughts to ration scarce water. Minimum charges would remain the same, but penalties for excess consumption would rise progressively.

(h) Other payment methods discussed included: capacity and service charges; interruptable service contracts; lot size, distance and connexion fees; and fixture and appliance charges.

45. Discussion on item 5 following the presentation of the documents centred mainly on systems of cost recovery from irrigation projects. In general, the feeling of the Meeting was in favour of charging farmers for the benefits received but political considerations and the limited capacity of farmers to pay prevented full cost recovery.

46. Some discussion on the use and philosophy of subsidies took place. The Meeting felt that subsidies were necessary in most of the irrigation systems of the region. Subsidies could be justified on social rather than economic grounds. In some cases the Government provided subsidies to encourage greater crop production, thus gaining some benefit by reducing the imports of certain crops and assuring the stockpiling of grains against shortfalls in dry years.

47. In discussing the quantification of social benefits from a water supply system, it was the concensus that social benefits could not be quantified although increased employment resulting from a project or benefits to other sectors owing to increased use for transportation, fertilizers, pesticides, etc., could be roughly estimated.

48. In discussing project preparation for external aid it was noted that, in addition to the technical and economic studies of alternative solutions, the presentation of financial projections for the project time and a period thereafter, including income statements, cash flow statements and balance sheets was also required. A positive rate of return on the value of the average net fixed assets in operation as revalued from time to time was usually required. That rate of return should in the long run be equal to the opportunity cost of capital.

IV. RECOMMENDATIONS

General

49. The Meeting agreed that appropriate levels of water prices could have beneficial results for countries in the utilization of their water resources.

50. The Meeting also agreed that in setting water charges, the price level should be such that:

(a) It would ensure efficient water use and lead to water conservation;

(b) It would ensure adequate return to fully cover operation and maintenance and to recover capital cost to the extent possible;

(c) It would be within the capacity to pay of the consumers;

(d) It would minimize the burden on the general taxpayer;

(e) It would be simple to administer;

(f) It would be based on a consistent and uniform policy applicable to various agencies;

(g) It would be consistent with and promote the economic and social development objectives of the country;

(h) It would be established after consultation with the consumers.

51. The Meeting also recommended that Governments should organize and mount a public information programme concerning the value and cost of providing water and reasons for setting appropriate price levels.

Irrigation

52. The costs of large irrigation projects in the countries of the region were currently borne by the Governments or the general taxpayer. At the same time the efficiency in the use of irrigation water had been very low. Appropriate prices of irrigation water could serve as an instrument to promote efficient use of water, minimize the burden on the general taxpayer and achieve other objectives, such as providing adequate incentives to farmers to use irrigation water and improving the economic conditions and financial capability of the rural people. The Meeting made the following recommendations.

53. In view of the fact that the farmers in small irrigation projects, including pump irrigation projects, in some countries of the region (Bangladesh, Thailand) were willing to pay a much higher rate for water than those in large projects, as a result of more reliable water supply, Governments should make greater efforts to improve the reliability and uniformity of water supply in their existing large projects. Farmers should be encouraged to participate in the operation of the system, to contribute to the capital cost and to cover the full expenses of operation and maintenance.

54. As subsidies for irrigation schemes in the countries in the region were inevitable under existing conditions, the level of subsidy should be subject to periodic review by the Governments. The Meeting recommended that Governments should carry out economic and financial studies for each irrigation project, which would include the investigation of primary and secondary benefits in order to reassess the subsidies from the Governments.

55. The feasibility of pricing irrigation water based on volume used (or approximations thereto) should be investigated.

56. Efficiency pricing of irrigation water might not be feasible and it might be necessary to consider the possibility of levying a benefit tax, in the form of land betterment tax, spread over, say, the life of the project. Land taxes offered scope for a progressive rate structure and thus achievement of distributional objectives.

57. Benefit taxes, if imposed, should allow for differences in net benefits generated by a project as well as differences in income levels; in short, benefit taxes should be progressive, while taking into account disincentives, tax evasion and problems of cost collection.

58. When establishing water charges and benefit taxes, a grace period should be included in the early project years, during which project beneficiaries would be required to pay substantially less than at full development. During the grace period, a schedule of gradually increasing rates should be adopted.

Urban water supply

59. Many countries in the region subsidized urban water supply heavily. Those subsidies required a large share of the Governments' budgets. In view of increasing needs for future investments and limited available resources, public funds should not be used, if possible, to subsidize recurrent expenditures (operation and maintenance expenses), since that would decrease investment capacity. Moreover, recovery of past investments was needed to continue the process of development, and loans would have to be repaid from income. Taking those needs into consideration, the objective of Governments should be to recover the full

cost of water supply from beneficiaries, namely, recurrent expenditures, as well as investments (depreciation) plus interest (actual or notional).

60. In order to reduce the difficulties of the water supply utilities in improving and expanding their service, it was recommended that the Governments should make greater and more sincere efforts to review the prevailing water rates and support their revision, if necessary, to place the utility on a sound financial footing. Governments should urge the people to support the rational water rate level.

61. An average water price should be set at a level which would recover the full cost of service. The average price scheme should incorporate differential rates with higher rates for industry and commerce which would provide some subsidy for domestic users. The costs of those service connexions (i.e. standposts) which provided for free water distribution to the lower income group should not be subsidized by the water distribution agency, but the costs should be recovered through a system of charges to be paid by the municipal government or welfare agency.

62. Water rates should be designed to approach the marginal cost of production and distribution as closely as possible on an over-all basis.

63. A dual rate structure might be employed, consisting of a fixed service charge based upon size of service connexions to recover fixed costs and a quantity charge which approximated the average incremental cost of water consumed. The dual rate system should guarantee the return of all fixed costs, regardless of quantity used, and should leave room for cross-subsidies from large to small users.

64. In those systems which did not have full metering, a flat rate should be established for the unmetered connexions, based upon the calculated capacity of the size of the connexion. That would assure full recovery of costs with rates that would be equitable to both metered and non-metered customers.

65. Each water supply utility, in addition to its budgetary system, should set up a sound accounting system on the basis of which the water rates could be revised periodically in accordance with the actual cost or the marginal cost. The Governments were requested to urge the decision-making bodies at all levels to acknowledge the importance of rate revision according to a rational formula and to permit the utilities to apply such rates.

66. Many urban water distribution systems had unaccounted for water, including leakage, estimated at 50-60 per cent of total water delivered to the system. Wastage through improper use of standpipes or house connexions without control valves could also consume a high percentage of the water in the system. It was recommended that Governments not only recognize that problem but also urge water distributing agencies to institute a programme of leak detection and repair and also of waste control. Through those programmes alone would water systems be able to defer capacity investments because the water saved would then be available for use.

V. ADOPTION OF THE REPORT

67. The report of the Meeting was adopted on 19 May 1980.

Part Two

WORKING PAPERS PRESENTED BY THE SECRETARIAT

I. PRINCIPLES AND ISSUES IN WATER PRICING POLICY: IRRIGATION AND MUNICIPAL WATER SUPPLY

(NR/WP/2)

INTRODUCTION

Traditional water policies have concentrated on the management of water supply. For irrigation water the management of demand, particularly through pricing, has seldom been attempted; prices are almost never used to control use. If properly implemented, pricing policies could avoid wasting resources on excessively large water supply systems, and at the same time prevent underutilization of capacity. Since water has come to be seen as a scarce resource which needs to be conserved, pricing policies are needed to contribute to the conservation objective.

Any increase in the consumption of water represents a benefit to the consumer. However, expansion in output of water for one use implies withdrawal of resources from the production of some other item or for some other use (opportunity cost). The expansion of output entails a cost to the would-be consumers of foregone alternative products and services. In a market economy, the general function of prices is to assert proper checks and balances on production and consumption. In this role, prices have two functions: to discourage excessive consumption of a commodity and to induce the desired supply of that commodity.

There are many reasons why water resource activities are concentrated in the public rather than the private sector. Most important is that the development of water resources is thought to provide basic infrastructural services and benefits to the whole community. Therefore, the public must finance such development. This rationale includes a number of subsidiary arguments in favour of public support: (a) income distribution; (b) externalities; and (c) economies of scale.

Some of the major factors which have an effect on the type of pricing policy the Government will choose are the need of the Government to earn revenue, the solvency of the particular agency and its ability to expand its services and the emphasis of the Government on income distribution or efficiency goals. Several of the important issues related to irrigation and municipal water-pricing policies are discussed in the following sections.

I. IRRIGATION PRICING SYSTEMS

Irrigation has traditionally been considered a means to promote development of agriculture, rather than economic efficiency. It has generally been implemented for the benefit of the farmer, rather than for revenue purposes, and is often co-operative in nature. Farmers have seldom been required to pay for it. Irrigation contributes to the stability of agricultural areas and prices and is therefore considered an economic good for the whole community. However, in recent years, water has become a scarce resource. The value of water in uses other than agriculture has made it uneconomic to use for irrigation under present pricing practices. Unless some portion of costs are recovered, irrigation may become an uneconomic proposition, even in the developing countries.

A. BASIC PRINCIPLES

1. Cost recovery

Cost recovery involves a repayment to the Government for all or part of the investment, interest, operation, maintenance and other expenses incurred in a given project by the people who benefit from that project. Ideally, cost recovery policies should be an integral part of project selection, design and evaluation. Such policies should concentrate on efficiency pricing of water as well as on discriminatory benefit taxes. Efficiency pricing leads to cost recovery by setting the level and structure of prices to be charged for output from an irrigation project so as to maximize its net economic benefits to the community. This principle, also called marginal cost pricing, aims to charge users up to 100 per cent of the actual costs incurred in building an irrigation project. The scope for efficiency pricing is limited, however, especially in developing countries where the actual volume of water consumed by each user is almost never accurately measured. These considerations are discussed in subsection (a) below.

In the absence of a means to measure the volume of water consumed, the extent of cost recovery of irrigation projects depends on the feasibility and desirability of levying special taxes on beneficiaries. This is discussed in subsection (b) below. Average cost pricing is referred to in subsection (c).

There are three main arguments in favour of assessing high water charges (or fees) in order to achieve cost recovery:

(1) Assessing high water charges makes it possible for the Government to augment its much-needed financial resources, and provide funds for further development projects.

(2) In one sense, cost recovery from beneficiaries promotes social justice in that only those who live in the command area pay. The alternative of all the people in the country paying the costs through general taxation is unfair and laden with potential political problems.

(3) Assessing farmers a high fee for water provides an economic incentive for less wastage of water. Farmers will perceive water as a more precious commodity. Furthermore, reduced wastage makes it possible to irrigate a larger area with the same quantity of water.

Opponents of cost recovery policies argue that:

(1) Some people receive direct benefits and others receive indirect benefits from irrigation projects. Therefore, there are difficulties in trying to recoup costs; it is not feasible to assess the indirect benefits and at the same time unfair to expect direct beneficiaries to bear the full burden.

(2) Irrigation potentials are frequently underutilized. Therefore if charges are increased, farmers will be less motivated to irrigate.

(3) Cost recovery policies do not take enough account of the need to help the socially underprivileged, to redistribute incomes toward the agricultural sector and to promote rural development.

(4) Cost recovery measures are difficult to implement, because both efficiency pricing and benefit pricing require accurate measurements and high administrative costs.

(a) **Marginal cost pricing (efficiency pricing)**

In economic terms the marginal cost is the cost of producing one additional unit of a product (in this case a unit volume of water). Marginal cost (efficiency) pricing means that all costs due to an increase in the output of a service are incorporated into the price of the increased output. It is based on the concept of "true prices", and should provide farmers with precise information regarding the real cost of water at the time of demand. It should enable the system to charge the farmer the real cost of his additional demand and should encourage him to use equipment at maximum capacity. Theoretically, it should encourage efficiency and avoid wastage.

Changes in costs are reflected in changes of price under efficiency pricing. Beneficiaries of existing projects are required to pay increased costs of operation, maintenance and off-site salinity. The price they pay should also be sensitive to their distance from the source and yearly variation in flow.

Furthermore, the opportunity cost of water should be taken into account when determining the marginal cost, that is, the cost of alternative uses foregone by using the water for irrigation. This must be included in the equation for determining marginal cost.

It is difficult to determine the true marginal cost of a unit volume of water. If a system is working well below capacity, the cost of an additional cubic metre of water is only the variable operating cost, which is much less than the average cost of one cubic metre. However, if the system is working at full capacity, and additional unit demanded will involve the cost of increasing the capacity of the dam, a new reservoir or distribution system.

A rather complicated method for determining the marginal cost of the various components of an irrigattion system has been worked out by Bergmann and Boussard.[1] The average or marginal cost of each service can be calculated for each geographical area, and the services required by each category of user can be summed. The problem with basing prices on the marginal cost of the construction works is that it ignores the demand for water. It is simply assumed that the quantities of water offered will be purchased at the set price.

Although marginal cost pricing may be more equitable than other systems, its use is limited as a result of measurement difficulties and complexities of the tariff structure. It is, moreover, impractical for farmers since they must be able to work out their budgets in advance on a relatively stable basis and should be able to understand the basis on which they are charged.

(b) **Benefit pricing**

The objective of benefit pricing or benefit taxation is to recover not only costs, but also some of the increased income accruing to the farmers as a result of the irrigation project built by the Government with funds from the general public. This objective entails not only the reimbursement of the costs of management, operation and maintenance and interest on capital invested, but also a certain proportion of net benefits obtained from irrigation by farmers. It is considered that increases in agricultural income from irrigation are substantial and that farmers should share the additional funds received with the community which implemented the project. In countries with a limited industrial base, the poor farmers in non-irrigated areas and workers are probably paying, through indirect taxation, for the investment useful to only a few farmers in the command area.

[1] Hellmuth Bergmann and Jean-Marc Boussard, *Guide to the Economic Evaluation of Irrigation Projects* (Paris, Organisation for Economic Co-operation and Development, 1976), p. 104.

A World Bank policy paper[2] emphasizes that discriminatory taxes on project beneficiaries should be a major focus of attention for cost recovery policies. It points out that the amount of recovery from benefit taxes should not exceed the incremental monetary income that accrues to beneficiaries from the project before the taxes.

Benefits may be determined by estimating the increased value of the farmer's income or of his land. An estimate of the former may be made by multiplying the market value of the crop grown by the probable quantity produced. Then a proportion of the increased income due to irrigation will be charged as sales tax. Moreover, a land betterment tax on the estimated increased value of the land can be levied on each hectare in the command area. The tax should be progressive: those who have more land should pay more tax per hectare than those with less.

The main disadvantage of this type of discriminatory pricing is that it is completely unrelated to both the volume of water used and differences of water costs in different locations. Another is that accurate monitoring of incomes is difficult, especially since beneficiaries have additional non-agricultural sources of income. Finally, it is difficult to overcome the problem of tax evasion, especially if the taxes are too progressive. The higher the progressivity, the higher the incentive to evade the tax.

(c) Average cost pricing (cost pricing)

Under the average cost-pricing approach, the water price is equal to the total costs of the project divided by the number of irrigated units of land or by the total amount of water consumed. In this case, total costs equal the amortization of the investment in irrigation, including interest from the capital invested over the estimated lifetime of the irrigation works, plus the annual expenses resulting from the operation and maintenance of the system.

The objective of average cost pricing is to provide total or partial reimbursement of public investment (with or without interest) and to cover the irrigators' working expenses so that the farmers may participate to some extent in gross investment capital formation. This approach is called cost pricing or price fixing based on average cost.

It should be noted that, in practice, the trend to subsidize costs of irrigation is such that average cost pricing is commonly understood as recovery of the initial capital investment over the project's lifetime, not including interest. This would be conservatively estimated as a subsidy of 40 per cent if the life time of the project is 40 years.

Reimbursement of investment in construction of a dam by the irrigation sector is often shared by other sectors benefiting from the water resource project (such as the power sector, inland navigation, etc.). In such cases, farmers benefiting from irrigation may be asked to pay some proportion of the total investment costs in instalments. This type of price fixing is based on the average cost of water and is designed to balance the annual costs of the irrigation system against the proceeds of water sales.

The advantage of charging on the basis of average cost is that, if applied correctly, it allows for total recovery of investment and interest. Furthermore, since everyone is being charged the same amount per unit land, it is much easier to levy and measure.

The disadvantages are that consumers must pay a very high price if the system is underutilized or working at less than capacity. Furthermore, new sites being selected for projects in recent years have been less productive and more expensive, since most of the good sites are now used up. Finally, if levied at a constant rate per unit land area, it will lead to wastage, as it is unrelated to volume used or marginal price.

2. Socio-political pricing (subsidies)

The objective of socio-political pricing is to recover only the working costs of the irrigation system, so as to provide maximum agricultural incomes to farmers in the area and to redistribute income from the non-agricultural to the agricultural sector. Although this system may go so far as to provide farmers with free water (i.e. Sri Lanka and Thailand), it generally has as an objective the recovery of at least operation and maintenance costs. Farmers are not required to participate in the costs of capital investment.

In most countries irrigation has been perceived to be so beneficial to the nation that it can justify considerable subsidization of irrigators. The goal of many Governments has been to provide the largest possible supply of water to irrigation, irrespective of real costs or economic demand. The subsidy is supposed to serve as an incentive to farmers to increase production by cutting down their costs. However, while the subsidies may have positive social and political results, they often do not produce the incentive effect. Although a lowering of fertilizer prices generally leads to increased fertilizer consumption and increased yields, the lowering of water charges often leads to an increase in consumption of water with little increased benefit.

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[2] Paul Duane, "A policy framework for irrigation water charges", Staff Working Paper No. 218 (Washington, D.C. World Bank, July 1975), p. 15.

In many countries, efficiency pricing of canal irrigation water has never been practised. The study of 17 irrigation projects financed by the World Bank[3] revealed that, on average, 30 per cent of total project costs were recovered. More significantly, the study showed that water charges comprised only 17 per cent of the incremental farm income.

Rather than making any pretense to recover costs, Governments often subsidize rural projects to meet their national development objectives: to increase exports and rural employment; to reduce migration to the cities; or to stabilize domestic food prices to redistribute income. It is often difficult to charge farmers during the initial years of a project because of considerable uncertainties; later it becomes politically impossible to introduce charges. Irrigation projects are, moreover, popular ways for politicians to help the people; each district must have its own irrigation project.

Subsidies are further justified by the difficulties encountered in trying to set water charges under conditions of uncertainty and variability in the quantity of water delivered. It is also difficult to determine water requirements on the basis of specific cropping patterns and delivery systems. For all the above reasons, most Governments have turned to general taxation to cover some or all of the capital costs of irrigation.

Bergmann and Boussard[4] note that such policies give rise to price distortions in the long run, creating disparities between the real cost of water and its price. They argue that it is doubtful whether national objectives such as income redistribution, regional agricultural development and lessening of economic disparities between regions can really be achieved by using the method of fixing the price of resources such as water at levels much below the real cost to the community.

If the price of water is too low, it leads to an increasingly large financial deficit for management of the irrigation system and to wastage and is likely to result in a shortage to the community.

(a) **General taxation**

Many irrigation projects are paid for by the general government budget, by taxes it collects from the public. Income taxes, consumer goods taxes and production taxes (on farm inputs and outputs) tend to affect project users and non-users equally. In many cases (i.e. Afghanistan, Indonesia and Thailand), no direct payment is made by the beneficiaries of the irrigation project. The economic justification for this is that the provision and disposal of water are integral parts of the infrastructure of the country, similar to roads, education and health services, and should be provided free of charge except for taxes.

However, experience has proved that the magnitude of investment required to satisfy the water demand for irrigation is greater than ordinary returns from taxation. Therefore, either more taxes are required or the irrigation works do not get built. The question then arises whether it is equitable for people to pay additional taxes for irrigation projects which benefit directly only a small group.

(b) **Indirect taxes**

Characteristic of many of the south and south-east Asian countries is that they rely heavily on indirect taxation in the non-agricultural sectors. This results from the difficulty of assessing and collecting taxes on the agricultural sector and from the general low level of rural incomes.

An indirect tax on principal crops is a method of charging mainly found in areas where crops are marketed by semi-State organizations (rice, cotton, etc.). An over-all charge is made based on the yield of the harvest in absolute terms and in price terms. Sometimes it is a flat rate and sometimes it is proportional to the price. This charging practice, the advantage of which is its great simplicity, does nothing to discourage wastage of water.

In some countries, taxes are reasonably specific to the irrigation sector, such as the rice export tax and related domestic pricing policies that favour consumers at the expense of producers in Thailand. Traditionally in Thailand farmers have not paid for irrigation water, in spite of the benefits received. The whole rice-growing sector therefore pays in the form of rice export taxes, which keep prices to farmers very low. There is strong resistance in the country to any rationalization of practices in the direction of charging users for benefits received.

(c) **Cross-subsidies**

Another method of subsidy, which enables Governments to recover the costs of investment, is cross-subsidy or cost sharing. This involves the payment of taxes on benefits by all who receive them, those who use the water for navigation, fishing, recreation and power as well as irrigation.

Cost-sharing induces local groups to select socially efficient projects since, if all users are paying a fair share, they will have no incentive to overdevelop the project. Ideally, local cost shares should be imposed in proportion to benefit shares at the margin for each purpose. Otherwise, if one sector (i.e. power) subsidizes another (i.e. irrigation), local irrigators will be

[3] *Ibid.*

[4] Hellmuth Bergmann and Jean-Marc Boussard, *op. cit.*, p. 99.

induced to demand larger irrigation projects than are socially efficient. H.E. Marshall[5] gives examples of how cost sharing could lead to better efficiency. He feels that in the United States larger shares should be paid by those using inland navigation and irrigation as well as those receiving benefits from flood control and improved water quality. Those users who are not yet paying a fair share for benefits are encouraged to over-develop systems.

Irrigators in the United States do not generally have to pay interest on capital investment; this is silently shifted to tax payers and may mean a huge subsidy over time. Furthermore, irrigators do not even repay the interest-free costs allocated to them on paper. Several projects in a river basin can be linked together so that large power-producing projects can be used to pay off costs of power-poor projects. In general, power revenues are used first to repay costs allocated to power, including interest, after which the revenues are utilized to meet the unpaid balance on irrigation costs. A study of the major river basin projects carried out by the United States Bureau of Reclamation[6] shows that power revenues pay 61.7 per cent of all project costs, while irrigators pay only 22.2 per cent.

(d) Special taxation (land tax)

It may be possible to recover investment costs by taxing the land benefiting from irrigation facilities, at a rate directly proportional to the benefits. However, it is difficult to quantity in precise terms the net benefits accruing to a farmer as a result of irrigation as well as the proportion of his net benefit which can be extracted without damaging his economic situation.

The yearly determination of benefits per farmer would require very complicated administration. Thus, a simplification can be used: the benefit to the irrigation district divided by the number of hectares in the district is considered as the benefit per hectare attainable by every farmer.

In Peru, fees are based on estimates of annual water deliveries, derived from expected water requirements of each crop times the number of hectares of each crop reported by each farm. The national user fees thus become land taxes that vary from crop to crop.

Land taxes offer a good opportunity for a progressive approach to cost recovery. Since a user's capacity to pay (net of other water charges) will be reflected in the value of his land, the most appropriate base for a land tax is the increment in the total unimproved value of command land attributable to the project. A progressive tax would require rates to increase directly with the size of the tax base.

3. Government objectives

(a) Conflicting government goals

Pricing policies are motivated by two fundamentally conflicting goals: efficiency and equity. Efficiency objectives are generally traded off or compromised on grounds of distributional equity. Prices are important instruments of policy in answering basic economic questions concerning the allocation of scarce resources to meet society's demands.

Pricing of any type, including systems of permits plus penalties, has effects on both the distribution of income and the allocation of resources. The goal of "capital recovery" aims to promote economic efficiency and to make all those who receive direct benefits for a project help pay for it. However, subsidized water rates are often used to redistribute income to particular groups. Such conflicting goals — the need to encourage efficient use of water, the desire to redistribute income towards the agricultural sector, the recovery of capital costs from users, the desire to favour small farmers, the need to minimize administrative costs — make policy making a very difficult exercise. Water laws need to be flexible enough to allow for a variety of site-specific solutions.

One way to combine the goals of efficiency and equity is a dual pricing system of permits or quotas combined with progressive penalties for exceeding them.

(b) Price determination

Price determination for irrigation water is a function of many inter-related site-specific physical, hydrological and agricultural factors such as climate, abundance of water, soils and crops. The combinations of regulations and prices also reflect trade-offs in the resolution of the conflicting goals mentioned earlier. Regulations and pricing systems also depend on the value of water, the dependability of supplies, systems of delivery, the extent to which flows can be regulated and the level of subsidization. Therefore, no one system of allocation can be universally recommended. Government objectives in the irrigation sector must be clearly defined before effective pricing policies can be adopted.

(c) Regulations

Conflicting government goals can sometimes be modified through a pricing system which includes both quotas and penalties. Such a system, used in Israel, assesses low prices for water within the official alloca-

[5] Harold Emory Marshall, "Economic efficiency implications of federal-local cost sharing in water resource development", *Water Resources Research,* June 1970, pp. 673-682.

[6] Robert K. Davis and Steve H. Hanke, *Pricing and Efficiency in Water Resource Management* (Washington D.C., George Washington University, December 1971), p. 123.

tions and progressively higher prices for water purchased in excess of these quotas. These higher prices (penalties) approximate marginal costs. The penalty rates for agricultural water use are lower than for other uses i.e., municipal, commercial.

When flows are uncertain and variable, it would be appropriate to consider allocating water to individual farmers on the basis of shares rather than volume. Resource efficiency will also be increased if shares or quotas are transferable among users or if the State stands ready to buy unused quotas and has alternative uses for them. These rights to preferential water deliveries can be used in the event of water scarcity. Making them negotiable allows market forces to allocate water to those users who, theoretically, can use it most efficiently.

An alternative to water pricing, particularly during water shortage, is rationing. Water charges may in some cases be poor instruments for allocation of scarce water resources among farmers. When there is a shortage of water the project authorities should instead ration either the amount of water supplied to each farmer or the total area that a farmer is allowed to irrigate. The first system, which is commonly known as **warabundi,** is used in Pakistan and north-western India. Limitation on area planted is practised throughout much of the rest of the sub-continent.

The real task of promoting water use efficiency in most developing countries has often been left to physical rationing. The purpose of the present paper, however, is to offer some alternatives to rationing as a means to promote efficiency.

(d) **Conclusion**

Water-pricing policies should no longer be viewed as simply the results of certain economic theories, but rather as important instruments to achieve certain national and regional goals, such as the following: economic use of water, promotion of production of certain crops; promotion of development in certain regions; proper allocation of water resources among users; and redistribution of income among economic sectors.

When pricing policies are viewed as a tool of socio-economic development, prices cannot be determined by economic criteria alone, but also by their social and technical impacts. Special attention should therefore be paid to: farmers' capacity and willingness to repay; productivity of land; need for water; profitability of the irrigation project; national agricultural production objective; and social benefits from irrigation development.

B. WATER PAYMENT METHODS

Water payment methods are the different ways in which water charges are assessed. Several common methods are discussed below, as well as some less common types found in specific projects. Prices are often calculated through a combination of these methods, as will be discussed below.

1. Volumetric pricing — payment per unit of water consumed

The need to encourage efficient use of water has led to pricing based on the measurement of the actual volume of water used. Where accurate measuring devices are not available, estimates of volume may be made by measuring the period of delivery or size of outlet. Knowledge of the shape and cross-sectional area of orifices, of the head of water in the water course and of the period of delivery gives a fair basis for estimating the volume of water supplied from a water course. Where water is scarce, it may be measured by the proportional division of variable flows along canals and the allocation of a certain number of minutes per irrigation cycle to each farm. The time indirectly gives the volume of the water supplied. Where irrigation water flows from a natural source, the unit of price may be a simple divider set in the channels to allocate the assigned portion to each farmer. The size of the outlet corresponds to the share purchased.

Other estimates of volume can be based on the type of irrigation delivery system used. If a rotation system is used, in which water is delivered according to a prearranged schedule, a farmer can contract to receive a certain approximate volume during each irrigation, or a fixed proportion (share) of total water available. He will pay per irrigation or according to the number of shares or proportion of water he receives.

In some parts of the world, but seldom in the developing countries, metered delivery systems are used, which provide accurate measurements and encourage efficiency. Under the demand delivery system, deliveries are made at the time and in the quantity requested by the user. This is the ideal system for the user as he will receive the most efficient and economic quantity of water. However, it is very difficult from the distribution point of view. Prices based on volume for this system are both feasible and sensible. The farmer need not be charged the same amount for each unit of water consumed. He may be given a basic quota at a low price plus gradually increasing rates for subsequent block quantities.

Volumetric pricing is particularly desirable in public tube-well and pumping schemes where water deliveries are relatively easily metered. Farmers in tube-well projects in India, Pakistan and the Philippines are willing to pay much higher prices for water if its availability is secure, leading to an extra crop. In water-short developed countries, where metering devices have become extremely sophisticated, closed-pipe sprinkler and trickle irrigation systems are used. Pipelines cover the entire project, and farmers can draw water at any time they desire. Full costs of water delivery may be charged to users. These are the most efficient types of irrigation in use at present.

The success of efficiency pricing of irrigation water depends on reliable measurement of water. However, the cost of measurement is often so high compared to the value of water that from an over-all social point of view, it is not desirable to measure it. In canal irrigation projects, especially those serving numerous small lots, metered sale of water is costly to implement and administer. It is rarely practised in developing countries.

(a) **Binomial rates**

Binomial rates, also called dual rates, consist of two separate charges to the user:

(a) A fixed rate, independent of water consumed, charged to everyone in the command area;

(b) A variable rate, based on the volume consumed.

The fixed rate is the charge made to every user regardless of whether he uses water and is basically set to cover original construction and maintenance costs. It assures a minimum guaranteed revenue to the managing body every year, and is an incentive to farmers to use the water made available to them. The variable rate is the charge made at a constant rate for each cubic metre of water delivered. It is set to cover those costs which are dependent upon the amount of water delivered, such as power costs and operation costs.

The price per cubic metre of water used may be made regressive: the first cubic metres consumed are of great value to the user and, beyond a certain volume, the price will fall. Regressive prices may encourage greater consumption in the initial stages of irrigation when farmers are still cautious. They reduce the cost of irrigation for crops which need a lot of water but are not highly profitable.

On the other hand, the price per cubic metre may be made progressive in order to limit consumption beyond the point at which the cost of the water becomes higher than its value in use. This method of charging is recommended where water is scarce.

Generally speaking, binomial rates are considered to be the most advanced method of paying for water, as they provide an opportunity to graduate the burden of the expense, particularly at the beginning of the irrigation scheme.

(b) **Monomial rates**

The user's charge is made on the basis of a single rate per cubic metre used. The basic rate generally remains constant, but regressive or progressive rates may be applied according to desires for encouraging or discouraging increased use of water.

2. Fixed rate pricing

Volumetric pricing is unworkable in many systems where the flooding method of irrigation is used (i.e. paddy production) or where undisciplined behaviour is widespread. It is also difficult to estimate volumes of water consumed in areas which use mainly the continuous flow irrigation method. Under such a method water flows through a farmer's canal on a certain day and he takes as much as he wants. Therefore, in most systems of Asia, some form of fixed rate is used, as discussed below.

(a) **Payment per unit of land**

The most universal form of payment for irrigation, particularly in developing countries, is per unit of irrigated land. The farmer will receive all the water he wants, but will pay only according to the number of hectares irrigated in the command area. The main disadvantage of this method of pricing is that it does not encourage farmers to use water efficiently.

However, it does help to recover some of the variable costs of the system and has the following important advantages: it simplifies the process of charging and accounting; and it reduces the chargeable costs to the farmer, since no water measuring devices are needed.

This method is favoured by many farmers and institutions, but it can only find economic justification in regions where water is abundant.

A similar charge per hectare of irrigable land is the flat rate, which is charged to every farmer in the command area for operation and maintenance expenditures, whether or not he uses the water. In this case, the water charge is similar to a land tax on number of hectares served.

(b) **Payment per benefits received**

As referred to above in section A.1 (b), pricing can take the form of a tax on the benefits received from an irrigation project.

Following the implementation of an irrigation project, land values generally increase rapidly in the command area. Land betterment taxes can be levied per hectare in the command area so that the fortunate farmers living there do not gain windfall profits at the expense of the rest of society. A land betterment tax spread over the life of a project should meet the test of user acceptability, if the tax base is an accurate measure of benefits received. Land taxes may also offer scope for a progressive rate structure and the achievement of distributional objectives.

Ideally, the benefits received per farmer should be calculated as incremental income resulting from the irrigation project. Taxes on benefits could be levied progressively, in the following way:

(i) Those with incomes below the "critical consumption level" (half the national average may be used as a rough guide) need not pay any tax on their incremental income;

(ii) Those with incomes below the national average but above the "critical consumption level" may be charged a small percentage of the estimated incremental income per unit land;

(iii) Those with incomes above the national income can be charged at a rate close to their capacity to pay, but it should be less than 100 per cent of their incremental income. Benefit taxes should be chosen and designed to minimize adverse effects of these taxes on the production and consumption decisions of farmers and others in the economy.

Although the basis for levying the tax is the benefit, it should be noted here that for practical purposes the charge is more often made per unit of land. The total benefits accruing to a command area are estimated and then divided by the number of hectares of land. Each farmer is then assessed at a proportion of that rate times the number of land units irrigated.

(c) **Payment on basis of crop**

Many systems charge farmers on the basis of the crop they grow (generally combined with the number of land units). There are several good reasons for this: some crops require much more water than others (i.e. paddy); some crops command much higher prices in the market than others ("rich" crops or "poor" crops); some crops achieve much higher yields than others. A common system is to charge a fixed price per crop per hectare and collect the charges at the end of the season. Another method is for the farmer to allocate a fixed amount of the crop yield for the payment of water. The actual income from the latter method will depend on the yield and price of each commodity.

Crop rates require a careful pricing structure to support sufficient rates of cost recovery. Crop rates are often imposed by the Government to encourage the production of certain crops and discourage that of others. However, such a policy may introduce distortions into cropping patterns and water use.

(d) **Payment per season**

The difference in the value of water between the rainy season and the dry season, and between the winter and summer, in many Asian countries is considerable. When water is abundant, an additional unit is worth every little. Therefore, charges during the rainy or winter season may be nominal, just to cover operation costs. Water for the rainy season should have a low enough price to encourage farmers to rely on irrigation water during drought periods, but not to the point of being free. However, water for dry season irrigation and that for seed beds preceding the rainy season may be charged at its full value, i.e. the cost it takes to store and deliver it.

Often a system of charging by the season is combined with payment by crop and by unit of land. It approximates a volumetric charge in the dry season, since it can be assumed that the total water requirements for a given crop are met by irrigation. Seasonal rates are very desirable as they help spread peak periods and use, at proportionate cost, throughout the year.

(e) **Payment according to distance from source**

It has been argued that prices should vary over distance, since the cost of distribution systems to outlying areas should be recovered. Thus, farmers located far from the source should be charged at higher rates than those located close to the reservoir. This charge reflects the marginal cost of delivering an extra unit of water to that location. Charges would be made to reflect canal costs and water losses with distance. This can be combined with a seasonal charge to reflect the differences in the abundance of water.

This type of discriminatory charge would encourage concentration of water in the upper reaches of the command area during periods of scarcity. This would minimize water losses and increase efficiency, but the farmers in the lower reaches of the system would receive only minimum amounts of water.

(f) **Continuous flow fee**

Under the continuous flow delivery method mentioned above, farmers usually pay annual fees for this service or contribute labour for the maintenance of the system. It does not make sense to levy charges per hectare irrigated or different rates for different crops.

It might make sense to charge according to the number of hectares in the command area or according to distance from water source.

(g) **Ability to pay contracts**

In the United States, the Bureau of Reclamation made long-term contracts for water supply to promote settlement and irrigated agriculture, not economy in water, and charges were made on an estimate of the user's ability to pay. Particularly in the United States, this is an obsolete concept which was introduced during the depression of the 1930s but is still in force in many areas today.

(h) **Additional payment methods**

Agreement rate. The price is agreed in advance according to a contract negotiated for a supply of water for one or several years. The rate is paid even if water is not actually used.

Occasional rates. These are charges levied in India for the use of water in an unauthorized manner, or for wastage of water. These charges are recovered as water rates in addition to any penalty on account of such use or wastage.

Percolation rate. In certain parts of India water charges are made on cultivated land within 200 yards of canals which receive by percolation or leakage from those canals an advantage equivalent to that which would be received by direct supply of canal after for irrigation.

Concessional rates. These serve as an incentive to farmers cultivating under rainfed conditions to change over to irrigation, and aim to meet minor expenses of land levelling, etc. Free water is allowed the first year after the distributary is opened. In the second and third year the charge is one third and two thirds, respectively, of the normal rate. The full rate is charged from the fourth year onwards.

Flat rate. The most basic charge is a flat rate for every farmer in the irrigation command area. This system is unrelated to the volume of water consumed and to the size of the area. It is a basic assessment used to help pay day-to-day operation costs.

Occupier's rate. Common in several States of Northern India, the occupier's rate is usually dependent upon the kind and extent of crop grown and does not take into account the cost of supplying water. Irrigators are charged lower rates to induce them to enter into long-term leases for water supply.

National tariffs plus local fees. Peru has two types of fees for irrigation water: (1) national tariffs, which are low and cover only costs of administration, operation and maintenance provided through the Ministry of Agriculture through its irrigation districts; and (2) local fees, which are levied by the local user committees to pay for their investments, canal cleaning and flood protection projects. Neither fee is intended to recover the capital costs of large projects.

Combination rates. The farmer living in a project who is receiving water through an old, dilapidated run-of-the-river irrigation system should not be expected to pay the same rate as one who lives in a new project with completely lined canals and storage water available from a reservoir. There may be several groupings of rates: the lowest for unlined canals, rainy season only; and the highest for piped water and year-round service.

II. MUNICIPAL WATER SUPPLY

Introduction

Rapid urbanization drastically increases demands for potable water to be piped to new residential areas. Meeting these demands often creates severe technical and administrative problems, arising primarily from lack of funds.

Financing the expansion and operation of water supply poses a number of issues of principle. Some argue that since potable water is a basic human need, it should be provided at the expense of the general public through taxation. Others contend that it should be specifically charged to the customer, for three reasons: (1) because not all taxpayers enjoy a public supply; (2) because water may be used for commercial purposes and (3) because water resources must be conserved.

Unlike irrigation water supply, the provision of municipal water fulfils the two necessary conditions for adoption of user fees. First, since it flows through pipes and is generally metered, it is possible to identify the beneficiaries of this service. Secondly, it is possible to ration use by piping only to those who request it and are willing to pay for water services.

One system for rationing use widely used in developing countries is intermittent service of water supply. Thus, water users will receive water for two to three hours per day (off-peak), which they collect and store for peak usage. During peak hours, enough water is available in the system for fire flow and emergencies. This system enables the water supply utility to postpone expansion of the system until funds and equipment are available.

A. COMPONENTS OF AN URBAN WATER SUPPLY SYSTEM

It is important to differentiate between the three main components of an urban system, as the costs to construct, operate and maintain them are quite different. These three groups of components account for varying proportions of total system investment. Howe and Linaweaver[7] estimate the rough averages for each component (in the eastern United States) as 30, 20 and 50 per cent respectively. The three groups are:

(i) Basic sources development, to supply average annual demand;

(ii) Transmission and treatment facilities, distribution pumping stations and major feeder mains to meet demands on the maximum day;

(iii) Local distribution mains, connexions and local storage to meet peak-hour system demands or maximum day plus fire flow, whichever is greater.

Thus, two systems experiencing equal average annual demands would be designed differently if their peak demand patterns differed. A large portion of system investment may be keyed to maximum day and peak hour demands, while the system is otherwise underutilized.

B. FACTORS AFFECTING PRICE

1. Cost of service

Appropriate prices must be related to appropriate measures of cost. In the usual water supply case, there are source costs; transmission costs; treatment, local distribution and storage costs. There are also some costs related just to the heavy peak demands placed on water supply systems. Sometimes one component of the system will have excess capacity and sometimes another component will have excess capacity. There are also economics of scale in most components of water supply systems that cause costs to depend on the sizes of system additions and their intensity of use.

There are all reasons why it is difficult to be very precise in specifying just how water supply and other services should be priced. The major point to be remembered, however, is that the method of pricing will affect the quantity demanded, and this quantity should influence the design of additions to the supply system.

It is also important to remember that costs of new source development are rising everywhere, not just in arid areas, and not just from inflation. The more any customer uses, the sooner the supply system will be forced to tap new, higher-cost sources.

2. Value of water

The value of water varies greatly depending on circumstances. When a system is working at less than capacity, the short-run marginal cost (of an additional unit of water) is very low. When a system is fully utilized, the long-run marginal cost equals the short-run marginal cost plus the marginal capacity cost. The marginal capacity cost is the total cost of expanding capacity, i.e. building a new reservoir. The long-run marginal cost is therefore very high. As Saunders and others[8] point out, capacity of a water supply is therefore expanded in large "lumps". In developing countries, especially, large backlogs of supply may be remedied and excess capacity created at the same time.

Because of this feature of capital investment, called "lumpiness" by some economists, there are periodic large expenses to pay, while day-to-day operating costs are minimal. Many economists recommend that existing small users and those who do not strain the capacity of the system need not pay for capacity expansion. Payment for the new system should be made by peak users, large users and new users, and should reflect the marginal costs of supplying them.

In addition to other measures of the value of water, it should be noted that the value of land increases considerably with house connexions. Bahl, Coelen and Warford[9] found that in Nairobi land values increased by 35 to 60 per cent following investment in water supply and by 20 to 50 per cent from investment in sewerage. Katzman[10] shows a similar increase in land values in Penang.

3. Demand elasticity

Demand elasticity of price for water measures the changes in quantity demanded stemming from a change in the price of water. Much of the literature on water pricing concentrates on this concept. Howe and Linaweaver in 1967 completed a pioneering study[11] of 39 municipal areas in the United States. The purpose of the study was to calculate demand elasticities and improve the procedures for estimating demand then being used by water utilities.

[7] Charles W. Howe and F.P. Linaweaver, "The impact of price on residential water demand and its relation to system design and price structure", *Water Resources Research*, First quarter 1967, p. 15.

[8] Robert J. Saunders, Jeremy J. Warford and Patrick C. Mann, Alternative concepts of marginal cost for public utility pricing: Problems of application in the water supply sector, Staff Working Paper No. 259 (Washington, D.C., The World Bank, May 1977).

[9] Reference to Roy W. Bahl, Stephen Coelen and Jeremy J. Warford, "Estimation of the economic benefits of water supply and sewerage projects", working paper (Washington, D.C., World Bank, October 1973) in Martin T. Katzman, "Measuring consumer surplus benefits of water supply extensions in developing countries", *Water Resources Bulletin*, February 1978, p. 48.

[10] *Ibid.*, p. 52.

[11] Charles W. Howe and F. P. Linaweaver, *op. cit.*, pp. 13-32.

Traditional method of demand estimation. The estimation of water demand has traditionally consisted of estimating population, multiplying by an average daily **per capita** use, and then applying peak-to-average ratios based on entire cities to estimate peak demands. In 1965, the United States Federal Housing Administration had promulgated the following standards: in the absence of reliable records, an average demand of 100 gallons (0.38 m^3) **per capita** per day and four persons per dwelling unit should be used. A maximum daily demand of 200 per cent of average and a peak hourly demand of 500 per cent of average were suggested, except for areas where "extensive lawn irrigation is practised", when 700 per cent of the average for peak hour rates was recommended.

Models of residential water demand. Howe and Linaweaver attempted to improve estimating procedures by breaking demand into domestic (inside) and sprinkling uses and also into metered, flat-rate, septic tank and apartment units. Their findings show that domestic demands are relatively inelastic with respect to price (i.e. there is not much reduction in demand when the price increases). On the other hand, sprinkling demands are elastic with respect to price, but less so in dry areas than in humid areas. Sprinkling demands constitute a major factor of total demand. Since sprinkling demand is price-elastic, reductions in consumer demand induced by increasing prices could have a significant impact on the design and size of the water supply system. Finally, Howe and Linaweaver found that maximum day sprinkling demands, which are very important to system design, were inelastic in the dry areas but relatively elastic in the humid areas. Thus pricing policies needed to modify consumer behaviour must be flexible and site-specific.

To support Howe and Linaweaver, other studies carried out in developing countries obtained similar price elasticities to those observed in the United States. Katzman demonstrates that over-all demand is price elastic and that there is a great difference between the amount people pay and the amount they are willing to pay. In Penang, he has found that poor families would be willing to pay about 150 per cent more than they are actually paying for water and that the benefits they receive are significantly greater than the financial returns actually captured by the water authority.[12]

Hanke, on the other hand, in his study of Boulder, Colorado, found a large decrease in domestic (inside) demand in response to the introduction of metering (see below). He feels that this reflects a higher elasticity of demand than had previously been measured.[13]

C. EFFECTS OF METERING

The effect of metering on domestic demand is a subject of much concern to water authorities throughout the world. The main questions are: Will the costs of metering be outweighed by increased revenue? Will metering reduce demand sufficiently to postpone expansion of the system?

The expected effects of a shift from a flat to a metered rate are as follows: reduction of waste; incentive to repair leaks; and the basis for a more equitable pricing system.

1. Reduction of waste

When meters are introduced, people can no longer take unlimited amounts of water at a fixed rate. Hanke's time series analysis of Boulder, Colorado shows that domestic (in-house) water demand fell by 36 per cent after meters were introduced and then stabilized at these lower levels. Sprinkling demand fell drastically, with actual sprinkling exceeding the calculated ideal under flat rates and being less than ideal under metered rates. Sprinkling use not only declined with the introduction of meters but continued to decline thereafter. The Hanke study shows that water users do not return to old wasteful use patterns after meters are installed and that metering results in a permanent and significant improvement in water-use efficiency.

He feels that the large decrease in domestic consumption probably reflects a once-for-all change in behaviour, such as putting in the stopper when washing dishes, that accompanies the introduction of a positive incremental change. Such a significant response of domestic demand to a further increase in incremental commodity charges will probably not occur.

Cross-sectional and time-series studies in different countries show that substantial reductions (up to 30 per cent or more) are possible when metered rates are used. Equally important is that metering, together with appropriate pricing structures, reduces by 50 per cent or more the average maximum day or peak hour water demands. This implies a reduction in system-design capacities, which in turn would reduce the size of investment in facilities.

2. Incentive to repair leaks

The large reduction in consumer demand following the introduction of meters results not only from a change in wasteful consumer behaviour. Perhaps more

[12] Martin T. Katzman, "Income and price elasticities of demand for water in developing countries", *Water Resources Bulletin*, February 1977, p. 48.

[13] Steve R. Hanke, "Demand for water under dynamic conditions", *Water Resources Research*, October 1970, p. 1258.

important is that the water authorities as well as homeowners can identify, and possibly correct, leakages in the system. Howe and Linaweaver show that annual average leakage and waste per dwelling unit is approximately 30 per cent lower in metered areas than in non-metered areas.[14]

3. Basis for a more equitable pricing system

Theoretically, metering would contribute to a more equitable system since it would reflect actual consumption, and users who consume less would no longer have to subsidize those who use more. However, charging on a volumetric basis does not cover all the benefits received from water service (such as increased land value). The benefits received are much greater than the water actually used, since it is the availability of the service that is really expensive. Therefore, most utilities advocate payment of a basic charge for investment or "sunk" costs, as well as a volumetric charge, which may be levied at a constant, rising or falling rate.

D. PRICING ALTERNATIVES

Most municipal water supply systems have several types of charges that they impose on customers, among them: a fixed service charge per billing period; minimum charges; charges linked to the number of fixtures or water-using appliances; installation charges; charges linked to lot size; **ad valorem** taxes; and water and sewerage charges that vary with the quantity of water used. Any arrangement of charges that does not vary with the quantity of water used is generally referred to as a flat rate charge. Charges varying with the quantity of water used are frequently referred to as commodity charges. Some of the most common systems of charging for water, as well as some which have recently been advocated, are discussed in the following sections.

1. Flat rates

Flat rates include any set of charges which are unrelated to the volume of water used. They generally include a set installation charge and a fixed services charge per billing period, no matter how much water is used. As several studies have shown, flat rates tend to encourage wasteful consumption: maximum daily usage and peak hour usage are much higher than in metered areas. Flat rates are only justified where there is an abundant supply of water and where the cost of metering is greater than the cost of supplying the excess demand.

2. Declining block rates (promotional pricing)

Under this system, a fixed (minimum) charge is paid for an initial volume of water, followed by succeedingly smaller unit prices within discrete ranges of quantities consumed. This system is most popular in the United States of America, where systems were initially overdeveloped and industries were given an incentive to use large quantities of water. Its main disadvantages are, obviously, that it encourages overdevelopment of systems and discourages conservation. Furthermore, the consumer who uses large and excessive quantities is being subsidized by the low volume users. Its advantage is that it encourages full utilization of the system. In 1965 a survey taken of 123 cities in the United States showed that 94 per cent of them used the declining block rate system[15]. In recent years, however, the need to treat water as a scarce resource has been recognized and some utilities in the United States have reduced the number of rate steps in the structure or have inverted the rate structure.

Declining block rate structures are strictly promotional, the result of an era when water utilities were making large but unavoidable investments in capacity and had excess water to sell. They are now an anachronism in the face of what are most certainly increasing long-run marginal costs. Today, nearly all of the economies from large-scale systems have been collected; and expansion, through competition for new dam sites and already over-used rivers, becomes more expensive.

3. Rising block rates (conservation pricing)

Rising block rates start with a nominal charge for a minimum quantity used, followed by increasing rates within discrete ranges. It is a relatively new concept and has come into widespread use in developing countries and areas which encourage the socially-favoured ability to pay criterion.

Generally the initial quantity sold at concessionary rates is determined at a basic needs level — that quantity of water needed for consumption by a large low-income family. In Bangkok, for example, the first 6 m^3 per month are supplied free of charge.

Increasing block tariffs have been adopted by 21 of the 36 developing countries in the studies carried out by the World Bank. Small customers are favoured and the rationale is clearly income distribution. Extension of service to the poor and avoidance of wasteful consumption tend to command a greater priority in the developing countries than in the more affluent ones. One disadvantage of this system is that it has no economic justification where there is excess capacity in the system.

[14] Charles W. Howe and F. P. Linaweaver, *op. cit.*, p. 14.

[15] Marshall Gysi and Daniel P. Loucks, "Some long-run effects of water pricing policies", *Water Resources Research*, December 1971, p. 1375.

It is expected that greater usage of "progressive" block rates or systems with low-priced quotas and progressive penalties for using more than one's quota will be spread throughout the developing world and that more affluent countries will increasingly realize the advantages of such a system.

4. Uniform rates

Uniform rates refer to a constant charge per unit of water consumed, without regard to quantity. It is based on the average cost concept, i.e. total system costs divided by number of units consumed. The same price is charged over a given area, over a given time and for a given user group, even though the costs of supplying different groups vary considerably over time and space. The main advantage of this method is ease of collection; the main disadvantage is that it does not at all reflect marginal costs of delivering the water.

Uniform rates applied over time and space do not properly charge those responsible for peak demands with the marginal costs of meeting those demands. Peak-users are subsidized by non-peak users and therefore have no incentive to curb consumption. The most obvious case of this is summer lawn sprinklers. Homeowners with small lots typically subsidize those with large lots. Uniform pricing over space similarly neglects the real incremental costs of expanding the system, resulting in large subsidies from those in high density areas located close to load centres to those in low-density suburban areas in outlying districts. Uniform pricing creates a disincentive for existing utilities to supply new customers in outlying areas.

5. Peak pricing

The objective of peak-demand pricing is to charge customers premium rates for using water during peak periods. Although ideally the peak period could apply to the peak hour of the day, the practice of applying peak rates has so far been limited to the peak season (i.e. summer in Europe and the United States; dry season in tropical areas).

In the 1950s and 1960s the water utilities in the United States began to realize that the local factor (ratio of summer use to winter use) was an important determinant of the cost of water and the size of the system to be built. As Graeser[16] points out, the ratios of maximum day to winter day average may be as high as 4.0 while the maximum day to the average day ratio ranges from 1.5 to 2.5, depending on lawn irrigation. These ratios, or load factors, reflect idle capacity and are a major factor in the unit price of water. If peak-rate demand could be reduced, the construction of additional capacity could be delayed, in some cases for several years.

Various types of peak demand pricing have been advocated. The summer differential rate charges higher rates for excess demand in summer. The minimum charge would remain the same, but unit charges at higher levels would increase. This encourages conservation and delays the need for capacity expansion.

A seasonal pricing system was tested for the Washington D.C. metropolitan area. For the test, the winter price included only generating costs, with no contribution to capacity costs, since capacity was underutilized. Summer (peak-load) prices reflected operating costs plus all of capacity costs. The most noteworthy result of the test was the reduction in summer season demand, by 8 per cent. This was offset to a degree by an increase in winter demand of 4 per cent. The main point is that the capacity load was reduced and the need to expand capacity was delayed (by an estimated 10 years).

Time-of-day rates are widely advocated, although examples of actural practice are difficult to find. Rates charged to industries which use a significant amount of water would be higher during peak hours. Long-term contracts could give concessions to industrial users who operate during off-peak hours. Time-of-day pricing will only be possible with the introduction of new meters employing clocks, and may require special meter readings and calculations.

Furthermore, the question of "shifting peaks" and long-term demand adjustment must be considered. If people knew they would be charged peak rates at some future time, they might store water, leading to a peak at an earlier time.

6. Drought supply pricing

Drought supply pricing is similar to peak-demand pricing and is based on the idea of using extra price increases during droughts to ration scarce water. When the reservoir is running dry, such rates can be used to raise money for a new reservoir. Drought supply prices could be much higher than seasonal peak prices, i.e. as the drought persists prices continue to increase. Minimum charges would remain the same for residential consumers, but penalties for excess consumption would be progressively rising.

7. Capacity and service charges

Many water utilities levy a fixed charge based on the size of the pipe or the water meter. The reasoning behind these charges is that the capacity of the system is rarely used and extremely costly. Users can pay for system capacity in proportion to the capacity available

[16] Henry J. Graeser, "The art of rate making", *Journal American Water Works Association*, May 1978, pp. 238-239.

to them. Since such a fixed capacity charge would have little effect on actual water usage during peak demand periods, economists often prefer peak-demand pricing. Peak-demand charges have the effect of limiting usage at critical times and hence cause a larger reduction in the required capacity.

In addition to the capacity charge there may be a fixed fee to cover administrative costs and meter reading, or a volumetric charge to cover the metered amount of water used.

8. Interruptable service contracts

Some electric utilities make concessions to large customers who agree to a termination over a specified time period or reduction of service during crises. In return the utility reduces rates to be paid. It would be practical to write such contracts in the case of water and sewer services as well. If cities use these contracts they can reduce reserve capacity for emergencies. Since such contracts reduce capacity requirements, it would be logical to reduce any capacity charges paid by those who sign them. Those who signed would be industries least inconvenienced by such reductions in service, i.e. the same customers who would make the largest reductions if peak demand pricing were introduced. Contracts have the advantage of reducing demand by a definite amount. Peak-demand pricing has the advantage of providing extra revenue and a clearer indication of how much customers value extra capacity.

9. Lot size, distance and connexion fees

The length of water and sewer main lines to local neighbourhoods is influenced by the size of the lots, their topography and layout. The smaller the lots, the lower will be the cost of the major trunk lines. One-time-only fees based on the size of the lot are sometimes charged when people connect to the water and sewerage system. Distance fees represent the cost of local service lines, while connexion fees represent the cost of the meter plus labour and equipment for making the connexion. Some cities now charge different "distance" fees for those living inside and outside the city limits. Distance or "zonal" charges could be added to service connexion fees to cover added fixed costs of main lines, and to volumetric water rates in order to recover the extra costs of pumping and maintaining longer lines. Ideally, the full cost of the pipeline should be charged to the customers along it, even to the owners who do not request water services. The rationale is that property owners should pay for the availability of the service.

10. Payment by user group

Discrimination among users means that different categories of customers are charged different rates per unit of water. This is a very common feature of municipal water pricing systems. A sample of categories: (1) schools, churches (temples), hospitals, private houses; (2) government offices, international organizations; and (3) commercial uses.

In Costa Rica a new tariff system, introduced in 1976, distinguished between five classes of consumers: domestic; ordinary (including commercial); reproductive (using water as a direct means of commercial profit); preferential (welfare, education, hospitals, etc.) and government. A different tariff was imposed on each class based on capacity to pay and volume used. A rising block-rate system is used within each class with a basic low minimum payment to cover the essential needs of a large family. The Costa Rican experiment has emphasized social equity. However, the charges to some people, such as commercial customers, are higher than the actual costs of supplying them.

11. Fixture and appliance charges

An alternative to metering would be to charge families according to the number of facilities and water-using appliances in their homes. For example, a house with three bathrooms may have only two people living in it normally. They have an extra bathroom in case guests come to stay, in which case they expect water to be available for all three baths. In this pricing system, a bathroom would be charged a given price, no matter what its size or how much it is used. This would also be true for a dishwasher, air conditioner, etc. The value of each would be measured in units. This system could incorporate a progressive tariff, i.e. the first bathroom would be charged at a lower rate than the second or third.

The main advantage of this system would be that metering would not be necessary and charges would remain the same between periodic inspections. The disadvantages are that periodic internal inspections would be needed and that such a system would discourage conservation.

12. Pricing combination

Combinations of the preceding pricing policies have been recommended by various observers as optimum, in terms of both efficiency and equity goals.

For example, Gysi and Loucks[17] advocate a combination of summer differential rates and an increasing block rate pricing schedule. This would offer higher economic returns (revenue), while it holds rationing requirements to a minimum and rewards low consumption users with lower average rates. In El Salvador, the water utility charges a low minimum rate with rising block rates and a uniform rate above a certain level.

[17] Marshall Gysi and Daniel P. Loucks, *op. cit.*, p. 1375.

E. CONCLUSION

An infinite variety of pricing combinations is possible. The combination of pricing policy alternatives chosen by each utility must be based on government policy priorities. The conflicting goals of redistribution of income, cost recovery, efficient allocation of resources and assistance to the poor can be reconciled partially by the correct combination of pricing alternatives.

As water is a basic need, the price of drinking water, which is usually low, can in general be increased. It has been mentioned that even low-income families are prepared to pay higher prices for drinking water. Provided therefore that delivery and service is good, the price of drinking water can be increased to raise needed funds for future expansion. The principal considerations which must be taken into account in designing the price structure are equity, capacity to pay, conservation, demand elasticity, cost of the system and the service, and the cost of developing an alternative water supply. On this last point, there is a limit to which the price of water can be raised because large commercial firms or industrial users can develop alternative sources of water supply such as ground water. The cost of water from such alternative sources is the maximum at which public utilities can set their water prices.

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II. WATER PRICING OF URBAN WATER SUPPLY IN SELECTED COUNTRIES OF THE ESCAP REGION

(NR/WP/1)

INTRODUCTION

Asia is the most populous continent in the world. As shown in table 1, the total population of 18 developing countries in the ESCAP region in 1975 was 1,121.6 million, of which about 261.9 million (23 per cent) lived in urban areas. Seventy-three per cent of the total urban population in 1975 was served with piped water supply, of which about 51 per cent was served by house connexions and 22 per cent by public standposts. The urban population served varied greatly, being 22 per cent in Bangladesh, 31 per cent in Burma, and 100 per cent in Singapore, Malaysia, Tonga and Samoa. The quality of the service is not uniform. In many urban communities the supply of water is intermittent and inadequate and the water is not properly treated or evenly distributed.

In order to improve the living standard in densely populated urban areas, alleviate the incidence of water-borne diseases and promote tourism, most countries in the region have been exerting great efforts to improve their urban water supply and sanitation services in accordance with the recommendation of the Mar del Plata Action Plan, designating the 1980s as the International Drinking Water Supply and Sanitation Decade.

In most countries of the ESCAP region, the local government has the responsibility for the provision of urban water supply or supervises the management of the utility. Owing to the lack of capital funds, particularly the foreign currency required for essential items of plant and equipment, and shortage of qualified engineering staff, the progress in the improvement in services has been slow and in many cases the systems have become inadequate owing to increase of population.

The urban water supply utility in most countries is a semi-autonomous enterprise. In general, it is required to be a financially self-supporting utility, generating adequate cash revenue to cover all operation and maintenance expenses, depreciation and an adequate surplus for its debt-service obligations and to provide a reasonable part of the capital funds required for its expansion. In other words, the water charges to the customers should be set at a level to meet the above criteria in order for the utility to have a sound management base.

There are many reasons, however, which prevent the water rates from being set at the required level. These include: unsatisfactory service resulting from insufficient water supply and low pressure, high percentage of losses in the transmission and distribution systems, and inadequate metering of house connexions; inadequate billing and poor collection; the great diversity of income among customers; and the increasing cost of system expansion.

The present paper describes the background of and provides information on water rate structures of urban water systems in seven countries of the ESCAP region in 1976-1978, based on the latest available information. Within a country the tariff structure varies from city to city, and most of these urban water supply utilities have development plans for their expansion and improvement, including innovations in their tariff structure and level of charging.

A. AFGHANISTAN

1. Background and organizations

The estimated total population of Afghanistan in 1976/77 was 14 million. It is estimated that 14 per cent of the population is urban, 77 per cent rural and settled and 11 per cent nomadic. Of the total urban population of two million, 35 per cent is located in the Greater Kabul area and the remainder in 86 other towns. The Central Authority for Water Supply and Sewerage (CAWS), is a quasi-autonomous authority under the Ministry of Public Works and is responsible, on a national basis, for the planning, construction, operation and maintenance of urban water supply and sewerage systems. In 1976 it operated the water supply systems in Kabul and in four other cities. In 1975, only 7 per cent of the urban population (175,000) was served by house connexions and 33 per cent (800,000) by public standposts.[1]

2. Water charges (Kabul)

The total population of Greater Kabul in 1976 was approximately 700,000, of which 560,000 were grouped in the urban area. It was estimated that 250,000 urban inhabitants were receiving an intermittent supply of water through about 6,700 private connexions and over 730 standpipes. Although 75 per cent of the consumers rely on public standpipes for their supplies, the maximum daily demand cannot be met. The combined production of the present public water supply sources is about 25,000 cu m per day.

All consumers with private connexions are billed on a flat-rate basis, depending on pipe diameter, because (a) supply is intermittent, and (b) the existing meters installed are inoperative. CAWS plans to replace the defective meters and intends to extend metering to all private consumers and thus rationalize water use by billing actual consumption. The consumers served by public standpipes are not charged. The operation of the flat-rate billing system has been ineffective. The Government continues to maintain CAWS' financial viability through budgetary allocations. The Government has not yet paid CAWS for the public standpipe and fire hydrant charges.

However, in order to improve the operation of the Kabul water supply system, agreement between the World Bank and the CAWS has been reached as follows:

(a) Until the beginning of its fiscal year 1980/81:

(i) CAWS will levy water charges equivalent to an average rate of not less than Af. 7.50 (or US cents 16.65) per cu m for water supplied at private connexions; and

(ii) The Government will pay to CAWS not less than Af. 7,500 annually for each public standpipe and not less than Af. 3,000 for each hydrant;

(b) From the beginning of its fiscal year 1980/81, revenues will be adequate to cover all expenses of operation, maintenance and administration, but not depreciation; and

(c) No later than for its fiscal year 1982/83, revenues will be adequate to cover:

(i) Expenses of operation, maintenance, administration and depreciation;

(ii) Rates of return on average net fixed assets in operation of not less than 1 per cent in 1983/84, 3 per cent in 1984/85, 5 per cent in 1985/86 and 7 per cent in each subsequent year.

The average unit cost of the incremental supply of the Kabul water supply and sewerage project was estimated at about Af. 17 (or US cents 37.7) per cu m using an interest rate of 10 per cent per annum.

B. BANGLADESH

1. Background and organizations

Bangladesh had a population of about 85 million in 1978. Dacca had a population of 2.3 million and Chittagong, the second city, about 700,000. These two cities, plus the other 76 towns, bring the total urban population to about 7 million. The high incidence of cholera and other waterborne diseases reflects the extensive use of untreated water from streams, tanks and dug wells. Fortunately, ground water is abundant; it requires little treatment and is relatively inexpensive and therefore, public water undertakings use it as a principal source of supply.

The central Government exercises control over the sector through the Ministry of Local Government, Rural Development and Co-operatives (MLGRD). The agencies operating under MLGRD are the Department of Public Health Engineering (DPHE), the municipalities and, in the case of Dacca and Chittagong, Water and Sewerage Authorities (WASAs). DPHE develops water supply projects country wide, and operates and maintains waterworks throughout the rural areas. In urban areas DPHE generally hands over operational and maintenance responsibilities to the municipalities, except in the case of Dacca and Chittagong, where the WASAs are responsible for all aspects of water supply and sewerage.

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[1] World Health Organization, *World Health Statistics Report*, vol. 29, No. 10, 1976.

Until the mid 1960s the **per capita** supply of water had increased from about 50 lcd (litre **per capita** per day) in 1940 to about 110 lcd in 1964. Thereafter **per capita** supply dropped to a level of about 86 lcd in 1979, although total production had increased from about 75 mld (million litres per day) in 1964 to about 214 mld in 1979.

In 1978 there were about 52,000 connexions of all categories serving about 1.8 million of Dacca's 2.3 million people. About 200,000 individuals depend on about 1,400 standpipes — about 150 persons per standpipe. About 1.6 million people are served by house connexions. However, only 25 per cent of total consumption is metered.

2. Water charges (Dacca)

The tariff structure of the Dacca water supply in January 1978 was as follows:

(a) **Premises with metered supply**

	Takas per 1,000 gallons	*US cents per cu m ($US 1 = Tk 15.5)*
(1) Residential/community type buildings	3.50	5.96
(2) Offices and commercial premises	18.00	30.67
(3) Industrial premises		
First 150,000 gallons/month	9.00	15.34
Next 150,000 gallons/month	7.50	12.78
Above 300,000 gallons/month	6.00	10.22

(b) **Premises with non-metered supply (payment based on assessed property value)**

(1) Resident/community	10 per cent per annum
(2) Commercial/offices/industrial	5 per cent per annum

In 1978 the total operating revenues were TK 35.3 million; the average tariff was Tk 5.6 per 1,000 gallons (or US cents 9.54 per cu m).

WASA's rate of return on net fixed assets in operation has been low. It reached 0.6 per cent in 1976, 1.7 per cent in 1977 and 1.1 per cent in 1978. Despite the low return, WASA has been able to generate sufficient cash internally to cover its operating expenses and debt service, and to finance a small portion of its investment programme (on an average about 14 per cent). The reasons for WASA's inadequate financial position are: (a) inadequate tariff levels, (b) inadequate metering (about 75 per cent of consumption unmetered) resulting in excessive water consumption and waste, and (c) inadequate billing and collection. In 1978, collections from non-government users were only about 65 per cent of the billings.

D. INDIA

1. Background and organizations (Greater Bombay)

While the central Government exercises considerable influence on the water supply sector, State governments in India have primary responsibility for the development of the water supply and sewerage facilities. They execute their responsibilities through various departments of government and agencies which, in turn, may delegate part or all of their duties to local authorities.

Bombay is the capital city of Maharashtra State and the second largest city in India, having a population of 7.6 million in 1977. The Water Supply and Sewerage Department (WSSD) of the Municipal Corporation of Greater Bombay (BMC) was established in 1973 and is responsible for the planning, development, operation and maintenance of water supply, sewerage and sewage disposal services.

The estimated yield in 1977 from the existing water supply sources was 1,600 million litres per day (mld), of which 955 mld was available for distribution to 7.6 million domestic consumers after allocations to industry, commerce, areas on the route of major conduits and after allowances for transmission and distribution losses. The resulting average availability of water of about 125 litres **per capita** per day was much less than the average demand and the supply was therefore limited to 2 to 8 hours per day, depending on the location. In 1976 it was estimated that about 2.5 million people were served by standpipes (on average 370 persons per standpipe) and 4.8 million people by house connexions (30 persons per connexion).

Approximately 47 per cent of the existing water connexions are metered, including all industries, most commercial undertakings and many domestic supplies. It is estimated that about 40 per cent of the meters do not function satisfactorily.

2. Water charges (Greater Bombay)

The tariff structure and details of charges in 1977-1978 are as follows:

	Rs per 10,000 litres	US cents per cu m	Percentage of total revenues
(a) **Premises with metered supply**			
Domestic use	2.50	3.00	13.5%
Domestic with lawns exceeding 25 m², swimming pools, fountains, sports grounds, food preparation premises, public utility undertakings, private hospitals and nursing homes	10.00	12.00	
Offices, banks, industries, electricity and gas production plants, hotels and other commercial uses	20.00	24.00	36.8%
The foregoing are subject to a minimum charge by meter size 15 mm to 80 mm and above	15.00 to 140.00	18.00 to 168.00	
(b) **Premises with unmetered supply**			
Water tax based on property value or compounded charges based on the following:		7%	3.4%
Temporary premises — per day	21.00 to 450.00	25.20 to 540.00	0.9%
Offices, banks, restaurants, lodging houses per month — per tap	15.00 to 35.00	18.00 to 42.00	
Charitable establishments — per year	18.00	21.60	
Other premises per month — per tap	11.00	13.20	
(c) **All premises**			
Water Benefit Tax (from 1/4/74)	5%		13.1%
(d) **En-route supply (metered) —**			
Industries	24.00	28.80	2.9%
Municipalities (Thana and Bhiwandi)	3.40	4.08	
(e) **Meter charges**			
Rentals 25 mm to 500 mm — per month	4.00 to 340.00	4.80 to 408.00	2.3%
Testing 15 mm to over 200 mm —per month	22.00 to 173.00	26.40 to 207.60	
(f) **Sewerage charges**			27.1%
			100 %

In financial year 1976, domestic consumers with a metered supply and sewer connexion paid a combined water and sewerage average of Rs 0.375 ($US 0.04) per cu m. Industrial consumers paid a combined water and sewerage charge of Rs 3 ($US 0.35) per cu m. In addition, all consumers paid a water benefit tax and a sewerage benefit tax of 5 and 3 per cent of property values respectively, which were introduced from financial year 1975 to finance the programme of capital expenditures. Slum dwellers are charged Rs 2 ($US 0.23) per month for water and sewerage services.

In 1977, total water revenues were Rs 332 million and the total quantity of water sold was 490 million cu m. The average tariff rate was Rs 0.68 (or US cents 7.91) per cu m.

The rate of return on revalued assets was 16.6 per cent in 1977.

E. INDONESIA

1. Background and organizations

In 1975 Indonesia's population was about 130 million. Java, which has about 65 per cent of the total population of the country, has only 7 per cent of the land area. About 24 million of the population are urban dwellers, living in cities of more than 5,000 inhabitants.

Three ministries of the Government of Indonesia are principally responsible for the water supply sector: the Ministry of Public Works, for urban areas, the Ministry of Health, for rural water systems, and the Ministry of Home Affairs, by virtue of its responsibility for local governments and enterprises. The Directorate of Sanitary Engineering (DSE) under the Ministry of Public Works is the implementing agency for urban water supply projects and provides technical and management assistance to Water Enterprises (WE). Local governments, or water enterprises organized by local ordinance in corporate form, are responsible for the operation and maintenance of waterworks and for extension of the distribution systems.

It is estimated that about 41 per cent of the total urban population have access to piped water supply. However, most of the water supply systems suffer from low pressure and intermittent supply. A considerable portion of the urban population is dependent on dug wells and streams, with the attendant health risks.

In late 1978 the Government formulated a new policy for urban water supply. This policy aims to provide a basic quantity of safe water to as many people as possible and as rapidly as possible during the third five-year plan (Pelita III) (1980-1984). The first priority for water supply is to provide about 60 litres **per capita** per day to about 60 per cent of the population in each of 10 large cities, 40 medium-sized cities and 150 small towns to meet basic needs.

2. Background of waterworks in four cities

Two of the cities, Jember and Tangerang, are located in Java, while Para Pare is located in Sulawesi and Ambon in the Ceram Islands.

The total population, the population served in 1978 and that expected to be served in 1987 of each city are shown in the following table.

City	1978 (thousands)					1987 (thousands)				
	Total population	Population served				Total population	Population served			
		By connexions		By stand-pipes			By connexions		By stand-pipes	
		Number	Percentage	Number	Percentage		Number	Percentage	Number	Percentage
Ambon	89	14	16	6	7	97	54	55	19	20
Jember	110	22	20	12	11	128	58	45	51	40
Para-Pare	70	5	7	—	—	80	37	46	28	35
Tangerang ...	75	5	6	—	—	129	98	76	26	20

Ambon. Ambon is an international entry point and the main port and capital of Maluku Province. Its present water system was originally constructed in 1925 and expanded in 1954 and 1974. The service area is about 4 sq km and serves about 14,000 persons through 2,500 connexions, about 30 per cent of which are metered, and 6,000 through standpipes.

Jember. Jember is Java's eastern seaport. It serves as the commercial centre of the Regency of Jember. The water supply system was originally constructed in 1930 and expanded in 1958 and 1976. About 90 per cent of its 1,800 customers are metered. The service is intermittent.

Para Pare. Para Pare is a port city and is the second most important trade centre in South Sulawesi Province. The water supply system operates for 6 to 12 hours per day.

Tangerang. Tangerang is an industrial city located 25 km west of Jakarta. The water supply system was built in 1925 and expanded in 1950. The service area has diminished and only six per cent of the population is served. Service is provided about 12 hours a day.

3. Water charges in four cities

The rate schedule depends in part on whether the connexions are metered. In 1978, the rate schedules prescribed flat monthly rates for unmetered connexions, based on the number of faucets or the type or size of connexions. For metered service, separate rates are usually specified for residential service and other classes of service such as commercial, industrial, government agencies and social institutions. The over-all effect of the present rate schedules is reflected in the average revenue per cubic metre of water sold, which, given the limited reliability of the available information on production and consumption of water, is estimated as shown in the following table.

Average water rates (Rupees per cu m)

		1978		1985 (Based on 6 per cent return on net fixed assets)	
			US cents		US cents
Ambon —	All classes	12	(1.92)	251	(40.16)
	Residential	10	(1.60)	196	(31.36)
Jember —	All classes	19	(3.04)	154	(24.64)
	Residential	15	(2.40)	92	(14.72)
Para-Pare —	All classes	22	(3.52)	201	(32.16)
	Residential	20	(3.20)	125	(20.00)
Tangerang —	All classes	30	(4.80)	204	(32.64)
	Residential	28	(4.48)	102	(16.32)

The present level of water rates will not be sufficient for the most part to fully meet current cash operating expenses. The resulting deficits will be covered, as in the past, by equity funds from the local governments. The estimated rates for 1985, which will generate sufficient funds to provide a 6 per cent return on net fixed assets in operation, are also shown in the above table, and are much above the present rates.

The question of reasonable and sustainable future rate levels is one of the most difficult in view of the uncertainties as to demand, income patterns and capabilities of paying for the service. The problem is compounded by the availability of alternative, although unsafe, sources of water from shallow wells and streams. The Government of Indonesia has undertaken to ensure that the guidelines, which follow the principle of graduated water rates based on quantity used and ability to pay, will be followed in formulating the water rate structures in the municipalities which will participate in the national water supply programme.

F. PHILIPPINES

1. Background and organizations

The total population in 1977 was about 44.5 million. It is estimated that only about 17.0 million people (38 per cent) are served by public water supply systems. Of these, 3.2 million are in the Metropolitan Manila Area (MMA), 3.7 million in other urban areas and 10.1 million in rural areas. Insufficient investments, growth in demand, advanced age of the facilities and high leakage rates arising from inadequate maintenance have reduced water main pressures. Many systems are operated to supply water for only a few hours a day to avoid loss of water during the off-peak hours.

In 1971 the Metropolitan Waterworks and Sewerage System (MWSS) was created to be primarily responsible for water supply and sewerage in MMA. In 1973 the Local Water Utilities Administration (LWUA), a semi-autonomous government corporation, was established to: (a) assist in the formulation and development of sound locally-controlled water districts; (b) provide loans; (c) provide technical assistance; and (d) establish and enforce standards of service. Responsibility for water supply in the urban centres, which are not covered by MWSS and LWUA, as well as in the rural areas, rests with the local authorities.

2. Background of the Manila Metropolitan Waterworks System

The 1977 service area of MWSS includes 5 major cities and 21 of the 22 municipalities that form MMA and continguous municipalities that are currently not in MMA. It covers a total area of 144,021 ha. The total population in 1977 was about 5.8 million. About 53 per cent of the total population is served by public water supply. The population served in the various classes of services are as follows:

	Direct service by connexions	Standpipes	Borrowers from neighbours	Total
Population (thousands)	1,975	378	722	3,075
Percentage of total	34	7	12	53

In 1977, the consumption of industrial, commercial and institutional and domestic uses was 21,100 and 158 million cu m respectively. The water unaccounted for (production less sales) was 48.6 per cent of the annual production. The total supply of 1,350 mld is treated in two independently-operated treatment plants at Balara, in Quezon City, northeast of MMA. In addition, about 3 mld is obtained from ground water. Though 82 per cent of MWSS's service connexions are metered, most of these meters are either defective or in such an advanced stage of dilapidation as to need replacement within the next few years.

3. Water tariffs of the Manila Metropolitan Waterworks System

According to the current water rates which have been in existence since May 1974, domestic consumers pay ₱0.20 per cu m (US cents 2.7 per cu m) for the first 30 cu m of monthly water consumption (with a minimum monthly charge of ₱6.50, including ₱1.50 as service maintenance fee), ₱0.40 per cu m for the next 20 cu m and ₱0.60 per cu m for consumption above 50 cu m. For commercial consumers there is a uniform rate of ₱0.60 per cu m and industrial consumers are charged ₱0.80 per cu m. The average revenue is ₱0.50 (US cents 6.75) per cu m. The operating results for 1977 show a surplus of ₱25.7 million, a rate of return of about 2 per cent on the book value of net fixed assets, which will drop to about 1 per cent if the assets are revalued at current prices.

In order to attain a financially self-supporting utility, the tariffs should be maintained at such levels as would be necessary to achieve a rate of return of at least 8 per cent on revalued net assets in operation. This rate of return will enable MWSS to provide from its own resources about ₱400 to ₱600 million annually for capital investment, thereby reducing its dependence on the government funds for expansion of its facilities. To achieve this rate of return, the average rate is forecast to be raised to ₱0.80 in October 1978, and ₱1.70 in January 1982.

For a very poor family of 8 members, 15 cu m of water per month (about 60 litres **per capita** per day) is an adequate consumption. The monthly water charge for this level of consumption, at the new rates, would be ₱6.00 (or $US 0.81). Assuming that such families have an income of $US 34 per month (half the poverty level), the water charge will be about 2.5 per cent of income.

G. NEPAL

1. Background and organizations

Nepal, with an estimated population of 12.6 million 1975, and an area of 141,000 sq km, lies parallel to the main Himalayan range of mountains. About two thirds of the land area is taken up by high mountains and the lower slopes, the remaining one third, a narrow strip to the south, called the Terai, is the borderline of the Indo-Gangetic plains.

About 10 per cent of the population lives in the Himalayan region, 50 per cent in the hills of the lower slopes and the remainder in the Terai. In 1976 only about 6 per cent of the people living in some 58 communities had piped water supplies, and the majority of those live in the larger urban areas. Twenty-four urban areas with a population in 1975 of 630,000 have water supply systems serving about 86 per cent of that population. About 20,000 house connexions, including 5,000 metered connexions serve a population of about 160,000 (25 per cent of the urban population). The balance of the population served use standpipes. All urban supplies are intermittent owing to insufficient supply, storage or distribution capacity.

The Water Supply and Sewerage Board (WSSB) was formed in 1973 to act as the executing agency for the first International Development Association (IDA)-financed project for water supply and sewerage service in the Kathmandu Valley and for Pokhara, a town about 200 km to the west. WSSB will eventually become a state-wide corporation. The Water Supply and Sewerage Department of the Ministry of Water and Power has responsibility for the design and construction of water systems in all urban areas other than the Kathmandu Valley and Pokhara, mostly by public standpipes. The Local Development Department under the Ministry of Panchayat was created in 1971 to assist communities of less than 3,000 with public works, including water supply.

2. Water charges of the water supply system in Kathmandu Valley

In 1976, the total population in Kathmandu Valley was estimated at 286,000, of which about 141,700 were served with private connexions and 133,280 with standpipes. By the end of 1975, some 2,000 connexions out of a total of some 17,000 had been metered. On average, it consumed 50 lcd in 1975. The supply is available only four to six hours a day. The system production capacity from seven sources is 364 litres per second, or 31.44 mld. The system losses amounted to about 50 per cent.

The 1977 charges for water were introduced in 1975. The flat rate charge varies according to the size of the supply pipe and the number of taps. The metered charge is at the rate of NRs 0.50 (or US cents 4) per cu m for the first 10,000 litres per month and NRs 0.80 per cu m for all consumption over 10,000 litres, with a minimum charge according to the size of the supply pipe. Standpipes are charged to the Government of Nepal at the rate of NRs 100.00 per standpipe per month.

In 1977, the total operating revenues of the Kathmandu and Pokhara systems were NRs 5.23 million, and the total quantity of water sold was 7.68 million cu m. The average rate of charge is computed to be NRs 0.68 (or US cents 5.44) per cu m.

It was estimated that with the current rate of charge the rate of return on net assets would be 1.5 per cent in 1977 and 0.33 per cent in 1978. With 100 per cent increase in charge rates, the rate of return would reach 3.5 per cent in 1979.

H. SRI LANKA

1. Background and organizations

The 1971 census shows that of 2.6 million people (21 per cent of the total population of 12.7 million) living in 135 urban communities, almost 2.0 million (77 per cent of the total urban population) in 66 communities have piped water supplies, but about four fifths of these supplies are judged to be inadequate in quantity and are of questionable quality.

The National Water Supply and Drainage Board (WDB) under the Ministry of Local Government and local authorities are responsible for provision and maintenance of water supplies; WDB's primary functions are planning, design, construction and supplying water in bulk. After construction, water supply systems are readily transferred to local authorities to operate and maintain, although in a number of cases WDB operates and maintains headworks or entire systems.

In 1976, Colombo had a population of 608,000 people. Its water supply system is intermittent and pressures are frequently reduced in an effort to reduce leakage and conserve water. In 1976 the supply was limited to some 4 to 6 hours per day. The situation is similar in towns to the south, where a population of 440,000 people receive an intermittent low-pressure water service.

Consumers in Colombo Municipality are supplied through 45,000 service connexions and some 750 standpipes. Domestic supplies are unmetered, but the larger commercial and industrial consumers are metered. In towns south there are 27,000 unmetered domestic connexions and some 60 per cent of the population is served by standpipes. Throughout these areas, the piped supply is supplemented by private wells. Under normal operating conditions the total quantity of water available for both areas is 54.5 million gallons (imperial) per day (248,000 cu m per day).

2. Water charges in Colombo and towns south

(a) Background

In the past, the Government's financing policy for the sector had tended toward providing "free" water by indirectly charging for it through property tax levied on households. There are indications that the policy is changing in favour of direct consumer charges based on usage.

(b) Bulk supply

WDB supplies most of its treated water to local authorities for distribution to consumers, but it also supplies water directly to a relatively few commercial users. Charges to the local authorities range from Rs 0.44 (US cents 5.5) to Rs 0.60 (US cents 8) and to the commercial consumers from Rs 0.75 to Rs 3.00 per 1,000 gallons (or 4,546 litres). The average charge is about Rs 0.60 per 1,000 gallons. WDB's provisional operating results for 1975 and estimated results for 1976 show that these charges are insufficient to cover operating expenses.

(c) Retail supply

The cost of providing a water supply in the local authorities' areas, along with the cost of all other local government services, is primarily borne out of the yield of the government rates levied on the annual value of assessed property.

The total rates on property value are 30 per cent for Colombo municipality and 16 to 21 per cent for authorities of the five towns south. It is the practice of Colombo municipality not to identify that portion applicable to water; in the five Towns South it varies from 6 to 9 per cent. Charges for metered commercial consumers vary among the local authorities and range from Rs 1 to Rs 5 per 1,000 gallons. The estimated average water charge of the National Water Supply and Drainage Board in 1976 was Rs 0.55 per 1,000 gallons (or US cents 1.66 per cu m), resulting in no return on investment.

(d) **Water charges with a reasonable rate of return**

WDB, in establishing a tariff, needs to ensure that the level is such as to generate sufficient revenues to cover operating expenses and debt service, and begin financing a portion of the capital investment from internal cash generation. It is estimated that in order to reach a rate of return of 5 per cent, the average charge should be raised to Rs 0.96 (US cents 13) per 1,000 gallons.

The charge rate of retail supply was roughly estimated to be Rs 2.70 to 3.00 per 1,000 gallons in Colombo and Towns South, respectively, for a rate of return of 7 per cent. The average incremental cost of water in the Colombo area is estimated at Rs 4.3 per 1,000 gallons.

SUMMARY AND CONCLUSIONS

The main features of the major water supply systems in the seven ESCAP countries as described in the preceding sections are summarized in table 2. It shows the percentage of population served by house connexion and public standpipe, level of service, main characteristics and average water charge rate. The conclusions which may be drawn from the preceding discussion are the following:

(1) Except for the customers in Kabul, where those served by public standpipe do not pay any water charge and the billing system is ineffective, the water users of the other six water supply systems paid tariffs to the water supply authorities. Compared with the cost of the water supply, the current rates are low except for those of the water supply system in Greater Bombay. Six systems had no surplus or a marginal surplus revenue. The rates of return to their net fixed assets ranged from negative to 1.5 per cent.

(2) In order to generate adequate internal cash surplus to provide a substantial part of capital funds for system expansion, the rate of return to the net fixed assets should be 6 to 8 per cent per annum. To attain a rate of return of 6 to 8 per cent, the tariff of these six systems should be raised considerably. The net fixed assets should be revalued after a few years owing to the high rate of inflation.

(3) It would be very difficult for a water supply utility to raise its tariff, if the service were poor and the water supply intermittent and inadequate. As indicated in table 2, six of the seven systems supply water only a few hours a day. The production capacity of 86 to 110 litres **per capita** per day in three of the systems listed in table 2 is too low to meet the demand. In many systems the pressure in the distribution system is also low in order to reduce the leakage loss in the transmission and distribution systems.

(4) The high percentage of water unaccounted for, which is estimated to be 48.6 per cent for the Manila waterworks system and 50 per cent for the Kathmandu Valley system, not only reduces the quantity of available water for the use of the customer, but also increases significantly the unit cost of the water sold.

(5) As shown in table 2, in most of the systems the percentages of metered connexions are below 25 per cent. Owing to the high percentage of unmetered customers, it may be inferred that wasteful consumption is inevitable and the cost of water is not distributed equitably among the customers served.

(6) Proper billing and an efficient system of bill collection are important requisites for improving the financial situation of a water supply system. If customers are not correctly billed according to the quantity of water used or only a low percentage of bills is collected, the raising of the tariff would not be effective.

(7) It is noted that a progressive tariff was applied in some water supply systems, such as those in Greater Bombay, Manila and Kathmandu. In such cases customers using more water pay a higher rate. While this measure is designed to conserve water and to place a greater burden on the affluent sector of society, the rates should be based on a careful study of the consumption patterns of the different sectors comprising the population.

(8) The commercial and industrial customers are charged much higher rates than individual consumers. However, in most developing countries of the region the commercial and industrial sectors consume only a small portion of the water supplied by the system. Moreover, the rates for this sector cannot be raised too high because it can turn to a cheap alternative source of water, such as groundwater, if it is available.

Table 1. Urban population and population served with piped water supply of some developing ESCAP countries in 1975

Country	Total population (thousands)	Urban population (thousands)	Urban population: Percentage of total population	Total urban population served with water supply (thousands): With house connexion	With public standpost	Total	Percentage of urban population
Afghanistan	16 660	2 437	15	175	800	975	40
Bangladesh	78 960	9 100	12	522	1 480	2 002	22
Burma	30 170	6 965	23	394	1 765	2 159	31
Fiji	570	227	40	200	2	202	89
India	598 430	133 750	22	75 000	32 000	107 000	80
Indonesia	130 600	23 195	18	7 210	2 300	9 510	41
Iran	33 020	15 524	47	9 252	2 546	11 798	76
Malaysia	11 920	3 736	31	3 329	407	3 736	100
Nepal	12 590	529	4	150	300	450	85
Republic of Korea	35 280	16 431	47	15 004	605	15 609	95
Pakistan	70 260	19 637	28	6 490	8 238	14 728	75
Papua New Guinea	2 760	367	13	88	22	110	30
Philippines	42 520	16 518	39	8 578	4 967	13 545	82
Samoa	150	43	29	37	6	43	100
Singapore	2 250	2 250	100	2 250	—	2 250	100
Sri Lanka	13 510	4 019	30	847	600	1 447	36
Thailand	41 870	7 154	17	4 201	735	4 936	69
Tonga	100	41	41	17	24	41	100
	1 121 620	261 923	23	133 744	56 797	190 541	73

Sources: (1) ESCAP, *Statistical Yearbook for Asia and the Pacific*, 1977.
(2) World Health Organization, World Health Statistics Report, vol. 29, No. 10, 1976.

Table 2. Summary of services and water charges of seven water supply systems in the ESCAP region

	Country/city	*GNP per capita, 1976 (US dollars)*	*Total urban population (thousands)*	*Level of service and character of the system* — *Percentage of population served*: *House connexion*	*Public standpipe*	*Total*	*Continuous or Intermittent supply*	*Percentage of connexions metered*	*Supply capability (lcd)*	*Water charge*: *Year*	*Average rate, US cents[a] per cu m*	*Rate of return to net fixed assets (percentage)*
1.	Afghanistan . . . . Kabul	160	560	11.1	33.5	44.6	Intermittent	—	100	1976	[b]	negative
2.	Bangladesh . . . . . Dacca	110	2,300	69.6	8.7	78.3	Continuous	25[c]	86	1978	9.54	1.1
3.	India . . . . Bombay	150	7,600	63.2	32.9	96.1	Intermittent	47	210	1977	7.91	16.6
4.	Indonesia . . . . . Four cities	240	344	13.4	5.2	18.6	Intermittent	...	...	1978	3.32	negative
5.	Philippines . . . . . Manila Area	410	5,800	46.5	6.5	53.0	Intermittent	82[d]	440	1977	6.75	1.0
6.	Nepal . . . . Kathmandu Valley	120	286	49.5	46.6	96.1	Intermittent	12	110	1977	5.44	1.5
7.	Sri Lanka . . . . . Colombo and Towns South	200	1,048	...	...	...	Intermittent	[e]	240	1976	1.66	negative

[a] Exchange rate local currency for $US 1: Afghanistan, Af 45.0, Bangladesh, Tk 15.5, India Rs 8.6, Indonesia Rs 625, Philippines ₱ 7.4, Nepal NRs 12.5, and Sri Lanka, SRs 7.28.

[b] Billing system is ineffective. Government allocates funds for its operation.

[c] Percentage of total consumption.

[d] Most of these meters are defective.

[e] Only larger commercial and industrial consumers are metered.

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III. IRRIGATION WATER CHARGES IN SOME COUNTRIES OF THE ESCAP REGION

(NR/WP/3)

INTRODUCTION

Agriculture is the principal economic activity in most countries in the ESCAP region, where more than 70 per cent of its population depend on agricultural production for a living. Many of the developing countries or areas[1] in the region are food-deficit countries, spending a large amount of foreign currency on importing food. A small number of food-surplus countries export agricultural products as their main export goods. The Governments of most of these developing countries have long followed a policy of increasing their agricultural productivity, either to meet the increasing demand of food of their increasing population, or to maintain the level of exports of their agricultural products.

Many countries in the region have been undertaking irrigation development for many years to increase the cropping intensity of existing cultivated land or to raise the crop yield per hectare of land. There are usually two main goals for most irrigation projects. The first is to increase food production to supply the food requirements of the population and to ensure low food prices through abundant supplies of agricultural products. The second is to improve the standard of living of the rural population through the improvement of their production capability and income. Because of high pressure owing to population increase, very low standards of living of the rural population and a limited base for industrial development, the main strategy for economic and social development adopted by many countries is to increase agricultural production without in many cases paying much consideration to the rate of return of capital investment or the recovery of capital cost.

In the ESCAP region the construction of major irrigation projects is undertaken with capital funds provided by the Government and loans from external sources. After completion of the project the farmers benefited are usually charged a fee for the operation and maintenance costs of the irrigation system and, sometimes, for the repayment of the capital cost. In almost all countries in the region the charges levied are very low as compared with the actual cost of irrigation water. In many cases, the water charges are even insufficient to cover the annual operation and maintenance expenses. Insufficient funds for operation and maintenance result in poor performance of the irrigation project and hinder the attainment of the real objectives of the project.

The capital cost of irrigation now ranges from $US 1,000 to $US 3,000 per ha of irrigated area. The low level of repayment of the capital cost by farmers results in wasteful use of capital, unequal distribution of wealth, depletion of limited financial sources and inefficient use of irrigation water.

There are, however, many factors which make it difficult to raise water charges. These include: irregularity and unreliability of water supply from irrigation systems; low level of cultural techniques; inadequate supply of farm inputs, credits and other services; small farm holdings; defective tenure systems; great variation of income among and low repayment capacity of farmers; lack of farmer's co-operation and inefficient co-operative organization at the farm level; inadequate government policies and laws dealing with irrigation water charges; and low prices of agricultural products at the farm gate.

The present paper reviews the current practices concerning irrigation water charges in nine countries of the ESCAP region. Within a country, the rate structure may vary from project to project, and depend on the nature of the project.

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[1] Bangladesh, Fiji, Hong Kong, India, Indonesia, Japan, Malaysia, Papua New Guinea, Philippines, Republic of Korea, Singapore and Sri Lanka.

A. AFGHANISTAN

1. Traditional systems

(a) Regulation and organization

There is no legally established water users' association. Local customary law acknowledges a practice whereby landowners in a particular area band together to exercise community control over water use. They have traditional rules for maintaining and repairing the waterworks and for selecting and rewarding a water master (Mir Aub). The elected Mir Aub is responsible for the supervision of the delivery of water and for the needed repair work.

(b) Water charges

There is a land tax which varies from Af 1 to Af 10 per **jerib**[2] (or $US 0.1 to $ 1 per ha) per annum, depending on the classification of the land and its location, the availability of water and other relevant factors. There is no separate charge on water. However, the farmers are requested by the **Mir Aub** to contribute separately in the form of labour necessary for repair work in proportion to the size of their holdings. In addition, the **Mir Aub** is paid by the farmers a salary of approximately Af 1 per **jerib** per year.

2. Modern systems

The Government has extreme difficulty in levying water charges for recovery of investment or to cover the operation and maintenance costs of any traditional scheme that has been remodelled or rehabilitated through government investment. At present, the Government resorts to indirect ways of recovering the project cost through collection of the Graduated Land Tax and revenues from cotton marketing.

B. BANGLADESH

1. Background and organizations

For centuries Bangladesh farmers have used bucket-lift methods for irrigating a dry-season rice crop on lands near low-lying water bodies and rivers. Until the late 1950s almost no effort was made towards further development of the water resources. In 1979 the total irrigated area was about 2.8 million acres (1.1 million ha), which consisted of 0.1 million acres by gravity supply, 0.2 million acres by ground water from tube-wells, 1.3 million acres by low-lift pumps and about 1.2 million acres by traditional methods. The Ministry of Power, Water Resources and Flood Control through the Bangladesh Water Development Board is responsible for planning, implementation and operation and maintenance of all projects, large or small, for flood control, irrigation and drainage for the whole country. The Ministry of Agriculture, through the Bangladesh Agricultural Development Corporation, is responsible for the installation of low-lift pumps and deep and shallow tube-wells, and for repairs and services of these pumps. The Integrated Rural Development Programme, under the Ministry of Local Government and Rural Development, provides training for model farmers and local leaders in various fields, including irrigation by pumps and tube-wells and construction and operation of small drainage and irrigation schemes.

2. Water charges

No unified regulations for water charges for various types of irrigation have been established.

(a) Deep tube-wells

The deep tube-well is the most expensive of the small-scale irrigation systems. One tube-well with a capacity of 2 cu ft per sec (cfs) can irrigate about 24 ha. The construction cost per unit is over Tk 180,000 (or $US 11,600),[3] but the farmers pay only Tk 1,200 per year for its use, and have to bear the cost of fuel and operator. About 90 per cent of the cost is subsidized by the Government.

(b) Shallow tube-wells

The shallow tube-well with a capacity of 0.5 to 0.7 cfs can irrigate 3 - 6 ha. They are sold to the farmers outright by cash or on an installment basis. Except for a part of the indirect overhead costs and possibly the import duties and taxes, all capital and operation and maintenance costs for the shallow tube-wells would be borne by the users.

(c) Low-lift pump

Low-lift pumps with a usual capacity of 2 cfs are employed to raise water from perennial streams or ponds to irrigation fields, normally during the dry season. The farmers pay the costs of diesel fuel, lubrication oil, operator's salary, spare parts and rental charges. In 1979, the rent was Tk 600 each per season. The subsidy by the Government is about Tk 3,500 each per annum, which is about Tk 220 per ha per annum, or about 70 per cent of the total cost.

(d) Traditional methods by manual operation

The total costs are borne by the farmers.

C. INDIA

1. Regulations and organizations

There are various irrigation acts and codes which regulate irrigation in the States in India. The authority to set and levy water charges resides in the State

[2] 1 jerib = 0.2 ha.

[3] $US 1 = Taka 15.5.

government. In a majority of the States the water rates payable by an irrigator are assessed by canal officers and the assessed amounts are recovered by revenue officers.

In recent years the Command Area Development (CAD) Organization a wing of the Irrigation Department, was established to take the responsibility for major irrigation development and management in order to improve the performance of new irrigation projects. A CAD authority (CADA) is set up for each major irrigation development project. Each CADA is headed by an administrator who, through an executive committee, co-ordinates the governmental agencies participating in crop planning and water allocation, operation and maintenance of the canal networks and maintenance of command area roads, farm support services and on-farm development. The operation and maintenance of canal networks are the responsibility of CADA.

2. Rate structure

There is considerable diversity in the systems for levying irrigation charges in different States. In north India, irrigation works supply water to a variety of crops raised on different fields and in different years. The irrigation requirement and the profit vary from crop to crop. Water charges are, therefore, fixed on a crop-acre basis with different rates for different crops.

In south India, the major irrigation works are primarily for irrigating rice. It is more convenient and economical to combine irrigation charges with land revenue and to recover a consolidated amount. On new projects, however, water rates are being levied on a crop-area basis.

In West Bengal, the deltaic region of Orissa and parts of Bihar and Madhya Pradesh, where climatic conditions make it uncertain whether the cultivators would in any particular season take water or not, attempts are made to induce the irrigators to enter into leases for irrigation, which could be for as long a period as 10 years, or for a single season. Under this system, lower rates are charged.

Water charges thus comprise: (a) an occupier's rate, which varies by season and crop and is levied per unit area actually served; (b) a flat charge or irrigation cess per unit area covering all areas served by the project, whether or not actually served during a given season or year; and (c) a betterment levy, applied per unit area served by the project. The first two charges are generally earmarked to recover operating and maintenance costs, while the betterment levy is earmarked for the recovery of a portion of capital cost.

3. Water charges

(a) Gujarat State (1968-1971)

(1) Irrigation water charge, Rs/ha ($US/ha)[4]

Kharif (wet) season		
Coarse paddy	44.5	(5.2)
Fine paddy	61.7	(7.2)
Rabi (dry, cool) season		
Wheat and vegetables	44.5	(5.2)
Perennial and hot weather crop season,		
Tobacco	49.5	(5.8)
Cotton	69.2	(8.0)
Sugar-cane	370.5	(43.1)
Bajri, donwar	44.5	(5.2)

(2) Irrigation cess, Rs 6.2 per ha on land served by gravity irrigation, whether actually served or not.

(3) Betterment levy: varies from project to project.

(b) Uttar Pradesh State (1967)

The only significant mode of levy is direct water charges; generally, no other cesses or betterment levies are imposed.

(1) Gravity irrigation schemes

	Charge (Rs/hectare)		
	Schedule I[a]	Schedule II[b]	Schedule III[c]
Sugar-cane	32.00	16.00	8.00
Rice, vegetables	14.00	10.00	4.00
Tobacco	16.00	12.00	4.00
Wheat, barley, their mixtures	12.00	10.00	4.00
Cotton	4.50	3.00	2.00
Fodder	3.00	2.00	2.00
Green manure	2.00	2.00	2.00
Other rabi crops	9.00	5.00	4.00
Other Kharif crops	7.00	5.00	4.00

[a] Schedule I generally applied in western, central and eastern Uttar Pradesh.

[b] Schedule II applied mainly in southern Uttar Pradesh.

[c] Schedule III, uncertain water supply, applied mainly to hilly regions.

(2) Tube-well irrigation schemes

Source	Charge (gallons per rupee)
Wells powered by:	
(i) Electricity from hydro or thermal sources	16,000
(ii) Diesel or diesel-electric	11,000

[4] Using exchange rate $US = Rs 8.6.

(c) **Maharashtra Irrigation II Project**

Background

The operation of this project would help to finance a substantial portion of the surface irrigation development programme of Maharashtra, i.e. the construction of six major surface irrigation schemes (519,000 ha) and the rehabilitation of two existing schemes (150,000 ha). Weather patterns are dominated by erratic rainfall; the annual average is about 600-800 mm, with four fifths occurring in the warm July through September monsoon season. Under rain-fed conditions, average land holdings vary between 2.0 to 7.5 ha. Typically, about 80 per cent of the land is owner-operated and 20 per cent rented. The average capital costs for the schemes are estimated as follows:

	Infrastructure	*Part I Works*	*Part II Works*	*Operation and maintenance*	*Total*
	(Rs per ha of net cultivable command area)				
Total capital costs[a]	17,060[b]	700	1,150	—	18,910
Annual financial requirement	1,720[c]	114[d]	186[d]	100	2,120

[a] All expressed in June 1979 prices.
[b] Including sunk costs.
[c] In present value terms, at 10 per cent interest rate over 50 years.
[d] In present value terms, at 10 per cent interest rate over 10 years.

Direct charges

(i) **Water charges**

At present, the prime vehicle for recovery of capital and costs for irrigation works is the water charge. Different rates are charged for each crop, roughly corresponding to the amount of water utilized. The present rates (1978) are the highest in the country:

Name of crop or season	Rate, Rs/ha
Sugar-cane and plantains	750
Other perennials	500
Kharif seasonal crops	50
Rabi seasonal crops	75
Hot weather seasonals	150
Hot weather cotton	250
Hot weather ground-nuts	250
Pre-seasonal watering	75
Post-seasonal watering	20–25

(ii) **Other water-related charges**

A 20 per cent local cess is levied on the water rate. An employment guarantee scheme cess is levied at a rate of Rs 25 per ha of irrigated land, and an education cess varies with the crops grown, as follows:

Crop	Rate (Rs/ha)
Sugar-cane (perennial irrigation)	190
Sugar-cane (on other lands)	110
Irrigated cotton	40
Hybrid seeds	40–110
Irrigated ground-nuts	40
Fruits	80–380
Turmeric	80
Irrigated tobacco	130

(iii) **Land revenue**

The land revenue varies by district and type of crop grown. The average difference between rates levied on irrigated and unirrigated lands in the six schemes would be as follows:

	Rs/ha
Bhima	5
Krishna	13
Kukadi	8
Upper Penganga	16
Upper Wardha	10
Warna	13

(iv) **Other agricultural taxes**

Since incomes in the agricultural sector are much lower than in the manufacturing and service sectors, the rate of agricultural taxation is relatively modest. Most of the revenues come from cash crops. A purchase tax, equivalent to Rs 630 per ha, is levied on sugar-cane and an agricultural sales tax of 4 per cent is levied on cotton and oilseeds.

(v) **Levels of cost recovery**

If the water and water-related charges remain at their present level, the Government of Maharashtra would recover about 30 per cent of the project cost:

	Cost/revenue Rs per ha of net CCA	*Cost recovery Index, percentage*
Annual capital and O and M costs	2,120	
Direct cost recovery		
Water charges	150	7.1
Irrigation related cesses	90	4.2
Incremental land revenue	10	0.5
Farmers contribution for on-farm works	301	14.2
Subtotal	551	26.0
Indirect cost recovery		
Purchase tax on sugarcane	33	1.6
Agricultural sales tax	43	2.0
Subtotal	76	3.6
Total cost recovery	627	29.6

E. INDONESIA

1. Background and organizations

Rice is the dominant irrigated crop in Indonesia. Of an estimated 8.4 million ha of rice harvested in 1977, 7.2 million ha were irrigated or grown under wet land conditions. Irrigation systems cover a service area of about 5 million ha, of which about 4 million ha are of a quality which is adequate for irrigated rice production. Java accounts for 60 per cent of the irrigated area.

Although irrigation has long been a major feature of Indonesian agriculture, by the late 1960s the systems built during the colonial period were in a state of complete disrepair. Irrigation development during the first two development plan periods concentrated heavily on the rehabilitation of those systems. Construction of new systems, mainly to serve as the basis for transmigration projects outside Java, lagged behind.

The Ministry for Public Works has over-all responsibility for irrigation, and the Directorate-General of Water Resources Development within the Ministry has the major responsibility for the planning and construction of irrigation systems. Operation and maintenance of irrigation systems down to the tertiary outlet has traditionally been the responsibility of the provincial public works services. Beyond that point farmers, through their various village organizations, are responsible for operation and maintenance.

2. Water charges

There is no direct charge for irrigation water to farmers for the recovery of capital cost or for operation and maintenance costs.

(a) **Primary and secondary canals**

The cost of operation and maintenance of primary and secondary canals in government irrigation systems is financed primarily through the provincial government's budget. Contributions to the costs of regional development are collected from owners of land through the IPEDA tax. This is basically a land tax collected annually from land owners at the rate of 5 per cent of the net value of production. The construction of an irrigation system would raise the net value of the land and consequently the IPEDA tax. At present, up to 10 per cent of the IPEDA tax is used for operation and maintenance of the main and secondary systems. The central Government, however, provides the balance of funds (90 per cent or more) in the form of subsidies to the provinces. For the year 1975/76, a total sum of Rp 5.74 billion was provided by the central Government for operation and maintenance. It was increased to Rp 6.27 billion in 1976/77 and Rp 7.92 billion in 1977/78.

(b) **Tertiary and quaternary canals**

Operation and maintenance of the tertiary systems is financed through a variety of gratuities, formal and informal payments by farmers to those in the village responsible for the allocation and distribution of water. There is a lack of uniformity and formality at the village level, which could be rectified by the establishment of formal water user associations. Up to January 1978, the formal water user associations covered a total area of only about 250,000 ha.

F. REPUBLIC OF KOREA

1. Background

The Republic of Korea covers some 98,000 sq km, with about one fourth of its area in farms and two thirds in forests. About 23 per cent, or 2.3 million ha, of the total land area is cultivated. Lowlands used primarily for rice production occupy just over 1.3 million ha and cultivated uplands account for nearly 1.0 million ha. The 1975 population is estimated at 34 million. The rural population accounts for 40 per cent of the total.

The Government places high priority on expanding foodgrain production to achieve self-sufficiency to the extent possible. The import of rice was greatly decreased from 1,007,000 tons in 1971 to 65,000 tons in 1977, while the import of wheat was maintained at 1.3 to 2 million tons a year from 1971 to 1977. Rice yields are already high: 3 to 4 tons per ha of polished rice (or 4.5 to 6 tons per ha of paddy).

Responsibility for the operation and maintenance of existing irrigation projects rests with the Farm Land Improvement Associations (FLIA). These associations operate as independent units, although their annual operating budgets must be approved either by the provincial government or the Ministry of Agriculture and Fisheries, depending on the size of the project. FLIAs would operate and maintain the irrigation systems, schedule water deliveries, allocate and collect project charges, and enter into co-operative arrangements with other agencies for various kinds of assistance to the farmers.

Nearly two thirds of farm households have less than one ha of cropland and only 4 per cent of farm households are landless.

The government policy of raising and stabilizing the prices of major farm products and subsidizing farm inputs had the effect of raising rural household incomes relative to urban incomes over the past years.

2. Water charge structure

The Government has a well-established system of charges applying to public land development projects.

(a) **Annual operation and maintenance costs**
Hundred per cent paid by farmers.

(b) **Capital repayment**

Irrigation works

Farmers repay 30 per cent of capital costs over 35 years at 3.5 per cent of interest per year, with an initial five-year grace period followed by 30 years of repayment.

Tidal reclamation

Farmers buy the developed land by repaying 100 per cent of capital costs over not more than 13 years at 7 per cent of interest per year, with an initial three-year grace period followed by 10 years of repayment.

(c) **Indirect charge**

In addition farmers pay production taxes of 6 per cent of the gross value of production on all foodgrain production above 1.4 tons per farm.

3. Water charges of the Yong San Gang Irrigation Project

The project would increase agricultural production on 20,700 ha by improved irrigation and drainage on 10,900 ha of existing paddy; irrigation of 3,700 ha of cultivated upland, of which 3,250 ha would be converted to paddy; and reclamation and irrigation of 600 ha of forest and 5,500 ha of tidal flats.

(a) **Direct water charges**

The direct water charges per typical farm and per hectare at full project development are calculated according to the above rates. The results are as follows. For comparison purposes, the annual incremental gross value of farm production and incremental farm net income at full project development are also shown.

	Rice land and upland development holding			*Tidal land reclamation holding*	
	0.3 ha	*1.0 ha*	*2.0 ha*	*1.0 ha*	*2.0 ha*
			(Thousand Won)		
(1) Annual incremental gross value of farm production[a]	140	510	986	1 317	2 376
($US per ha)	(962)	(1 052)	(1 016)	(2 715)	(2 449)
(2) Incremental cash production costs	20	83	182	238	585
(3) Other incremental costs (depreciation, family labour, taxes, other allowances)	70	257	432	741	1 082
(4) Incremental farm net income	50	170	372	338	709
($US per ha)	(344)	(351)	(384)	(697)	(731)
(5) Annual incremental operation and maintenance costs	7	23	46	32	61
(6) Annual capital repayment	11	36	72	451	902
(7) Total annual direct charges	18	59	118	483	963
($US per ha)	(123.7)	(121.6)	(121.6)	(995.9)	(992.8)

[a] The farm-gate price of rice is W 283,000 (or $US 583.5) per ton.

(b) **Cost recovery**

All project charges, costs and benefits are measured at present values discounted at 10 per cent interest rate over a 50-year period.

In the cost recovery analysis, $US 105.4 million construction costs (base cost estimate plus physical contingencies less cost of feasibility studies and taxes) are charged against the project. Annual incremental O & M costs are W 33,600 ($US 69) per ha. The present value of construction and O & M costs, discounted at 10 per cent, is $US 79.2 million. At full project development, and during the period of maximum capital repayments, incremental project charges total $US 8 million per year. Discounted at 10 per cent and assuming no inflation over the project's life, their net present value totals $US 32.2 million, giving a 41 per cent cost recovery for the project.

G. MALAYSIA

1. Regulations and organizations

Under the Malaysian constitution all matters pertaining to land, including the levying of irrigation and drainage rates for land in officially gazetted irrigation and drainage areas, fall within the jurisdiction of the State governments. These rates vary widely from State to State. No rates are charged in Sabah and Sarawak, as the settling of nomadic indigenous people in the stable pattern of irrigated padi production is seen as a basic policy to protect the forest from shifting cultivation, and imposition of taxes on irrigation land is viewed as an obstacle to this basic policy.

In Peninsular Malaysia the irrigation and drainage rates, together with quit rents and land taxes, are paid by landowners to the State Land Officer, and not to the Drainage and Irrigation Department. It is noted that the operation and management of irrigated facilities in Malaysia is totally divorced from water rate collections and that irrigation operation and management is financed out of general revenues supported by a highly efficient and generally progressive tax system.

2. Operation and maintenance costs

In 1976, the operation and maintenance costs ranged from below $US 10 per ha for controlled drainage and large gravity systems in some States to about $US 20 per ha for most gravity systems and $US 35 per ha for small pumping systems which, with pumping energy costs included, would rise to $US 50-60 per ha.

3. Irrigation and drainage rates

The irrigation rate varied from $M 2.5 to $M 25 per ha in Peninsular Malaysia in 1976. In general the average rate was about $M 23, (or $US 9) per ha.

The drainage rates varied from zero in Kelantan and Trengganu States to $M 25 per ha in P. Penang State.

4. Padi production tithe

In addition to irrigation and drainage rates, padi farmers in the Peninsular States pay an Islamic padi production tithe (**zakat**) to the State Departments of Religious Affairs. Such payments are assessed on gross padi production at rates ranging between 4 to 10 per cent in the average payment at 7 per cent. Actual recorded payments in small schemes area in recent years have ranged between $US 16 and $US 45 per ha.

5. Level of cost recovery

Take the National Small-Scale Irrigation Project as an example. The project would consist of a small irrigation scheme construction programme, covering 195 subprojects with a total irrigable area of 54,000 ha operated by 60,000 farm families. The capital costs of project schemes would average about $US 1,100 per ha, while incremental O & M costs would amount to approximately $US 20 per ha per annum at full development. Assuming a 10 per cent discount rate and a repayment period of 25 years, full cost recovery from project farmers would require incremental annual payments of $US 141 per ha for the period. Actual average incremental irrigation and drainage rate payments would amount to about $US 6 per ha. Average incremental zakat payments are estimated at $US 25 per ha at full project development. These combined payments would represent a cost recovery index of 22 per cent.

H. PAKISTAN

1. Background

Beginning in the 1870s, barrages were constructed on the major Indus tributaries in Punjab Province, and more recently on the Indus itself, enabling water to be diverted throughout the year. The Indus Basin now is irrigated by a canal system with one of the largest culturable commanded areas in the world. In 1973/74 the cropped area was 24.9 million acres (or 10 million ha).

Over the last 100 years of irrigation, the groundwater table has persistently risen causing waterlogging. Where it has risen within six feet of the ground level, saline moisture is being drawn by capillary action into the topsoil, evaporating and depositing soluble salts in the crop root zone. Where farmers have applied insufficient water for leaching, salinity has become pronounced. About 16.9 million acres were affected by waterlogging, and about 19.5 million acres by salinity.

The Irrigation and Power Department is responsible for the operation and maintenance of the existing canal system. Maintenance of water courses is the responsibility of all farmers in each water-course command under the direction of the Irrigation and Power Department.

2. Water charges (Sind Province)

Sind landowners, who are entitled to a proportion of the water-course flow determined by their size of holding served, pay a composite tax which contains a component for water charges. The owner pays land revenue to the Revenue Department and water charges to the Irrigation Department overseer at each water course. The amount is determined as follows:

Land revenue = area owned × produce index unit × land rate

Water charge = area owned × produce index unit × water rate.

The Product Index Units (PIU) and the land and water rates were most recently fixed in September 1973 pursuant to the "Sind Canal Water Flat Rate Rules of 1973". The figures are effective for five years from the date of publication. A different PIU is applicable in each **taluka**[5] based on evaluation of the land productivity. Within each **taluka** there are several PIUs, one for land under each type of irrigation reflecting the general water availability. The water rates are assessed for each village area (**deh**), taking into account local land fertility/salinity relative to land elsewhere in the **taluka.**

The PIU for Rohri **taluka,** as an example, is 34, and for all **talukas** of Khairpur district, 40. The assessment for the water averages Rs 0.30 for the **dehs in** Rohri **taluka** and Rs 0.29 for the **dehs** in Khairpur **talukas.** The average for the Khairpur Tile Drainage and Irrigated Farming Development Project area is Rs 0.30. Therefore the expected revenue in the project area is:

Rohri: 31,800 ac × Rs 0.30 × 34 = Rs 324,400

Khairpur and Kot Diji: 12,200 acre × Rs 0.29 × 40 = Rs 141,500

Total

Rs 465,900
(or Rs 10.59 per acre)
(or $US 2.61 per ha)

The capital costs of the Khairpur II project investments, excluding the costs of land levelling and equipment to be financed directly by farmers themselves, would amount to, for irrigation, about Rs 430 per acre (or $US 106 per ha) of the project and, for drainage, about Rs 3.0 per acre ($US 0.74 per ha) spread over the entire irrigated area of the Indus Basin (about 30 million acres). Annual charges to recover the irrigation component over 30 years with 10 per cent interest per annum would be about Rs 45 per acre ($US 11.1 per ha) of the project area, while the charges to recover the drainage component would be Rs 0.32 per acre ($US 0.08 per ha) over the Indus Basin. Annual O and M costs of the project area are roughly estimated at Rs 30 per acre (or $US 7.41 per ha).

I. PHILIPPINES

1. Background

The Philippines covers some 297,000 km² scattered over more than 7,000 islands. Out of a total land area of some 30 million ha, more than half is forest and about one third under cultivation or in plantations. The population was around 43 million in 1975, growing at a rate of about 2.8 per cent annually.

Agriculture accounts for about one third of net domestic product, about 55 per cent of total employment and 70 per cent of export earnings. One of the major goals of the agricultural sector is self-sufficiency in cereals, particularly rice and corn. The import of rice has decreased rapidly from 336,000 tons in 1973 to 31,000 tons in 1977.

Performance of the existing irrigation systems falls far short of their potential. The 1974 survey[6] estimates that, out of a total of 960,000 ha which can be served by existing systems, only 630,000 ha are served in the wet season and 254,000 ha in the dry season. Almost all the irrigated area is devoted to rice. Maintenance has been minimal due to shortages of staff and funds. This unsatisfactory situation began to change in the late 1960s when the National Irrigation Administration (NIA) was reorganized, more advanced irrigation designs were introduced and much higher levels of water management became a goal.

The technical responsibility for operating and maintaining all irrigation systems is with the Operations Department in the central office and the Operations Divisions at the regional level. The smallest organizational entity is made of two 50 ha units under a ditchtender.

NIA surveys show that some 56,500 farm families live in the National Irrigation Systems Improvement Project II area, of which 11,500 are landless.The mean farm size is about 1.7 ha.

[5] *Taluka* is the first subdivision of an administrative district in the Sind. There are usually five or six *talukas* in a district.

[6] IBRD Agricultural Sector Survey, Philippines, May 2, 1974 (Report No. 39a-PH).

2. Water charge structure

NIA has the authority to collect fees from users of irrigation systems to finance operations and to reimburse construction costs. Fees on the national irrigation systems were set in July 1975, to the equivalent of 2.0 **cavans** (one cavan equals 50 kg) of paddy per ha ($US 15 per ha) in the wet season and 3 **cavans** ($US 22 per ha) in the dry season, to be applied uniformly to all national irrigation systems.

As an exception to the uniform rate policy, the Government has agreed to raise rates on World Bank-assisted projects to the equivalent of 3.5 **cavans** of paddy per ha in the wet season and 4.4 **cavans** in the dry season. These rates would be reached gradually over a period of five years from completion of the construction work.

3. Water charges of National Irrigation Systems Improvement Project II

The project consists of irrigation development and a schistosomiasis control programme. The irrigation development would include the rehabilitation of 26 existing NIA irrigation systems serving a total area of 53,700 ha, construction of new irrigation, drainage and road facilities on about 27,200 ha of currently rainfed land adjoining these systems, construction of a sub-regional headquarters building, seven new field offices and other facilities. The total project cost was estimated at $US 140 million, including contingencies, and $US 34 million for expected price increases. The average irrigation facilities cost was estimated at $US 709 per ha for the rehabilitation area and $US 909 per ha for extensive area. The average annual O and M cost was estimated at $US 30 per ha.

(a) **Direct water charges**

The estimated incremental water charges at full project development for each typical farm and per hectare are shown below. For comparison purposes the gross value of farm production and incremental farm net income at full project development are also shown.

	Southern Luzon		*Western Visayas*		
	Rainfed *1.0 ha*	*Irrigated*	*Rainfed* *1.5 ha*	*Irrigated*	*Sugar-cane* *10 ha*
			(In pesos)		
(1) Incremental gross value of production	7 195	3 610	9 335	3 500	12 800
($US per ha)	(972)	(488)	(841)	(315)	(173)
(2) Incremental cash production costs ..	1 465	885	1 880	780	4 900
(3) Other incremental costs[a]	4 390	2 215	5 440	1 860	2 900
(4) Increase of net farm income	1 340	510	2 015	860	5 000
($US per ha)	(181)	(69)	(182)	(77)	(68)
(5) Incremental water charges	480	240	650	255	2 150
($US per ha)	(64.9)	(32.4)	(58.6)	(23.0)	(29.1)

[a] Other incremental costs include return on own capital and credit charges, imputed value of family labours, imputed value of farm management and allowance of risk and uncertainty.

(b) **Cost recovery**

All project charges, costs and benefits are measured at present values discounted at 10 per cent over the 40-year life of the project.

In the cost recovery analysis, $US 86 million construction costs (base cost estimate plus physical contingencies) are charged against the project. Annual incremental operation and management costs are $US 13.2 per ha. The present value of construction and operation and management costs, discounted at 10 per cent, is $US 75 million. At full project development, incremental project charges total $US 3.5 million per year. Discounted at 10 per cent, their net present value totals $US 17.3 million, giving a 23 per cent cost recovery index for the project.

J. THAILAND

1. Background and regulations

The Government of Thailand has never levied water charges to the farmers of irrigation schemes constructed and operated by the Royal Irrigation Department. Since 1973 the five irrigation projects financed by the World Bank loans and credits have placed more emphasis on tertiary or on farm development and have led to clearly identifiable improvements in the productivity of individual holdings. There was a general consensus in the Government that more direct and recovery measures should be applied.

The existing legislation which empowers the Government to collect fees for irrigation is contained in the Land Consolidation Act and the Irrigation Act. The Land Consolidation Act allows collection of up to 90 per cent of the cost of common irrigation works, the full cost of land levelling and a fee for operation and management in officially designated land consolidation areas, where holdings are fragmented and the construction of project works involves boundary realignment and land levelling. The Irrigation Act empowers the Government to collect a fee for operation and management of irrigation projects, but has never been enforced because of the irregularity and unreliability of most of the irrigation systems constructed in the past.

However, the Government is collecting an indirect tax on exported rice: rice premium, export duty and municipal tax.

2. Indirect taxes on exported rice

(a) **Rice premium**

The rice premium is a fee per ton paid for an export licence and depends on the grade of rice. It varies according to world market prices in order to stabilise the domestic price for urban consumers and to ensure that windfall profits, when world prices are high, accrue to the public sector rather than exporters or producers. In recent years the average premium for all grades has ranged from a low of B 600 ($US 30) per ton in 1972 to a peak in early 1974 of B 4,000 per ton. Annual government receipts in the 1970s have ranged from $US 13 million to $US 165 million. In January 1979, the premium was B 900 per ton on 5 per cent broken rice and B 700 per ton on Grades A and C rice (10 to 45 per cent broken). In 1978, the total production of rice amounted to 11.4 million tons, of which 1.6 million tons were exported.

(b) **Export duty**

Export duty is 5 per cent of the "assessed price" which is about 87 per cent of the export price.

(c) **Municipal tax**

Ten baht per ton.

SUMMARY AND CONCLUSIONS

The irrigation water charges in nine countries of the ESCAP region and in five typical irrigation projects as described in the preceding sections are summarized in the following tables 3 and 4 respectively. Related information such as the national agricultural product **per capita** in rural areas and the status of irrigation users' associations are shown in table 3 and the incremental gross and net farm incomes per ha after the completion of the projects in table 4. The following conclusions may be drawn from the preceding discussion.

(1) Among the nine countries included in the present paper, only the Republic of Korea appears to have an effective system of water charges for public irrigation projects, i.e. the farmers bear full annual operation and maintenance costs and share a fixed portion (30 per cent) of project capital cost with 3.5 per cent per annum of interest. In Thailand and part of Malaysia (Sabah and Sarawak) there is no official water charge either for operation and maintenance or for recovery of capital cost of irrigation projects.[7] In the other countries, the water charges are assessed based on land productivity, area of irrigated land, season and kind of crop (related to the amount of water used), which has no bearing on the actual operation and maintenance costs or capital cost of the irrigation facilities.

(2) Except in the Republic of Korea and Bangladesh, farmers do not share in the capital cost of irrigation projects constructed from public funds.

(3) One important factor affecting the willingness of farmers to pay water charges is the adequacy and reliability of irrigation water supply. As an example, farmers in Bangladesh, though earning a very low income, are willing to pay the Government the full capital cost of shallow tube-wells and full operation and maintenance costs because of the reliable supply of irrigation water from that source. However, for deep tube-wells irrigating larger areas in the same country, the Government has to subsidize 90 per cent of the capital cost owing to the unreliability of the water supply.

(4) Another important factor affecting the farmers' willingness to pay water charges for irrigation is the level of their income. As shown in table 3, the national agricultural product **per capita** in the rural area in the Republic of Korea is estimated at $US 462 in 1977, which is much higher than the corresponding figures of $US 55 for Bangladesh, $US 42 for India and $US 82 for Pakistan. This higher income in the Republic of Korea is mainly due to the better utilization of the cultivated land and more advanced cultural techniques producing a national average yield of 4.3 tons per ha of brown rice (or 6.4 tons per ha of paddy) in 1976, which is the highest in Asia.

[7] In Afghanistan and Indonesia, there is no water charge for capital cost recovery but operation and maintenance costs are partially covered through gratuities and some form of payments by farmers.

(5) The reliability of water supply is directly related to the efficient operation and maintenance of an irrigation system, particularly the tertiary canal network which requires a large amount of manpower. As shown in table 3, only the Republic of Korea has well-established farmers' associations to operate and maintain irrigation systems extending to the farm level. In most other countries, the operation and maintenance of primary and secondary canal systems are the responsibility of a government agency while the operation and maintenance of tertiary distribution systems are left to the farmers. Owing to the lack of trained manpower and co-operation, the distribution systems are usually not well operated and maintained. In recent years the Governments of India, Indonesia and the Philippines have exerted great efforts in strengthening the operating units at district and lower levels to improve the operation and maintenance of tertiary systems. In order to collect the full annual operation and maintenance costs and recover a reasonable portion of the capital cost from farmers, the supply of water must be reliable and adequate, and the facilities at farm level in many existing irrigation systems and their operation must be improved.

(6) Table 3 also shows that in most of these countries the Governments collect a land tax and/or production tax which are related to production but not to the actual cost of irrigation water.

(7) Table 4 shows the estimated water charges to farmers in five irrigation projects in the ESCAP region. The water charge of $US 156.9 per ha[8] in the Yong San Gang Irrigation Project in the Republic of Korea is much higher than those in the other four projects. In the National Small-Scale Irrigation Project in Malaysia and the Khairpur Tile Drainage and Irrigated Farming Development Project in Pakistan, the farmers are expected to pay only $US 6 and $US 2.6 per ha respectively. Consequently, project cost recovery index for the Yong San Gang Irrigation Project is 41 per cent, while those for the other four projects range from 14 to 30 per cent.

(8) Table 4 also shows that the incremental gross and net farm incomes per ha from the Yong San Gang Irrigation Project are the highest among the five projects. The annual water charge in that project accounts for about 44 per cent of the farmer's incremental net farm income, while the corresponding percentages for the other two projects in India and the Philippines are 9.8 and 15.6 respectively. The lower percentages in these two countries appear to be justifiable, considering the very low rural **per capita** income of their farmers.

[8] This is the annual equivalent during the 50-year period. The actual rate paid by the farmers after the grace period would be higher than this rate.

Table 3. Irrigation water charges in nine countries of the ESCAP region

Country	National agricultural product 1977[a] (million US dollars)	Rural population, 1977 (millions)	Per rural capita agricultural product, 1977 (US dollars)	Status of irrigation users' association	Direct charges paid by farmers: Operation and maintenance	Direct charges paid by farmers: Capital	Direct charges paid by farmers: Interest	Indirect charges paid by farmers
					← percentage		→	
Afghanistan	1,588[b]	14.98	106	non-existent	partial[c]	0	0	land tax & cotton sale tax
Bangladesh	4,068	74.19	55	non-existent				
Deep tube-well					100	10	...	
Shallow tube-well					100	100	—	
Low lift pump					100	30	—	
India	20,895[d]	492	42	non-existent	partial	0 to partial		land revenue & other taxes
Indonesia	11,595[d]	114.6	101	weak	partial[e]	0	0	land tax
Malaysia	2,191[f]	8.29[d]	264					
Sabah and Sarawak				non-existent	0	0	0	
Peninsular				non-existent	partial	0	0	production tax
Pakistan	4,405[d]	53.75	82	non-existent	partial[g]	0	0	land tax
Philippines	2,795	29.22	96	non-existent	100[h]	partial[g]	0	
Republic of Korea	7,397	16.0	462	well established	100	30	3.5	production tax
Thailand	5,169	36.51	142	non-existent	0	0	0	rice premium & export duty

Sources: (1) ESCAP, *Statistical Yearbook for Asia and the Pacific*, 1977, (2) ESCAP, *Demographic Trends and Policies in ESCAP Countries*, 1978.

[a] Exchange rate, local currency for $US 1: Afghanistan Af 45; Bangladesh Tk 15.5; India Rs 8.60; Indonesia Rp 415; Malaysia M$ 2.52; Pakistan Rs. 10.0; Philippines ₱ 7.40; Republic of Korea, w 485; Thailand B 20.40.

[b] As of 1975.

[c] Farmers contribute labour for repair work and pay a small amount of money to reward the water master.

[d] As of 1976.

[e] Operation and maintenance of the tertiary systems is financed through a variety of gratuities, formal and informal payments by farmers.

[f] As of 1974.

[g] Small portion.

[h] 100 to 175 kg of paddy per ha in the wet season and 150 to 220 kg of paddy per ha in the dry season, which can generally cover the full O and M costs.

Table 4. Water charges in five typical irrigation projects in the ESCAP region

Country/Project	*Investment cost*	*Incremental gross farm income*	*Incremental net farm income*[a]	*Water charge*	*Indirect charges*	*Annual costs*		*Project cost recovery index*
						Operation and maintenance	*Capital*[b]	
	← (US dollars per ha) →							(percentage)
1. India, Maharashtra Irrigation II Project	2,200	542[c]	286[c]	27.9	45.0	11.6	234.9	29.6
2. Malaysia, National Small-Scale Irrigation Project . .	1,100	...	...	6	25	20	121	22
3. Pakistan, Khairpur Tile Drainage and Irrigated Farming Development Project .	107	...	...	2.6	—	7.4	11.2	14
4. Philippines, National Irrigation Systems Improvement Project II	700–900	646[d]	140[d]	21.9[e]	...	94.8[e]		23
5. Republic of Korea, Yong San Gang Irrigation Project	5,092[f]	1,010[g]	360[g]	156.9[h]	...	385.9[h]		41

[a] The difference of farm income with and without the project and after deduction of production cost, family labour cost and other allowances.

[b] At 10 per cent interest rate.

[c] Average of six irrigation scheme areas.

[d] Weighted average of three subproject areas by area of each farm model.

[e] Annual equivalent of 40-year analysis period after completion of the project with an annual discount rate of 10 per cent.

[f] Average cost of the existing paddy land, upland and reclaimed tidal land.

[g] Average of rice land and upland development areas at full development stage.

[h] Annual equivalent of 50-year analysis period after completion of the project with an annual discount rate of 10 per cent.

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IV. WATER PRICING: PRINCIPLES AND PROBLEMS *

INTRODUCTION

1. Scope

The volume of written material on the pricing of water in texts, monographs and papers is massive. It is therefore difficult, if not impossible, to add a new approach to this subject. This paper will provide a discussion of the principles involved, the problems encountered in the application of those principles and suggestions for practical pricing policies.

2. Allocation of resources

In the management of natural resources one is concerned with allocations which will achieve maximum benefits and satisfaction from their use. One is dealing with more or less known maximum available water resources and, since those resources are not distributed in a free market, the role of pricing assumes great importance in achieving efficiency of distribution. Because of the technical differences in the distribution of water for irrigation and water for municipal use, the systems of pricing of the commodity will differ greatly. If maximum efficiency in the use of this resource is to be achieved, then pricing policy should be governed by economic principles. Unfortunately the principle of efficiency is seldom applied, but rather allocations are made through political expediency. This usually leads to allocations which have nothing to do with efficiency. A specific example of allocational problems exists when a municipality seeks to increase its supply in an area in which available water is fully utilized for irrigation. However, it is rare for a study to be made along those lines: usually the water is allocated on the basis of the strength of the user groups, without consideration of the economic or social gains. It will be only through enlightenment that equity and efficiency can be attained. Pricing policies cannot cope with these situations but must rather be concerned only with the efficient use of the water which may be available.

A. PRINCIPLES OF WATER PRICING

If the goal of a pricing policy is economic efficiency, then the principles of economic theory must apply. Since there are practical constraints to the use of pure theory, other principles may be used to arrive at practical pricing policies. Constraints will be dealt with in the following sections.

1. Economic efficiency

All countries are faced with the realities of limited resources. The most effective use of the resources for the maximum satisfaction of the population should be the objective of Governments. In a free market economy where competition exists, economic theory assumes that price is determined by consumer demand. Producers who do not have a monopoly will produce a sufficient quantity to satisfy demand at a price which will return a profit. An increase in price will result in consumers foregoing purchases for other products which will give them equal satisfaction. A decrease in price should result in an increase in demand. This phenomenon is termed "elasticity of demand". The price at which market equilibrium exists should, in theory, equal the producers' cost of producing one additional unit and is termed "marginal cost". In public water supplies, a free market never exists and therefore theory will dictate that the price of the water should equal the marginal cost of production for optimum economic efficiency.

Before going into the details of marginal cost pricing, marginal value-in-use or marginal utility, will be discussed below. The latter signifies consumer demand, an understanding of which is necessary because price and value-in-use are interactive.

2. Marginal value-in-use

The marginal value-in-use (or marginal utility) for any product is the value which a consumer places upon the value-in-use of the last unit consumed. As long as the marginal value-in-use exceeds price, the consumer will buy the product up to the point where his value-in-use falls below the price, at which point he will cease to buy. Stated in another way, the marginal value-in-use will decrease as the quantity consumed increases. If equity is desired, then resources should be allocated so that all consumers derive equal value-in-use from the marginal unit consumed. The marginal unit at equal value for one consumer may occur at a different level of use for other consumers. Therefore, if all consumers from an irrigation project are allocated equal amounts of water and the marginal values-in-use differ between consumers, transfers between consumers may occur. Where a consumer with a relatively low value-in-use might transfer part of his allocation to a consumer with a higher value-in-use for a monetary consideration which would equal the marginal value-in-use of the buyer for the quantity transferred, such transfers would theoretically occur until the marginal value-in-use was the same for all users of the project. That is, the value placed on the last unit of consumption would be equal for all, re-

* This paper was prepared for the secretariat by Charles B. Adelmann, consultant. The views expressed in it are those of the author and do not necessarily reflect those of the United Nations.

gardless of the amount used by each consumer. This value is termed the "equi-marginal value-in-use" and can only occur where free transfer of the rights for water from the project is allowed. Where government control on transfers is imposed, inequities are liable to exist.

In municipal water supplies it is desirable that the price of water consumed should be equal for all. If such a price is set, and consumers are allowed to take whatever amount of water is desired at that price and the aggregate use of all users equals the amount of water available, the marginal value-in-use for all consumers is the same. In other words, each consumer would use only that quantity of water at which the last unit of consumption would have a marginal value-in-use equal to price. Since no advantage is gained from trading between users, an efficient allocation of available water is made.

3. Marginal cost pricing

In the discussion of marginal value-in-use, it was assumed that a certain quantity of irrigation water would be available without cost which is, of course, seldom the case in practice. The usual situation is one in which more water can be supplied only by the expenditure of financial resources and, in existing systems, the cost of production of the present capacity is already established. If it is assumed that consumers are currently being supplied with water at a price which equals their marginal value-in-use, then the marginal cost of supplying additional water should not exceed the marginal value-in-use. In fact, the marginal cost should be lower than the marginal value-in-use, to encourage consumers to increase their use to the point where marginal cost and marginal value-in-use are equal. This would satisfy the requirements for efficiency. Optimally all of the additional capacity would be utilized under this condition. It must be assumed that price is again equal for all users.

4. Average cost pricing

In order to establish a basis for later discussion of problems, it is necessary to discuss the dynamics of marginal cost. However, first of all the principle of average cost pricing should be set forth. Average cost pricing does not concern itself with efficiency but rather the financial requirement that all costs be met by the pricing policy. Because of the constantly changing cost patterns encountered in municipal water utilities, an approach to pricing on a marginal cost basis must necessarily be short run. Again because of the cost of keeping such costs current, an average variable cost policy might approach the short-run marginal cost, but such a policy is not likely to recover all the costs of operation. Therefore, there is a strong tendency to rely on average total cost in establishing the price. The interaction between the average total cost and marginal cost will be shown in the next section.

5. Relationship between average and marginal cost

Marginal cost is defined as the cost of producing (and distributing) one additional unit of production, whereas average cost is the total cost of operations, including fixed and variable costs, divided by the total number of units produced. Before going on to a discussion of problems of application, the theory of marginal cost and its relationship to average cost and demand must be understood.

A classical marginal cost curve would be one resembling a saucer tipped so that its right extremity would be higher than the left. Marginal cost plotted against output would initially decrease with increases in iutput and would then rise again after its nadir had been passed. Average cost may be increasing or decreasing, but its curve where the average cost is decreasing is also shaped like a shallow saucer with the left extremity higher than the right. With decreasing average cost, the usual case for municipal water supplies, the marginal cost curve takes on a different orientation so that its left extremity is lower than its right.

The demand curve, in the case of water, is either a straight line or an extremely shallow curve starting at a point above the average and marginal cost curves and descending, so that it crosses both curves at points to the left of their right extremities. The point to be made here is that for the marginal cost at the optimum output for efficiency, i.e., where the marginal value-in-use is equivalent to the marginal cost, a price based upon marginal cost would result in a demand for water equivalent to the output at that marginal cost. If average cost were more than marginal cost at the most efficient output, the operation would incur a deficit. Economy theory would dictate that this deficit be covered by distribution of surpluses from other sectors of the economy in the form of subsidies; otherwise the operation could not continue. If the price were set at the average cost at the point at which it intersects the demand curve, less than an optimum amount would be consumed because, under conditions of decreasing average cost, the average cost would exceed marginal cost at that point.

All the above assumes that demand is perfectly responsive to changes in price or perfectly elastic. However, in reality demand in municipal supplies and in some irrigation schemes is not perfectly elastic. Therefore, the goal of efficiency through marginal cost pricing may not be attainable.

Both marginal and average costs include the fixed costs of operation. Fixed costs are the total of capital costs, depreciation and those administrative and other costs which are not affected by changes in output.

B. PROBLEMS IN THE APPLICATION OF PRINCIPLES

In the preceding sections, the theoretical principle of marginal cost pricing was applicable to both agricultural and municipal supplies. In practice, the pricing of water for these uses is entirely different. It will be shown that the goal of economic efficiency through marginal cost pricing may not be reached because of constraints, either financial, political or social, which are encountered in application.

1. Pricing of water for agriculture

The fact that ownership of land has traditionally implied a right to the water from natural streams touching or closely adjacent to the land or to ground water underlying it complicates the problem of pricing of irrigation water. In order to fully develop the agricultural potential of land, irrigation schemes have been necessary. Those lands immediately adjacent to natural water courses may not be able to use the full flow of those streams and the surplus can be diverted through the use of dams, canals and other appurtenances to lands which can then produce crops. The production of crops is an economic benefit which is measurable, and therefore the marginal value-in-use for farmers using water from the irrigation project should be easily determined. It has been pointed out that if free transfers of rights to water are allowed, the marginal value-in-use for all users should equalize. In practice, however, free transfers are not permitted. The price of water, if any, is set by government (no major irrigation projects are controlled by the private sector), and that price may be zero for a fully subsidized project. There is no quarrel with the practice of subsidization as long as it is recognized that a redistribution of economic benefits between sectors occurs and that the subsidy represents a benefit to farmers at the expense of tax payers or other governmental enterprises which may produce a surplus. This would be true for any subsidy.

If a price can be applied for water delivered and collection can be made on some equitable basis, then efficiency can be attained, but only under conditions where water is supplied at the same price to all users. Users can be supplied with all the water they can use and the full capacity of the project will be utilized. In practice, price, being politically sensitive, is frequently less than optimum and subsidies are provided. Although it is desirable for the distribution of subsidies to be logically determined and applied, such determination is much too complex and is hardly ever made. The constraints to efficient pricing of irrigation water derive from considerations other than economic efficiency, in a non-industrial society. If it were possible to make decisions based upon considerations of efficiency, solving the problems presented by the necessity of deriving enough income to cover the costs of a project would be all that would remain. This problem would then become similar to that of producing sufficient income in a municipal water supply.

2. Municipal supplies

Municipal water supplies differ from irrigation projects in that they have a large number of customers who use relatively small quantities of water. The same economic principles apply but, as with irrigation projects, the theory of marginal cost must be modified.

(a) Compromises with theory

Theoretically the marginal cost applies to an infinitesimally small additional unit of production. In order to make this concept more manageable, a much larger increment of production must be used, the marginal cost of which is the average of that of the infinitely small increments. The incremental unit selected is usually the unit of billing, which may be 1,000 gallons, 100 cubic feet or a cubic meter. There are other problems, since marginal costs are continuously changing for individual users or for consumer classes. Any pricing system must be based on the premise that marginal cost pricing cannot be perfectly applied. It is impossible to administer a municipal water supply rate structure which is continuously changing. One author has suggested that if the users could be educated to accept the variations necessary in applying true marginal cost principles, then the system would become practical. This of course is an impractical suggestion which could be applied only in a community consisting solely of users possessing advanced degrees in economics. Other compromises must be made, as will be seen in the following sections.

(b) Effect of large investments

Probably the most difficult problem in the application of marginal cost pricing involves the increases in capacity periodically required by all water systems. It is possible to cope with increases in marginal cost as long as the total amount of water distributed does not exceed the capacity of the system. The problem arises when the provision of the increment of production exceeds the system capacity. It is usually not practical, except in small water supply systems using ground-water sources, to provide additional capacity in small increments. Almost always, the additional supply must come from construction of additional impoundment, storage and treatment facilities, increased transmission facilities and enlargement of treatment works, local storage and distribution systems. Such an investment decision is made after a study has been effected of alternative schemes and a present worth analysis has been conducted. From the present worth analysis the scheme with the least cost emerges. The very nature of the present worth analysis almost always favours the scheme with the larger capacity. In any event, a large investment in capacity is required and such an investment produces a scheme which may supply the increases in demand for 10-25 years or more. Over-capacity, therefore, exists initially. Since it is frequently not possible to provide for small increments of investment, one is faced with the indivisibility of capital and its effect on marginal cost.

One method of handling the increased marginal cost due to investment for increased capacity after demand equals present capacity is to ration supplies by applying progressive price increases until the price equals the marginal cost after investment. The fact that customers express their willingness to pay for the cost of additional investment is taken as a signal that the investment is justified. This approach presents problems in the use of textbook marginal cost, as is discussed below.

(i) **Textbook marginal cost**

In order to resolve the problems of capital indivisibility, sometimes referred to as "lumpiness", in marginal cost pricing, it is necessary to further define marginal cost. As long as system over-capacity exists (assuming safe yield of sources as a limit), the cost of additional consumption will only be the cost of additional operations and maintenance. These are termed short-run marginal costs. Long-run marginal cost, on the other hand, is the sum of the short-run consumption costs and marginal capacity cost where marginal capacity costs are those associated with the increase in capacity of the system. Long-run marginal cost is also termed "textbook marginal cost".

(ii) **Textbook long-run incremental cost**

Textbook long-run incremental cost provides smoothing by including the marginal capacity cost on an annual basis for the next lump of investment. This cost looks forward only to the year in which the next investment is planned and emphasizes the need to sacrifice some allocation efficiency in the interest of providing investment signals by present and future consumers. Price under a textbook long-run incremental cost policy rises immediately following an investment to reflect the annual equivalent of the next large investment in capacity which will have to be increased.

This definition of textbook marginal cost does not agree exactly with the theoretical definition since the increment of capacity differs from the theoretical increment and the inclusion of the amortization of capital costs is not a part of the theoretical definition. These two compromises with theory provide some smoothing of the marginal cost which theoretically would show a large instantaneous increase in marginal cost after completion of the investment in capacity for the next increment of production. However, the marginal cost of the very next increment would fall to the level of cost before the investment. This is an unacceptable condition in practice and, even with the smoothing provided by this definition of textbook marginal cost, peaks occur after each investment, unless the investment is made at least annually (see annex).

(iii) **Present worth of incremental system cost**

The present worth of incremental system cost is another definition of marginal cost which emphasizes the necessity for providing investment signals which reflect forthcoming investments. It is defined as the present worth of the increment of system cost resulting from a permanent increment of consumption at the beginning of year "t" minus the present worth of incremental system costs resulting from an equal permanent increment in consumption at the beginning of year "t" + 1 (see annex).

(iv) **Average incremental cost**

The concept of average incremental cost is a compromise between (a) efficiency of allocation in the short run and the need for a justification of investment in additional capacity; and (b) all investment in the long run for a future period of, say, 10-15 years, the period considered the maximum for which reliable information is available. Average incremental cost makes different assumptions about the proportion of investment which must be made at a point in time in order to reveal consumer willingness to pay and about the relevant magnitude of the next increment of capacity.

Average incremental cost assumes that when investment is "lumpy", the marginal capacity cost can be estimated as:

$$\text{Marginal capacity cost} = \frac{\text{Present worth of the least cost investment stream}}{\text{Present worth of the stream of incremental outputs resulting from the investment}}$$

If consumers are willing to pay a price equal to the incremental operating cost plus the marginal capacity costs, this can be taken as the benefit in a cost-benefit study the total of which would be price times total number of units consumed, or the present value of total revenue.

Average incremental cost can be calculated by discounting all the incremental costs which will be incurred in future to provide the additional amounts of water estimated to be required over a finite period and dividing the result by the discounted value of incremental output over the period (see annex).

The interest rate should be equal to the opportunity cost of capital for the investment stream. But the interest rate for outputs should be the time preference rate for consumption, reflecting the fact that consumption today is more valuable than consumption in the future.

This definition of average incremental cost provides for marginal cost estimates which smooth the lumps in the expenditure stream and also reflects the level and trend of future costs to be incurred in order to satisfy rising demands.

(v) **Selection of definition**

The four alternative definitions of marginal cost given are attempts to reconcile the application of true marginal cost to pricing where "lumpiness" of investment and necessary system over-capacity exist. Textbook marginal cost presents difficulties in administration of water rates which would preclude a purely theoretical approach. Textbook long-run incremental cost and present worth of incremental system cost tend to smooth the fluctuation of marginal cost while providing adequate signals for investments. However, only textbook long-run incremental cost will avoid the drops in price associated with textbook marginal cost and present worth of incremental system cost and therefore may be an acceptable practical solution. But of all the four definitions, average incremental cost seems best where "lumpiness" of investment streams is present. The question is, can any of these definitions be useful in actual pricing situations? All of the approaches to the definitions of marginal cost must assume elasticity of demand in relation to price and it is questionable whether such elasticity exists! Certainly where water is supplied to the poor at no cost, elasticity is zero (see annex).

(c) **Differential rates**

In municipal water systems there is a practice of differential pricing for supplies to customers by class. Industrial rates, for example, frequently are higher than domestic rates and, where a low-income group is present, water may be distributed to them free of charge. It is argued that the marginal value-in-use or marginal cost for industrial consumers may be higher than for other users and therefore a higher price for those users is justified. However, price is usually the same for all industrial users (as opposed to different rates for each one) in order to reduce administrative costs. Yet the marginal value-in-use is probably different for each industrial user. Furthermore, the marginal cost for supplying industries is most probably the same as for domestic users. The result of such pricing practices is cross-subsidization between classes and can be justified on social rather than economic grounds. The distributional effects of differential pricing must also be recognized.

(d) **Pricing for low-income groups**

Pricing of water for low-income groups must be based upon ability and willingness to pay. Because it is desirable for good sanitation to encourage water use among these groups the price, if any, is less than the marginal or average cost. Subsidization of the cost of serving low-income groups may be by cross-subsidization between consumer classes or by direct subsidy from the Government. A redistribution of income occurs and gives rise to the question of whether the agency distributing water should be involved in the problem of redistribution. A better solution is for the Government to pay for the cost of service to this class on some equitable basis which would relieve the water supply system of a welfare function.

3. Financial considerations

The costs of operating a water supply include operation, maintenance, depreciation and capital costs. Capital costs and depreciation represent fixed costs which are not related to the incremental cost of water produced. Therefore, unless one of the alternative definitions of marginal cost is used for pricing, the total income requirement may not be met. Investment is considered as a sunk cost which is not related to marginal cost. If the pricing policy of the water authority does not provide for the recovery of capital costs and depreciation, it must rely on a government subsidy, a practice which is considered undesirable by most lending agencies. Suggested means for providing a pricing structure which would cover fixed costs will be discussed in a later section.

4. Joint costs

Quite frequently a municipal water supply system will also be associated with an irrigation or power generation system or with a flood-control project. Where power generation or irrigation is concerned, it may be possible to determine the marginal costs for each system. However, pricing is seldom related to marginal costs in these cases. The price is more often determined by what the traffic will bear. Costs for each operation are nonetheless separable, and costs should be allocated to each operation according to informed calculations. Pricing for water supplies is determined by the allocated costs and there is little point in determining a marginal cost which would be a difficult and costly exercise.

Where the joint costs are associated with flood control, only a study of the respective benefit from the two systems could be used for proration of costs. Here again the determination of marginal costs of the water supply will probably not be a practical exercise.

5. Political constraints

The universal problem which confronts economic and financial planners is the conflict with political considerations. In most communities in less developed countries, the pricing of water is influenced to a large extent by political factors. There are too few examples of governing bodies that are willing to implement rate structures involving increases in price. Under such conditions, any sort of logical financial planning is defeated at the outset. Lending agencies have minimal control over this problem and they themselves are sometimes politically motivated. One possible solution lies in the development of a consuming public that is more interested in seeing that its representatives provide it with an improved environment. Although long term in nature, this would be a feasible approach.

C. PRACTICAL PRICING POLICIES

In arriving at a practical pricing policy, a polygamous marriage of economic theory, financial necessity and the **status quo ante** is consummated. The two following sections set forth proposals which have been derived from experience with the problem of pricing but are certainly not intended to represent the only solutions.

1. Irrigating water

Policies for pricing of irrigation water now in use involve heavy subsidies, and any costs recovered from users through taxation or other means are usually much less than the annual capital cost. Allocations and charges are generally made on the basis of area to be irrigated and crop; therefore, some measure of control exists. However, government policies of subsidization are intended for income distribution purposes. At the central government level, the recommended policy is often practically unrelated to pricing but more often involves the application of the economic principle of income distribution, implying subsidization of irrigation water.

2. Municipal rates

Of the alternative definitions for marginal cost, average incremental cost would be most suited to the pricing of water supplied to consumers in a municipal system because it provides a forward-looking solution for future investment in expanded capacity, which would allow for uniform tariffs over long periods. This is all very well in the case of a new system or one which has no sunk costs. Normally the problem involves a system which has been in existence for some time and has an investment in plant which has not been fully depreciated and also has liabilities for borrowing which have not been amortized. Marginal cost ignores sunk costs but a pricing policy must provide for them. If a marginal cost can be calculated by using average incremental cost it is suggested that tariffs be designed using average incremental cost as the price for units of consumption. Fixed costs can be covered by assessing fixed charges for different categories of service. Ideally, the fixed charge would not allow for a minimum consumption allowance; however, social considerations may override this. The minimum allowance should therefore be set at the lowest amount commensurate with social needs.

For higher income groups and industry, the marginal value-in-use should be studied so that an equitable tariff for each could be set. For the lowest income group the tariff, if any, should be low enough so that it would not inhibit the use of water for adequate sanitation.

If alternative sources are available to the higher consumer classes, laws should provide for control of all sources of water and on the basis that use of any source of water is subject to efficient allocation, the marginal cost of the existing system should be used as a price for use of the alternative source. Otherwise pricing may be such as to drive the consumers to use an alternative, less costly, source and the full capacity of the water system will not be utilized.

A suggested tariff structure might include:

(1) A fixed charge based upon the capital cost and demands placed upon a system by each consumer class.

(2) A consumption charge for water used, based upon the marginal value-in-use for each consumer class.

(3) Either subsidized service or the smallest possible charge for the lower income groups.

Ideally the tariff structures would provide sufficient revenue to cover all the costs of operation, capital costs and depreciation.

Where service to lower-income groups is provided without charge, it is recommended that the cost of such service be recovered from the Government and not through cross-subsidization by other consumers. This relieves the water distribution agency of trying to determine the most efficient distribution of income, which is really a government function.

In many water systems, a form of taxation for water and sewerage is superimposed on the tariff structure. This is nothing more than a political expedient and serves to defeat the use of marginal cost as a goal for efficiency.

D. SUMMARY

In order to achieve efficient allocation of resources, where price determines demand, the principle of marginal cost should govern the pricing policy. The pricing of water for agriculture is so affected by long-established practices and considerations other than economic efficiency that economic principles of allocation and distribution could be almost impossible to apply in most cases. In municipal supplies the principle of marginal cost could be applied if one of the alternative definitions of marginal cost were used. The average incremental cost definition of marginal cost is probably applicable, but gives rise to the question of how to account for accumulated funds for investment. Such an accumulation of funds by a water distribution agency is always subject to pressure to distribute what is viewed as a surplus or to reduce rates. In the end, a water distributing agency is usually forced to borrow periodically for investment in capacity, and the annual cost of capital becomes part of the fixed cost of operation. The best pricing solution in this case may be a combination of fixed cost assessed against each property served either through taxes, meter rents or other media and a price for consumption based upon use in which the marginal production cost can be used as a guide. Differential rates and pricing for the lower income groups may be rectified by cost of service studies and direct subsidy or cross-subsidization between consumer classes. Finally, if studies of marginal cost are not too complex and costly, they may be used as a guide, but any pricing policy must also satisfy the need for generation of enough revenue to satisfy all the financial needs, including the liability for financing of sunk costs.

Annex

ALTERNATIVE DEFINITIONS OF MARGINAL COST

1. **Textbook marginal cost (TMC)**

$$TMC_t = SRMC_t + MCC_t$$

$$TMC_t = \frac{R_{(t+1)} - R_t}{Q_{(t+1)} - Q_t} + \frac{r\,I_t}{Q_{(t+1)} - Q_t}$$

Where t = Year for which TMC is being calculated

R_t = Operation and maintenance expenditures in year t

Q_t = Water produced in year t

I_t = Capital expenditure in year t

r = The capital recovery factor

2. **Textbook long-run incremental cost ($TLRIC_t$)**

$$TLRIC_t = \frac{R_{(t+1)} - R_t}{Q_{(t+1)} - Q_t} + \frac{r\,I_k}{Q_{(k+1)} - Q_k}$$

Where k = The year in which the very next major investment in capacity is completed.

3. **Present worth of incremental system costs**

$$PWISC_t = (R_{(t+1)} - R_t) + \left[\frac{I_k}{(1+i)^{k-t}} - \frac{I_k}{(1+i)^{k+t-1}} + \frac{I_k}{(1+i)^{k+x-t}} - \frac{I_k}{(1+i)^{k+x+1-t}}\right]$$

Where i = The opportunity cost of capital

x = is generally taken as 29 years to allow for a full investment programme of 30 years.

4. **Average incremental cost (AIC)**

$$AIC_t = \frac{\sum_{\hat{t}=1}^{T}\left[\frac{(R_{(t+\hat{t})} - R_t) + I_{t+\hat{t}-1}}{(1+i)^{\hat{t}-1}}\right]}{\sum_{\hat{t}=1}^{T}\left[\frac{(Q_{t+\hat{t}} - Q_t)}{(1+i)^{\hat{t}-1}}\right]}$$

Where T = Number of years for which water expenditures and attributable output are forecast and over which price is being smoothed

i (numerator) = Opportunity cost of capital

i (denominator) = Time preference rate consumption

Part Three

INFORMATION PAPERS SUBMITTED BY PARTICIPANTS

I. IRRIGATION WATER PRICING IN BANGLADESH*

A. INTRODUCTION

Bangladesh has an area of 14.4 million hectares lying in the delta of the world's three great rivers the Ganges, the Brahmaputra and the Meghna, of which 9.1 million ha (64 per cent) are cultivated. The population is about 85 million (about 9.3 persons on a cultivable ha), of which 90 per cent live in rural areas.

Agriculture is the most important sector of the economy. It accounts for about 60 per cent of gross domestic product (GDP), gives employment to 80 per cent of population and provides the base for more than 80 per cent of the country's export.

The mean annual rainfall in Bangladesh varies from about 1,300 mm in the western part of the country to almost 5,000 mm in the northeast and is characterized by wide seasonal fluctuations with about 90 per cent of the rainfall occurring in the five-month period of the monsoon (May to September). Inspite of an overall abundance of rainfall, serious droughts do occur. There are instances of inadequate rainfall during the monsoon season and the minimum rainfall during the dry season (October to April) is almost 'nil', when much of the land remains uncultivated unless irrigated.

It has a population density of about 590 per square kilometre, Bangladesh is the most densely populated country in the world, if the city states of Singapore and Hongkong are excepted. It is the most densely populated country by a fairly large margin and this is all the more remarkable since density is related in most cases to high degree of urbanization, whereas over 90 per cent of the population of Bangladesh live in rural areas, and about 80 per cent are engaged in agriculture.

Foodgrain self-sufficiency has emerged as one of the major policy objectives in Bangladesh. The population growth rate has generally surpassed that of food production in recent years, necessitating the annual imports of more than 1.6 millions tons of grain, a serious difficulty in a country which depends primarily on agriculture. Consequently, the overall development programme, particularly agricultural investment have been geared to a foodgrain self-sufficiency objective. In this context, the Government of Bangladesh has perceived that the activities should focus more on irrigation investments with immediate impact on the foodgrain production.

At present, 9.1 million ha, or almost all of the arable lands are cultivated, but only 0.55 million ha are tripple-cropped and 3.4 million ha double-cropped, while the remaining 5.15 million ha are single-cropped. This implies the potential for cultivating additional crops particularly in the dry season (October to April) through the provision of irrigation. Irrigation presently covers only 12 per cent of the cultivated area but could be expanded to cover a large part of the country by adopting proper technology.

Over the past five years, the annual cropped area has averaged about 12.3 million ha giving a cropping intensity of about 135 per cent. Rice, by far the most important crop, accounts for 80 per cent of the cropped area; jute, the main export for 6 per cent and a variety of other crops such as pulses, oilseeds, wheat, sugarcane and vegetables for the remaining 14 per cent.

Since the late 1950's the official development strategy for the agricultural sector of Bangladesh has heavily emphasized the control and development of the country's water resources. Typically over the past two decades, public investments in irrigation and flood control works have accounted for some 10-15 per cent of the total development budget and over one-quarter of the total allocations for agriculture and rural development activities. As a result of these efforts, it is estimated that over the past two decades, about 0.7 million ha have been brought under irrigation and about 0.8 million ha have been provided with total or partial flood protection. While there is a considerable variation in the level of benefits derived from the various water development schemes, there is little doubt that where reasonably assured irrigation water has been made available, there has been a marked increase in farm production and income levels.

Practically all irrigation development in Bangladesh has been financed from the Government budget. The charges assessed to the beneficiaries vary with the type of irrigation, in most cases, however, they involve very large subsidies.

Till now, the irrigation water charge policies have been based on a series of ad hoc decisions, they contain numerous anomalies e.g., different charges for similar facilities in the same locality depending upon the implementing agency.

Heavy subsidies imposed excessive burden on the Government budget. Given the considerable scope for increasing charges from the present low levels, the burden could be substantially reduced, if not eliminated

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altogether. Subsidies also promoted wasteful water use as well as capacity underutilization. Also the current rate structure acted to distort relative economic priorities by promoting demand, and therefore developmental expenditures on the least efficient modes of irrigation and they mostly benefitted the relatively "better off" farmers and the rural elite rather than the small farmers.

B. WATER RESOURCE AGENCIES

The Bangladesh Water Development Board (BWDB) and the Bangladesh Agricultural Development Corporation (BADC) are the major government agencies which plan and implement water development projects.

The Bangladesh Water Development Board was created to provide centralized control for water resources development. The Board was granted broad powers including eminent domain to plan and construct water resources projects, establish rates, and collect revenues, and take over works in progress under other agencies, all subject only to the approval of the Government.

The most important mission of the Board is to develop water resources for increasing food production by providing irrigation, drainage and flood control facilities, the other important functions are soil erosion control and town protection and river training.

Over the last 15 years, BWDB have completed construction of five major water-control projects: Ganges-Kobadak, Coastal Embankments, Brahmaputra Right Embankment, Dacca-Demra and Chandpur and one tubewell projects, Thakurgaon. Besides, a number of small projects have been completed by BWDB during the last 20 years.

The Bangladesh Agricultural Development Corporation (BADC) was established in 1962 in response to the recommendation of the Food and Agriculture Commission to assure expeditious distribution of agriculturel inputs as well as to carry out various development functions in agriculture.

BADC primarily serves as a supplier of seeds, fertilizer and irrigation pumps to farmers and pumps groups. The pumps supplied by BADC are: low-lift pumps (LLPs), deep tubewells (DTWs) with submersible pumps and engines, shallow tubewells (STWs) with horizontal centrifugal pumps and engines and from 1978-79 BADC has begun supplying hand pumps. In addition, BADC gives technical assistance in pump siting and provides maintenance services.

C. VARIOUS METHODS OF IRRIGATION

The present irrigation methods in Bangladesh include: (a) the large projects diverting or lifting water from river (BWDB), (b) low-lift pumps lifting from surface water (BADC), (c) deep and shallow tubewells (BADC), and (d) various manual methods in private sector.

1. Large projects

Under this type of irrigation projects, river water is diverted and pumped to obtain head for gravity distribution within the project area. In some projects, flood protection is provided by enclosing the area with flood embankments. These are the most expensive and at the same time the most subsidized, costing the government a large sum of money and almost nothing to the farmer. These schemes take the longest periods of gestation before results can be achieved. Even after the scheme is completed, there are serious technical and institutional problems, due to which irrigation facilities benefit only about one third of the project area.

2. Low-lift pumps

These are fairly small (normally 2 cfs) pumps used to raise water from perennial streams and ponds to irrigate fields, usually during the dry season. Irrigation by low-lift pumps cover the largest area in the country. They can be easily fielded and operated. The low-lift pump programme has been, by far, the most effective irrigation effort in Bangladesh to date. These pumps yield highly favourable economic returns. The major factor limiting the potential for this form of irrigation is the availability of surface water during the dry season.

One of the problems with the low-lift pumps is that the cost to the farmers using LLPs is so low that they have little incentive to improve the water use efficiency. Since most of the pumps are available to farmers only for the boro season, the benefits of the supplementary irrigation which could be provided to the aus and aman crops are lost. Although appropriate mechanisms exist in paper, there is no real control on the technical aspects of siting the pumps in accordance with surface water availability. Thus, some surface water sources may be over-exploited while others are left untouched.

3. Deep and shallow tubewells

Tubewells depend on water beneath the earth's surface and hence their potential is constrained by the availability of groundwater.

The distinction between "deep" and shallow tubewells is something of a misnomer since some shallow tubewells are in fact sunk deeper than some deep tubewells. Deep tubewells refer to those made from largely improved, technologically complex pumps and engines, of 2 cfs or more capacity and sunk by power rigs. Shallow tubewells are made of pumps and engines of largely local construction involving simple technology, with less than 1 cfs capacity and sunk by labour intensive percussion methods. The deep tubewell is the most expensive of the small scale irrigation systems. Mechanized drill rigs are needed to sink this type of well and being of 2 cfs (or more) in capacity, it can irrigate about 24 ha and the group of farmers under it is comparatively large (about 40) which is difficult to manage.

Shallow tubewells are sold to the farmers outright, they are relatively cheap and technically not nearly so difficult to install as deep tubewells. Most of the requisite components can be manufactured locally. Since they irrigate only 3-6 ha, the on-farm development needs are less complex.

4. Manual irrigation methods

These include water lifting devices like 'dhone', 'swing basket', hand pumps and dug wells. The dhones and swing baskets are used for lifting surface water. The hand pumps are used for pumping groundwater. Water from dugwells are lifted by baskets.

Table 5 shows that about 39 per cent of irrigated area is supplied with irrigation water by traditional manual methods. These methods received no public investments. This table also shows that large projects and deep tubewells irrigate 5.8 per cent and 6.9 per cent of the irrigated area with investments of 54 per cent and 28 per cent respectively in First Five-Year Plan.

Table 5. Comparison of various irrigation methods in Bangladesh

Methods	*Dhone*	*Swing Basket*	*Dugwell*	*MOSTI*	*Low-Lift Pump*	*Deep Tubewell*	*Shallow Tubewell*	*Large Projects*
Area Irrigated: in thousand acres	850	150	10	50	1,300	190	60	160
in percent	31	5.4	0.3	1.8	46.6	6.9	2.2	5.8
Water Source Surface/Groundwater	S	S	G	G	S	G	G	S
Source of Energy: Diesel/Electric/Manual	M	M	M	M	D/E	D/E	D/E	D/E
Discharge (cfs)	0.26[a]	0.08[a]	0.02	0.027	2	2	0.5	—
Pumping Height (feet)	0–5[b]	0–6[b]	0–15	5–20	0–20	40	0–20	0–30
Capital Cost (Taka)[c]	300	20	150	1200	38,000	210,000	25,500	—
Working Life (years)	4	2	3	6	7	10	7	—
Command Area (acre of dry season paddy)	4–5	1–1.5	0.33	0.5	40	40	10	—
Government Subsidy in percent	Nil	Nil	Nil	Nil	48	66	19	98
Public Sector allocation's in FFYP[d] in million Taka	Nil	Nil	Nil	Nil	740	1 621	210	3,095
in percent	Nil	Nil	Nil	Less than 1	13	28	4	54

[a] Maximum discharge, [b] A double stage system can be used for greater lifts, [c] 1 US Dollar = 15 Taka, [d] First five-year-plan.

D. WATER CHARGES REVIEW

The two major agencies involved in water resources development in Bangladesh — BWDB and BADC — have so far followed essentially independent policies as regards the recovery of costs from the beneficiaries of their developmental schemes. Although both agencies have subsidized their facilities, the users of the BWDB facilities have generally enjoyed a marked advantage over those of the BADC facilities. Specific details of the current policies of the two agencies are described below.

1. BWDB projects

Until June 1976, BWDB levied on charges for water on the beneficiaries of its gravity or gravity-pumping schemes. In areas where such schemes required the supplemental use of low-lift pumps, BWDB imposed no, or only nominal charges for the use of the low-lift pumps as well. On May 10, 1976, Government of Bangladesh announced that a 1963 Irrigation (Imposition of Water Rates) Ordinance, which had never been implemented, would become effective from July 1976. As promulgated, the Ordinance provides for the imposition of a water rate of 3 per cent of the gross incremental benefits accruing to the owners or occupiers of cultivated lands benefitting from the developmental schemes of BWDB. According to the Ordinance, the benefitted lands are to be gazetted from time to time and the incremental benefits are to be estimated by determining the gross returns from the lands prior to and after the supply or regulation of water by the BWDB schemes.

BWDB indicated that it planned to use 1967/68 as a base year for preinvestment yields, and some crop-cutting experiments to establish actual yields in 1976/77. Details on the acreage to be affected by the implementation of the Irrigation Ordinance or the likely level of per acre charges are not available. The 1978/79 budget estimated that collections would amount to about Tk. 3 million for the year, although informal BWDB estimates were that the collections could go as high as Tk. 10 million. According to information available to-date, collections were not satisfactory as the details for implementation of the Ordinance could not be worked out properly.

As things stand now, beneficiaries of most BWDB schemes receive water as a free good. It is estimated that once the Irrigation Ordinance is implemented, the charges would be about Tk. 60-70 per acre. It is unclear how soon the full implementation of the Ordinance will start. However, when it does, it will not go very far in meeting BWDB expenditures, which are estimated at about Tk. 50 million per annum for O&M alone, or about Tk. 270 per acre irrigated.

2. BADC projects

BADC is involved in three types of irrigation schemes: low-lift pumps, deep tubewells, and shallow tubewells. The present level of charges under the three schemes are as follows:

(a) **Low-lift Pumps (LLPs)** LLP program is the most successful irrigation programme in Bangladesh accounting for about three quarters of the total irrigated area developed through Government schemes. Government has a monopoly on the import of pumps, engines and spare parts and effectively controls the supply of locally made pumps. Most of the pumps are owned by BADC and rented to groups of farmers on a seasonal basis although recently BADC announced its intention to sell LLPs to farmers. In addition to paying for the direct operating costs (i.e. diesel, lubricating oil and the operator salary), the users pay Tk. 300 for spare parts and Tk. 600 as rental charges. Assuming 800 hours of operation per year (necessary to irrigate about 39 acres of boro[1]), the estimated costs per LLP is about Tk. 29,500 or about Tk. 767 per acre of boro. Taking into account the pumps amortization and indirect O&M costs borne by BADC (e.g. workshop facilities), the cost borne by the users represents a recovery rate of about 52 per cent (table 6).

(b) **Deep Tubewells (DTWs)** Like LLPs, most DTWs are also BADC-owned and rented to groups of farmers. The users pay for spare parts, diesel, lubricating oil and the operator salary. In addition, they pay to BADC Tk. 1,200 as rental charges. Assuming 1,000 hours of operation per year (48 acres of boro), the estimated costs per DTW are Tk. 60,760 or about Tk. 1,266 per acre of boro[2]. Because of the relatively high capital costs, the cost recovery rate for DTWs is only about 34 per cent (table 7).

(c) **Shallow Tubewell (STWs)** Unlike LLPs and DTWs, the Government policy on STWs calls for their private ownership. Under the "hire-purchase" scheme, BADC sold STWs to farmers roughly at cost (net of import taxes). The users paid 10 per cent of the price as down-payment and the rest in five equal annual installments. No interest was charged on the unpaid balance. Maintenance is supposed to be provided free of charge by BADC. All other operating expenses are borne by the users. Assuming 700 hours of operation per year (irrigating about 9 acres of boro), the estimated annualized cost to the users under the "hire-purchase" scheme is Tk. 8,680 per STW or about Tk. 964 per acre of boro, representing a cost recovery rate of about 69 per cent. Under the IDA and ADB Shallow Tubewells Projects, the essential terms are similar to those under the "hire-purchase" scheme. However, buyers would pay an interest of 12 per cent per annum on the outstanding balance. Also they would pay 50 per cent of the indirect O&M costs incurred by BADC. The estimated costs to users would be about Tk. 10,000 per STW or about Tk. 1,131 per acre of boro. The corresponding cost recovery rate would be about 81 per cent (table 8).

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[1] Rice harvested in spring.

[2] The per acre costs are not greatly affected by capacity utilization since most of the costs borne by the users are directly proportional to the number of operating hours.

The qualifications to the estimated per acre charges given above are worth mentioning here. First, they ignore any 'extra-legal' payments by the users for obtaining and operating minor irrigation facilities such as pumps and tubewells. In practice, at least in some cases, the farmers have to pay a substantial sum to BADC field staff at various times for getting allocation of a newer pump or getting timely maintenance from BADC mechanics in case of a breakdown. Second, the above estimates assume that the per acre costs would be applied uniformly to all members of the group. In practice, it often happens that a few relatively "better off" farmers take effective control of the pump/tubewell and "sell" water to other members of the group, at rates substantially higher than those necessary to cover the various costs. Because of these, the actual per acre cost to the farmers, particularly the small ones, can be considerably higher — as high as Tk. 1500-2000 per acre of boro.

It is clear that currently a large variation exists in the charges paid by the beneficiaries of the various irrigation schemes, ranging from practically nothing in the case of BWDB schemes to about Tk. 1100 per acre (boro) for STWs schemes. The continued demand for the higher priced irrigation sources (DTWs, STWs) as well as willingness of farmers to pay substantial premiums over the official rates are indicative of the scope for higher charges, at least for users who at present pay none, or nominal charges only.

3. Assessment of current policies

A review was undertaken by the World Bank (1978) of the cost/benefit structure of the various types of irrigation prevalent in Bangladesh. The review was preliminary and the results should be treated as indicative only.

The review dealt with two assumed cropping patterns (with the main irrigated crops being boro rice or winter wheat, respectively) in combination with three alternative assumptions on foodgrain prices:

Alternative I:

Prices would average 1977 official procurement prices (in constant 1977 values).

Alternative II:

A continuation of the price situation experienced during 1976 and 1977, wherein good harvests and large food aid shipments from abroad depressed from gate prices to 20-25 per cent below official procurement prices.

Alternative III:

Prices would correspond to projected 1980 world market prices appropriately adjusted for freight, handling, processing, and quality differentials.

The main conclusions from the review with the cost and benefit figures adjusted according to the analysis given in this study are summarized below:

(a) In most cases, irrigation facilities are a highly attractive investment in financial terms. Depending upon cropping patterns and crop prices, the annual net value of production NVP)[3] is increased by Tk. 3000-5000 per acre representing generally a more than 150 per cent increase in the "without irrigation NVP". These levels are more than adequate to cover the full per acre costs (capital and O&M) of of irrigation from LLPs and STWs, which are estimated to range from Tk. 700-1000 per acre. The returns also would be adequate to cover the costs of most DTW operations, estimated at Tk. 1200 per acre, but would appear to be inadequate to cover the capital and O&M costs of many composite gravity pumping schemes which are estimated to range from about Tk. 3000-5000 per acre. The analysis clearly indicates that for most irrigation facilities even after a substantial increase in charges, there would be enough incentive for the beneficiaries to continue using the facilities and, accordingly, there should be little adverse effect on the overall demand for irrigation.

(b) The potential for cost recovery is highly sensitive to assumptions about foodgrain prices. Estimated increments in NVP would be doubled if the foodgrain prices were to be in accordance with Price Alternative III rather than Alternative II. On the one hand, this highlights the need for Government efforts at stabilization of domestic foodgrain prices; on the other, it indicates the need for keeping policies on irrigation charges flexible so as to adapt to the prevailing foodgrain price levels in the country, and to be able to reflect the effects on farm income of significant changes in subsidies and/or costs of important agricultural inputs.

(c) Currently, most irrigation facilities in Bangladesh are heavily subsidized. Cost recovery

[3] NVP is return after deducting all production costs, including cost of labor (hired and family) but excluding irrigation costs.

ranges from a low of about 2 per cent for BWDB schemes to 34 per cent for deep tubewells, 52 per cent for low-lift pumps, and 70-80 per cent for shallow tubewells. Generally, the most expensive irrigation modes are also the ones with the largest subsidies. As a result, present policies encourage misallocation of development resources as evidenced by the current share of budgetary resources devoted to expensive gravity and gravity-pumping schemes.

(d) Even though the net and gross values of production for wheat growing areas are somewhat smaller than those for boro growing areas, wheat cultivation is more economical where feasible climatically. This is particularly true in areas with porous soils where boro cultivation means very high seepage losses. Since farmers bear only a small fraction of the total costs for irrigation, they fail to appreciate the comparative economics of rice and wheat growing, and this results in inefficient use of the scarce water resources.

(e) In many cases, current policies on water charges encourage capacity underutilization. In the case of LLPs and DTWs, about 95 per cent of the costs borne by the users are direct costs. Consequently, even with serious underutilization of the pump/tubewell, per acre costs to beneficiaries increase only marginally. For example, assuming that a LLP is operated only 400 hours per annum (rather than 800 hours), the irrigated area would be only 19 acre of boro instead of a potential 38 acre. However, the cost per acre increases only from Tk. 767 to Tk. 830. The difference of Tk. 63 per acre is a rather small price to pay in order to reduce the administrative problems associated with organizing and managing the larger group of farmers needed to cultivate 40 acre. This explains, at least in part, the severe underutilization of installed irrigation capacity in Bangladesh.

(f) To make the overall water development program self financing, recovery rates of about Tk. 600 per acre for wheat and Tk. 1200 per acre for boro would be necessary. Were such rates applied to existing irrigation facilities and those foreseen for the next few year incremental annual revenues of about Tk. 1600 million should accrue to Government, a very substantial sum considering the difficult budgetary situation.

(g) Although definitive studies on the distribution of irrigation benefits are lacking, the limited data available suggests their benefits have largely accrued to relatively "better off" farmers. This is because such farmers, being better educated and politically well connected, are able to influence the siting of developmental schemes in line with their interests. Also, often they take effective control of Government owner facilities, such as LLPs, and extract from small farmers charges substantially higher than those envisaged under the Government policies.

In summary, it would appear that present policies are far from optimal as regards the three criteria of 'economic efficiency' 'public savings' and 'income distribution'[4], and that there is considerable scope through appropriate changes in present policies, to do considerable better on all three accounts.

E. COMPUTATION OF TOTAL COST AND COST TO USERS

1. Classification of costs

(a) **Capital costs**

The capital costs include the cost of the water lifting devices, its accessories and their installation. A tubewell, for example, consists of an engine, pump, pipes, fittings and pump houses. A low-lift pump set consists of an engine, a pump and a trolly on which these two are mounted, fittings to join the pumps and trolleys, and the suction and delivery pipes.

(b) **Direct O&M costs**

Expenditures borne by the farmer for the operation and maintenance (O&M) are:

(i) Pay of operator. An operator is needed to run the pump or the tubewell. The duration of the irrigation season is 4½ months and the pay of the operator is Tk. 1500 for the season i.e., @ Tk. 300 per month.

(ii) Honorarium of the group manager. Manager is the key person for tubewell or pump. At the beginning, he follows the scheme through the various stages of approval and the tubewell/ pump is installed at the site. He looks after the timely procurement of fuel, lubrication oil, spare parts and other services. He schedules the irrigation water. He pays most of charges and costs

[4] Discussed in the next chapter.

in advance or arranges loan for them from other sources and he collects water tax from the farmers after the crops are harvested.

(iii) Pay of drainman. Small irrigation units are used only for boro season. Damages occur to the channels during the period when irrigation water is not used. So a drainman is appointed to re-excavate the channels before the irrigation season and to maintain and repair the channels during the irrigation season.

(iv) Irrigation channels. Irrigation channels are excavated for distributing water to individual channels.

(v) Diesel. Diesel is supplied by BADC at the fixed rate of Tk. 14 per imperial gallon. It is also available in local markets. The cost of diesel, according to international price, is about Tk. 18 per imperial gallon.

(vi) Lubrication Oil. It costs Tk. 80 per gallon.

(c) **Indirect O&M Costs**

These are expenditures borne by the Government (BADC and BWDB), which include:

(i) Salaries and Allowances of Staff. BADC and BWDB employ staff in field offices to supervise the installation and maintenance of irrigation units.

(ii) Depreciation of Buildings and Structures.

(iii) Maintenance of Structures.

(iv) Depreciation of Workshop Equipment.

(v) Headquarter Administration.

(vi) Interest on Foreign Loan.

(vii) Interest on Government Loan

2. Computation

The computations of the total cost and cost to users for various types of BADC and BWDB projects are given in tables 6, 7, 8 and 9.

Tables 10, 11 and 12 give the costs of irrigation water for LLPs, DTWs and STWs respectively.

Table 13 shows the subsidies on BADC and BWDB projects. The heaviest subsidy of 98 per cent is given to BWDB projects. The subsidy is least on BADC's shallow tubewell projects.

Table 6. Estimated total cost and cost to users of a 2-cfs low-lift pump[a]

Item	*Total cost*	*Cost To users*
A. *Annualized capital costs*[b,c]	—— (Tk) ——	
(a) Engine (Tk 25,000)	5,250	
(b) Pump (Tk 5,000)	1,040	
(c) Trolly (Tk 1,500)	250	
(d) Pipes (Tk 3,500)	480	
(e) Fittings (Tk 3,000)	500	
Sub-total (A)	7,520	600
B. *Direct O&M costs*		
(a) Pay of operator annual lump sum	1,500	1,500
(b) Spart parts @ Tk, 900 per annum	900	300
(c) Diesel 500 gallons @ Tk. 18 (Tk 14 to user)[d]	9,000	7,000
(d) Lub. oil 10 gallons @ Tk 80 per gallon	800	800
(e) Irrigation channel	500	500
(f) Pay of drainman	1,200	1,200
(g) Group manager (honorarium)	1,500	1,500
(h) Interest on capital	1,000	1,000
(i) Miscellaneous	1,000	1,000
Sub-total (B)	17,400	14,800
C. *Indirect O&M costs*		
(a) Salaries & allowances of BADC staff	1,800	—
(b) Depreciation of buildings and structures valued at Tk. 100 million for 50,000 pumps and tubewells	250	—
(c) Maintenance of Structures @ 2.5%[e] of the initial cost	50	—
(d) Depreciation of workshop equipment valued at Tk. 100 million for 50,000 pumps and tubewells[f]	300	—
(e) Interest (Government and foreign)	1,700	—
(f) Miscellaneous	500	—
Sub-total (C)	4,600	—
Total O&M cost (B+C)	22,000	14,800
D. *Total annual cost (A+B+C)* For 800 hours of operation per annum	29,520	15,400[g]
E. *Total cost per hour*	(36.9)	(19.4)
of which: Capital cost	(9.4)	(0.8)
Direct O&M cost	(21.7)	(18.6)
Indirect O&M cost	(5.8)	(—)

[a] Estimates are based on the raw data collected.

[b] Figures in parenthesis refer to the estimated initial cost.

[c] Assuming a 10 per cent scrap value, a 12 per cent annual interest rate and a useful life of 7 years for engine and pump, 10 years for trolly and fittings and 15 years for the pipes.

[d] Assuming 800 hours of operation per year.

[e] Assuming useful life of 40 years and an annual interest rate of 12 per cent.

[f] Assuming useful life of 10 years and interest rate of 12 per cent.

[g] Assuming rental only during boro season. Rental during aman season requires additional charge of Tk. 300.

Table 7. Estimated total cost and cost to users of a 2-cfs deep tubewell[a]

Item	Total cost	Cost To users
A. *Annualized capital costs*[b,c]	—— (Tk) ——	
(a) Engine (Tk 30,000)	6,270	
(b) Turbine pump (Tk 35,000)	5,995	
(c) Tubewell boring (Tk 75,000)	10,040	
(d) Tubewell materials (Tk 50,000)	6,695	
(e) Pump house (Tk 20,000)	2,650	
Sub-total (A)	31,650	1,200
B. *Direct O&M costs*		
(a) Pay of operator, annual lump sum	1,500	1,500
(b) Honorarium of group manager	1,500	1,500
(c) Pay of drainman	1,500	1,500
(d) Irrigation channel	500	500
(e) Spare parts @ Tk. 1,200 per annum	1,200	1,200
(f) Diesel 800 gallons per annum @ Tk 18 (Tk 14 to the user)	14,400	11,200
(g) Lubrication oil 25 gallons @ Tk 80 per gallon	2,000	2,000
(h) Miscellaneous	1,000	1,000
Sub-total (B)	23,600	20,400
C. *Indirect O&M costs*		
(a) Salaries and Allowances of BADC staff	2,500	—
(b) Depreciation of building and structures	200	—
(c) Maintenance of structures	50	—
(d) Depreciation of workshop equipment	400	—
(e) Headquarter administration	800	—
(f) Interest on foreign loan	1,500	—
(g) Interest on government loan	60	—
Sub-total (C)	5,510	—
Total O&M Cost (B+C)	29,110	20,400
D. *Total annual cost (A+B+C)* for 1,000 hours of operation per year	60,760	21,600
E. *Total cost per hour*	60.7	21.6
of which: Capital cost	(31.6)	(1.2)
Direct O&M cost	(23.6)	(20.4)
Indirect O&M cost	(5.5)	(—)

[a] Estimates based on the raw data obtained from BADC.

[b] Figures in parenthesis refer to the estimated initial cost.

[c] Assuming a 12 per cent annual interest rate, a useful life of 7 years for the engine, 10 years for the turbine pump and 20 years for the rest. Also assuming 10 per cent scrap value for the engine, pump and the pump house.

[d] Assuming 1,000 hours of operation per year.

Table 8. Estimated total cost and cost to user of a 4-inch diameter shallow tubewell[a]

Items	Total cost	Cost to users: Hire-purchase scheme	Cost to users: IDA-STW project
A. *Annualized capital costs*[b,c]	——— (Tk) ———		
(a) Engine (Tk 7,000)	1,460		
(b) Centrifugal pump (Tk 3,500)			
(c) Tubewell materials (Tk 12,000)	610		
(d) Tubewell boring (Tk 3,000) & misc.	1,590 440		
Sub-total (A)	4,100	2,200[e]	3,100
B. *Direct O&M costs*			
(a) Pay of operator, annual lump sum	600	600	600
(b) Spart parts @ Tk 500 per annum	500	500	500
(c) Diesel 210 gallons at Tk. 18 per gallon[d]	3,780	3,780	3,780
(d) Lub. oil 5 gallons at Tk 80 per gallon	400	400	400
(e) Miscellaneous	1,200	1,200	1,200
Sub-total (B)	6,480	6,480	6,480
C. *Indirect O&M costs*			
(a) Salaries and allowances of BADC staff	1,000	—	—
(b) Depreciation of building and structures	200	—	
(c) Maintenance of buildings	50	—	
(d) Depreciation of workshop equipment	250	—	
(e) Interest on loan	500	—	
Sub-total (C)	2,000	—	600
Total O&M cost (B+C)	8,480	6,480	7,080
D. *Total annual cost (A+B+C)* for 700 hours of operation	12,580	8,680	10,180
E. *Total cost per hour*	18.0	12.4	14.5
of which: Capital cost	5.9	3.1	4.4
Direct O&M cost	9.3	9.3	9.3
Indirect O&M cost	2.8	—	0.8

[a] Estimates based on the raw data obtained from BADC.

[b] Figures in parenthesis refer to the estimated initial cost.

[c] Assuming a 12 per cent annual interest rate, a useful life of 7 years for engine, 10 years for pump and 20 years for the tubewell, and assuming 10 per cent scrap value for the engine, pump and tubewell materials.

[d] Assuming 700 hours of operation per year.

[e] The average subsidy on capital cost due to absence of interest charges under the hire-purchase scheme is estimated to be about 46 per cent.

Table 9. Estimated capital and O and M cost of BWDB projects[a]

Item	*Total cost per acre*	*Cost to users per acre*
	Taka	
A. Annualized capital costs	2,400[b]	—
B. Direct O&M costs		
(a) Pay of project employees . . .		
(b) Spare parts		
(c) Power for pumps		
(d) Irrigation channel		
	350	70
C. Indirect O&M costs		
(a) Salaries and allowances of HQ staff		
(b) Depreciation of buildings and structures		
(c) Interest on loan (foreign and local)		
(d) Miscellaneous		
	220	0.00
Total O&M cost per acre (B+C) . .	570	70
D. Total annual cost (A+B+C) per acre .	2,970	70
	or	
E. Government subsidy per acre . . .	97.6 per cent	

[a] Unlike BADC projects, estimates are based on very approximate figures.

[b] The cost per acre may be significantly higher (4-5 times) depending upon other benefits like flood control and drainage.

Table 10. Per acre cost of irrigation of a 2-cfs low-lift pump

Operating hours	*Area irrigated (acres)*	*Annual cost/ acre-inch (Taka)*	*Annual cost/ acre (Taka)*
800 hrs. (8 hrs/day) .	38.5	18.6	767
1200 hrs. (12 hrs/day) .	58.0	16.0	657
1600 hrs. (16 hrs/day) .	77.0	14.9	612

Table 11. Per acre cost of irrigation of a 2-cfs deep tubewell

Operating hours	*Area irrigated (acres)*	*Annual cost/ acre-inch (Taka)*	*Annual cost/ acre (Taka)*
1000 hrs. (10 hrs/day) .	48	30.6	1266
1500 hrs (15 hrs/day) .	72	24.7	1020
2000 hrs. (20 hrs/day) .	96	21.5	1008

Table 12. Per acre cost of irrigation of a 4-inch shallow tubewell

Operating hours	*Area irrigated (acres)*	*Annual cost/ acre-inch (Taka)*	*Annual cost/ acre (Taka)*
700 hrs. (7 hrs/day) .	9.0	36.2	1413
1000 hrs. (10 hrs/day) .	12.7	32.0	1245
1500 hrs. (15 hrs/day) .	19.1	25.8	1004

Table 13. Government subsidy on various types of irrigation

Type of irrigation	*Government subsidy (per cent)*			
	Capital cost	*Direct O&M*	*Indirect O&M*	*Total*
2 cfs Deep Tubewell .	96.2	16.9	32.7	65.7
2 cfs Low-Lift Pump .	92.0	14.4	67.7	47.5
4-Inch Shallow Tubewell				
Hire-purchase . .	46.3	00.0	23.6	31.0
IDA	24.4	00.0	16.5	19.1
BWDB Projects . . .	100.0	20.0	100.0	98.0

F. ISSUES IN FORMULATING WATER PRICING POLICY

The development costs and recurrent costs of operation and maintenance (O&M) of irrigation projects tend to be high, as compared with other forms of agricultural investment and other agricultural inputs. Hence the charges made for irrigation water in relation to the investment and O&M costs to the user is an important issue in the formulation and operation of irrigation projects.

1. Economic efficiency

The first of the principal issues requiring analysis is concerned with the level and structure of the prices to be charged for supplying the irrigation water input so as to minimize waste and to allocate it optimally, or, to put it another way, to maximize the project's net benefit to the economy. How feasible is it to charge such "economic efficiency" prices? True efficiency pricing is rarely encountered in existing irrigation projects since it normally requires accurate measuring of supplies by metering the volume of water delivered (or close volumetric estimates), plus a sales mechanism to obtain market-clearing prices for the water. However, even a nominal price for water would offer users some incentive to eliminate at least some of the conspicuous waste and over-watering that often results when water is treated as a free good. Volumetric pricing of water, whether through the actual installation of meters or through other means of estimating water allocation, are used in several countries. It is desirable, therefore, to investigate seriously the possibilities of pricing based on volume metering (or approximations thereto) in irrigation projects, rather than automatically ruling out such possibilities.

2. Income distribution

Specific taxes designed to capture part of the benefits of a project should take into account the ability of project beneficiaries to pay such taxes. This means that benefit taxes should allow for differences in net benefits generated by the project as well as for differences in income levels: in short, benefit taxes should be progressive, while taking into account disincentives, tax evasion and problems of cost collection.

It is desirable to identify the target income group, preferably classified into a number of sub-groups. One such classification uses the critical consumption level (CCL) as the reference point, with the CCL being defined as the (consumption) level at which the social value of a unit of extra consumption equals the social value of a unit of extra public revenue. In principle, those who remain below the CCL are judged to be so poor that no additional tax burden should be imposed on them, while those who remain above the CCL should be taxed progressively by a proportion of their incremental rent. The CCL varies considerably from country to country. As a rough guide, it is likely to range between two-thirds and one-third of the national average level of income. The CCL is an extremely important concept in cost recovery, especially in projects dealing with small farmers. It should not change with projects, but should remain the same for all projects in the country. If no special estimates are available, then the CCL should be taken as one-half the national per capital income.

3. Public savings

Most governments in developing countries are short of fiscal resources for development. Consequently, it may be desirable for a government to collect more revenues than would result solely from efficiency pricing (which in any case, is frequently impractical). This would help make projects financially self-supporting and enable government to undertake additional projects. On the other hand, as suggested in the previous paragraph, the project beneficiaries may be so poor, i.e., below the CCL, that it would be undesirable to recover costs greater then would result from efficiency pricing of water, and it may be desirable to recover less. The trade-offs between these considerations will determine the appropriate level of cost recovery.

4. Benefit taxes

Efficiency pricing of irrigation water is usually not feasible, and at any rate efficiency pricing, or some form of volumetric pricing together with the effects of general taxation, are unlikely to meet fully the objectives of income distribution and public savings. It is then necessary to consider the possibility of levying a benefit tax. The most robust form of benefit tax is a land betterment tax spread over, say, the life of the project. As long as the tax base is an accurate measure of the benefits conveyed, which implies careful revaluation of land values at reasonably frequent intervals, it should meet the test of user acceptability. Land taxes offer scope for a progressive rate structure and thus achievement of distributional objectives.

The level of benefit taxes should preferably incorporate a degree of progressivity, subject to the constraints of disincentives to work and tax evasion propensities. Thus, it may be desirable to charge very poor farmers, (i.e., those with incomes below the Critical Consumption Level (CCL) at a low rate, while those beneficiaries whose incomes are above the CCL might be taxed at progressively higher rates. Imparting a degree of progressivity into benefit taxes should lead to higher levels of cost recovery than otherwise would be the case.

In some instance, it may be desirable to consider the feasibility of land redistribution within command areas. To the extent that such redistribution is effected, the need for progressivity in benefit taxes would be reduced.

When establishing water charges and benefit taxes, it is often desirable to include a grace period in the early project years, during which project beneficiaries would be required to pay substantially less than at full development. A grace period of about five years is often appropriatee, but a longer period may be justified in some cases. During the grace period, a schedule of gradually increasing rates should be adopted.

To facilitate evaluation of the recommended water rates and benefit taxes, rent recovery indices should be presented separately for beneficiaries in different income classes. It is suggested that, where feasible and relevant, the following income classes be distinguished:

- those with incomes below the CCL;
- those with incomes between the CCL and the national average;
- those with incomes between the national average and twice the national average;
- those with incomes above twice the national average.

G. WATER USE EFFICIENCY

The level of management of the developed water is the most important factor that determines the efficiency of water use in the project.

If the total acreage actually irrigated by the project is any indication of the level of water management, the performances of the big projects, with the exception of the D-N-D Project, have been appalling. Table 14 gives an overview of their recent actual water use.

Table 14. Actually irrigated area of large projects

Projects	*Designed Acreage*	*No. of Acres Irrigated*			
		73–74	*74–75*	*77–78*	*78–79*
G-K	120,000*	17,000	30,000	50,000	65,000
D-N-D	14,730	10,000	10,000	10,000	10,000
Thakurgaon	78,000	6,400	—	30,000	24,000

* The project was actually designed in mid-fifties for the supplemental irrigation on 350,000 acres. With the introduction of HYV of rice within the project area later, water requirement figures were changed. The area of 120,000 acre shown here is a conservative estimate of the present potential acreage that can be served.

The average performances of tubewells and low-lift pumps are also far from satisfactory.

Recent field measurements by Khan and Mirjahan (1978) showed that more than 50 per cent of water is lost in the main canals of deep tubewell units. The causes for such poor water utilization are many and heavy subsidy in the units cost is one of them.

The system of irrigation supply to the farmers under two State agencies differ considerably, and this has resulted in a serious set-back to achievements, particularly when the two organizations operate in the same area providing widely different facilities to the farmer.

The BWDB constructs the canal free, supplies the fuel to the pump and bears the cost of the operator, whereas the BADC expects the farmer to construct the canal, and bear the cost of fuel and operator. These disparities cause serious problems — e.g., farmer groups under 39 of the BADC deep tubewells in Dinajpur district did not utilize their deep tubewells probably because they expected the same free facilities which were provided by the BWDB.

H. CONCLUSIONS

The Government is subsidising most of the irrigation systems, the largest subsidy being on large scale projects, which unfortunately are showing the least percentage of progress, compared to the small scale systems. These subsidies now are not uniform and the most suitable types of irrigation, which are likely to show the best results, are receiving little or no subsidy. The Government policy on subsidies for irrigation development will have to be reviewed and streamlined for future development.

For most irrigation facilities, particularly the gravity schemes, present charges are so far below levels which are financially feasible and economically desirable that a first step should be to substantially raise the present charges.

For the longer run, Government should develop a more refined overall nationwide policy on water charges. This policy, while applicable to all Government agencies or entities, would not necessarily establish uniform water charges throughout the country and for all types of irrigation. Basically, the policy should be aimed at establishing cost recovery levels that are mutually consistent with providing adequate incentives to farmers to use irrigation water and thus with promoting the growth of irrigation development; beneficiaries' abilities to pay; and minimizing the charge on the national budget for the construction, operation and maintenance of irrigation facilities.

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Annex

GROWING SEASON OF DIFFERENT VARIETIES OF RICE

In Bangladesh the rice growing is divided into three seasons, somewhat overlapping. They are:

Aus:

Seeding —

Broadcast, March 15 - May 15
Harvest, mid-July to mid-September
Transplanted, March 1 - April 15

Aman:

Seeding —

Broadcast, March 15 - April 30
Harvest, November 15 to January 15
Transplanted, July 15 - Sept. 15

Boro:

Seeding —

Harvest, end of March to May
Transplanted Nov. - Feb.

The **Aus season** (about 28 per cent of total paddy acreage is characterized by scattered spring rains. The crop may suffer from drought in some areas, especially during the early part of the season. Paddy is usually grown with serious weed problems. Harvesting takes place during the monsoons and there are grain drying and storage problems.

The **Aman season** with the largest rice acreage (60 per cent of the total paddy acreage) is characterized by heavy monsoon rains. During this season, deep water can accumulate over wide areas up to 15 to 20 feet deep. Aman rice is either broadcast or transplanted. In the case of broadcast rice in Aman the yields are poor but no other crops could be planted in deep water. Transplanted Aman is the major rice crop on medium lands and represents about 65 per cent of the total Aman area. Seedlings are raised in nurseries in June-July and transplanted to puddled fields in July-September.

The **Boro season** is characterized by dry weather during the growth stage of the crop and by the lowest temperature of the three seasons. The paddy acreage during Boro season is limited to low lying areas where paddy is planted into receding flood water and growth is sustained by residual soil moisture or to areas with some form of irrigation, either traditional devices, low-lift pumps, tubewells or gravity diversion. Late in the season high winds and showers may spread disease and cause lodging.

II. IRRIGATON WATER PRICING IN INDIA*

A. INTRODUCTION

Agriculture accounts for nearly half of the national income of India and it supports about 70 per cent of the country's population. But large parts of the cultivated land usually experience the problem of insufficient rainfall for crop growth either in terms of total precipitation or its distribution to match with crop water requirements. Provision of irrigation facilities is therefore considered a necessity over most parts of the country for securing cultivation against the vagaries of rainfall. In the era of planned development which commenced in 1951, irrigation schemes have played an important role in stepping up food production and improving rural economy. As a result of sustained efforts, the total area under irrigation in the country has risen from 20 million hectares in 1950 to over 50 million hectares by 1977. The creation of additional irrigation facilities involves outlays of capital investment of even up to Rs. 10,000 per hectare. In this context of ambitious programme for developing the irrigation facilities with high investment, the study of water pricing assumes particular importance.

Prior to Independence (1947), irrigation schemes other than minor ones were financed from public loans and were required to satisfy a productivity criterion. Under this, a project was required to yield in the tenth year after completion a specified rate of return on the sum at charge (sum of capital cost of the Project and arrears of interest on the capital). The revenue that is considered for the productivity test accrues almost exclusively from water rates. In view of this test the irrigation water rates had to be maintained at a sufficiently high level so as to yield the stipulated rate of return.

Since Independence, development of irrigation facilities has received particular attention for stabilising agriculture. The rate of return in the productivity test was relaxed initially to accommodate more projects. At the same time, it was recognized that the productivity approach is based purely on the income from water rates and does not consider the role of the project in improving the socio-economic conditions in the regions which are far more important. The approach of benefit-cost analysis was considered suitable for assessing the economic viability of projects, in place of the earlier financial productivity test. While this new approach has helped in faster development of irrigation facilities, the financial returns from the projects have, however progressively decreased over the last three decades. Whereas the irrigation works in the country as a whole yielded a net annual profit of Rs. 10 million after meeting the interest charges and cost of maintenance immediately after Independence, the total loss on irrigation works in 1976-77 exceeded Rs 2442 million.

* This paper was prepared by B.M.K. Mattoo, Joint Secretary (Financial Adviser), Department of Irrigation, India.

B. PRACTICES OF LEVYING CHARGES

Irrigation is a State subject in India and charges for supply of irrigation waters are fixed by the State Governments. Charges for irrigation supply from Government sources are levied differently in different States. These include one or more of the following:

(i) Water rate depending on the kind and the extent of crop irrigated.

(ii) Increment in land revenue based on increased benefit derived annually from providing irrigation facilities.

(iii) Betterment levy representing the Government's share in the increase in land value accruing with the provision of irrigation facilities.

(iv) Irrigation cess, being the annual charges per acre of the irrigable area, whether water is actually taken for irrigation or not.

(v) Maintenance cess.

1. Surface water schemes

There is considerable diversity in the system for levying irrigation charges in different States in India. In the northern States like Uttar Pradesh, Punjab, Haryana and Rajasthan, the water rates are charged for the actual areas irrigated under different crops. In West Bengal, the Deltaic region of Orissa, and parts of Bihar and Madhya Pradesh, the assessment is made on the areas and crops entered under the agreements for irrigation, irrespective of the fact whether the areas covered are actually irrigated or not. This system came into vogue because of the uncertainty prevailing under the climatic conditions in the region. The leases are either on long-term basis (for a period of 10 years or so) or for a single season. Lower rates are charged for long-term leases to serve as an incentive to the farmers to enter into such leases.

In Maharashtra and Gujarat in Western India the crops to be grown on individual plots are decided in advance taking into account the soil and other pertinent factors, and the water rates are charged accordingly on 'crop-rate' basis. In Tamil Nadu and other southern States, the water charges for a single crop are realised as a part of the land revenue. This system was found to be more convenient as the earlier projects in this region had primarily catered to irrigation of a single crop raised over the same area year after year. For the purpose of assessment the lands are classified as dry and wet. On wet land a consolidated amount which includes an element of dry land revenue and a charge for water is realised, whereas on dry land the charge for water pertains only to the land revenue.

2. Tubewells

On public tubewells, the irrigation rates are charged according to the volume of supply in the States of Gujarat, Madhya Pradesh and Uttar Pradesh. In Haryana and Punjab the charges are related to the per unit of consumption of electricity. In Gujarat a two-tier system tariff is in vogue on the tubewells. This includes a standing charge per unit of crop area irrigated with a minimum yearly charge per unit of land irrespective of whether actual irrigation in any season is carried out or not, and a variable charge levied on volumetric basis on the actual supply of irrigation water.

3. Maintenance cess

In some States viz. Madhya Pradesh, Gujarat and Karnataka, a cess called the irrigation cess or the maintenance cess is levied in respect of land under the culturable command of a project in addition to their irrigation rates. The cess is charged whether the farmer takes water in any season or not.

4. Betterment levy

Almost all the States have enacted legislation for raising a betterment levy in addition to the water rates. The aim of the levy is to appropriate to the State a part of the unearned increase in the value of land due to introduction of irrigation and to adjust the same towards capital outlay on the irrigation projects. Practically, however, no attempts for collection of the levy have been made except to some extent in the States of Haryana, Rajasthan and Andhra Pradesh. The Betterment-levy Acts generally stipulate the recovery of the levy to be made in lump sum or spread over a period of 15 to 20 years. In some States, there is a provision for the payment to be made wholly or partly by surrender of land. A rebate is admissible on payment of levy in lump sum or within one or two months of notice. In a few States areas benefited by individual projects below a specified magnitude are exempt from the levy.

5. Variation of irrigation rates

The irrigation rates in a State usually vary for different categories or classes of works according to the adequacy or dependability of irrigation supply. They are usually higher for storage works than for flow schemes of the diversion type.

The rates for lift irrigation, including public tubewells are usually higher than for flow irrigation projects. A reason for this apart from the fact that lift irrigation projects usually provide more assured irrigation particularly as compared to the flow irrigation schemes of the diversion type, is that the operation and maintenance expenditure on lift schemes is higher. This has resulted in characterising the lift irrigation projects as the ones which incur a heavy recurring annual loss as compared to the flow irrigation projects.

On similar type of projects in a State, irrigation rates are usually kept lower on projects which are located in comparatively backward or drought-prone regions of the State, in consideration of the fact that the capacity of the farmers to pay for irrigation is less in such regions.

Irrigation rates within a project usually vary from crop to crop. Sometimes the variation is limited to different seasons only and a uniform rate is kept for all the crops in a season. The variation in rates is usually governed by two factors, viz., (i) the water requirement of the crop; the more the water requirement, the higher the rate, and (ii) paying capacity of the farmers as determined by the relative value of the crop; more the value of the crop, the higher the rate. Even on public tubewells, in some States where water is sold on volumetric basis, the rate per unit of water is higher for sugarcane as the crop has relatively more cash value. Sometimes the rates for a particular crop or group of crops in a particular season are deliberately kept low to provide a special incentive for utilisation of irrigation water in that season. Rates are usually low for irrigating such portions of the command area as cannot be irrigated by gravity flow and involve lifting of water by the cultivators. In some States, concessional rates are levied for the first few years ranging from 4 to 11 years on the new irrigation projects in order to induce the cultivators to take to irrigation and in consideration of the fact that the cultivators during the gestation period have to bear the burden of heavy expenditure on on-farm development and the return for irrigation is also below the optimum. The rates are gradually increased from year to year to reach the full level.

Tables 15 and 16 indicate the charges levied in different States in 1951 and in 1978 for flow and lift irrigation under principal crops respectively.

C. TOWARDS REVISION OF WATER RATES

1. Past review and studies

The subject of revision of water rates has been studied at different times. In 1964, a High Level Committee examined this question and recommended that water rates should be on the basis of 25-40 per cent of the increased net benefit derived from irrigated crop or 5 to 12 per cent of the gross income of the farmers. The Irrigation Commission set up by the Government of India in their report (1972) also examined this question and recommended certain guidelines and principles to be followed in fixing water rates. These are:

(a) Water rates should be levied on a 'crop basis' except in the case of irrigation from tubewells which should be charged for on the basis of the quantity of water supplied.

(b) The rate should be related to the gross income from the crop and not to the cost of the projects. It should range between 5 per cent and 12 per cent of gross income, the upper limit being applicable to cash crops.

(c) The rates should be within the paying capacity of irrigator and should aim at ensuring full utilisation of available supplies.

(d) Between regions with a similar class of supply there should be the minimum disparity, if any, in the rates charged.

(e) For fixing rates, irrigation should be divided into A, B and C categories on the basis of the quantity and timeliness of supply. Lower rates may be fixed where on account of good rainfall, the demand for irrigation water is less or where the supply is inadequate.

(f) The general level of rates in a State should be such that, taken as a whole, the irrigation schemes do not impose any burden on the general revenues.

The Commission pointed out that the above recommendations would require a substantial upward revision of the existing water rates in most States. In view of the key role of irrigation in increased production, there was, according to the Commission, full justification for levying adequate irrigation charges. The capacity of the farmers to bear higher charges was evident from the fact that the Commission had come across several instances where cultivators were purchasing water at price several times higher than the rates on Government projects from owners of neighbouring tubewells or lift pumps. The Commission also endorsed the suggestion made by some of the States that water rates should be fixed simultaneously in a region. Besides, it was suggested that the irrigation rates should be revised after every five years.

2. Water Rates Review Board

The subject was discussed in several conferences of State Irrigation Ministers wherein the principle of revision of water rates was accepted and recommendations made that a Standing Inter-departmental Water Rates Review Board should be set up by the State

Governments to review, on a continuing basis, the rates structure and make recommendations for appropriate increases.

Seven States have already set up Inter-departmental Water Rates Review Boards. In some other States, such Boards have not been considered necessary in view of the alternatives already available for fulfilling the functions of Review Boards.

Since the commencement of planned development of irrigation in India, i.e., 1951, water rates have been increased a number of times in most of the States of the country. The increases effected in different States in respect of selected crops like sugarcane, paddy, wheat and dry crop may be seen from tables 15 and 16.

3. Covering of annual costs

The cost of irrigation per hectare varies widely from State to State. Because of the terrain and the nature of schemes, irrigation projects in peninsular India cost more than those in the Indo-Gangetic plains. The cost per ha. for major and medium schemes taken upto the end of IV Plan in the various States has been worked out. The cost of continuing schemes (Rs. 7,518 per ha.) is the highest in Tamil Nadu, followed by Maharashtra. The lowest cost for continuing schemes (Rs. 1,156 per ha.) is in West Bengal followed by Assam. The average for completed schemes is generally lower than for the schemes under construction. The cost of new projects is likely to be still higher. In Southern States (Kerala, Tamil Nadu, Karnataka, Andhra Pradesh, Orissa and Maharashtra), the average cost per ha. for the continuing and completed schemes is about Rs. 3,996. In the Northern and Eastern States, the average cost per ha. of completed and continuing schemes is about Rs. 2,177. The interest liability at the current rate of 5.5 per cent would amount to Rs. 231 and Rs. 116 per ha. in the case of Southern and Northern regions respectively. To this should be added the cost of maintenance and operation which is estimated at Rs. 50 per ha. in flow irrigation works. For covering these costs, the average water rates should be as follows:

Southern region	Rs. 281 per ha.
Northern region	Rs. 166 per ha.

Information contained in table 15 clearly indicates that the rates prevailing in 1978 are on a considerably low side with respect to the average rates worked out above.

D. CONCLUSIONS

In a country like India, where water resources are limited and where comparatively easier schemes have already been exploited, irrigation water rates should broadly keep two objects in view, viz. (i) to serve as an instrument to promote efficient water use and (ii) to minimise the burden on the general tax-payer on account of losses sustained on irrigation works. Present assessment indicates that on full development of utilisable water resources in the country, it may be possible to provide irrigation facilities to about half of the cultivated area in the country. Consequently, large tracts of cultivated land which are in need of irrigation facilities may have to go without this basic input for assured agriculture. The system of water rates should be able to serve as an instrument to promote efficient use of water in developing specific types of cropping patterns in accordance with the Government policies. Unless water is made a valuable commodity, there would be wastage in water use. Higher rates can be expected to induce a sense of awareness that water is a valuable commodity and has to be used economically and judiciously. It is basically an introduction of volumetric supply of water that can achieve this object. But in view of the small size of holdings, volumetric supply is not generally feasible on a large scale in gravity systems. The object of economy in water use can however be achieved by releasing supplies on a pre-determined roster, known locally as Warabandi system. This would also help in developing specific types of cropping patterns since the Warabandi system will be designed keeping the requirements of a specific crop or group of crops in mind.

The second important object of water charges is to ensure that the losses being incurred at present on irrigation systems are arrested, so that the general tax-payer is not unduly burdened with the task of subsidising irrigation. The water rates at present are not adequate to meet even the maintenance and operational cost of the canal system and these will have to be raised to meet at least the maintenance and operational costs, to start with.

At State level, reviewing bodies should study the water rates structure in the light of the agricultural production, cropping pattern and other related factors, with a view to rendering the rate structures more rational and acceptable to the farmers. A National Consensus needs to be evolved regarding the philosophy of water rates structure and water rates reviewed upwards periodically depending upon increases in agricultural production.

Table 15. Water rates of flow irrigation in various states of India
(Rs. per acre)

Name of State	Sugarcane		Paddy		Wheat		Dry crops		Remarks
	1951	*1978*	*1951*	*1978*	*1951*	*1978*	*1951*	*1978*	
1 2	3	4	5	6	7	8	9	10	11
1. Andhra Pradesh	6.00	32.00	4.00	16.00	—	—	2.00	8.00	i) Meghalaya and Tripura have no Act to charge water rates.
2. Assam	—	—	—	90.00	—	45.00	—	—	
3. Bihar	—	55.00	5.00	31.50	3.25	18.00	—	19.50	
4. Haryana	16.50	40.00	9.75	30.00	6.37	25.00	4.88	20.00	ii) Assam has no water rates at present. Rates mentioned are realised on mutual agreement.
5. Jammu & Kashmir	6.48	8.13	6.48	8.13	3.04	4.38	2.48	3.13	
6. Karnataka	35.00	120.00	4.00	30.00	6.00	18.00	—	18.00	
7. Kerala	6.00[a]	—	6.00[a]	40.00	—[a]	—	2.00[a]	—	
8. Madhya Pradesh	30.00	40.00	12.00	24.00	10.00	15.00	4.00	12.00	iii) Manipur has no water rates at present. The rates indicated are under consideration.
9. Maharashtra	80.00	300.00	5.00	20.00	8.00	30.00	12.00	60.00	
10. Manipur	—	—	—	30.00	—	15.00	—	9.00	
11. Orissa	7.50	27.00	4.25	8.00	2.00	9.00	2.50	3.00	
12. Punjab	16.50	27.00	9.75	19.50	6.37	11.69	4.88	8.94	iv) Regarding Gujarat and Himachal Pradesh, information is not available.
13. Rajasthan	9.60	40.00	6.40	28.00	4.60	21.00	2.80	20.00	
14. Tamil Nadu	6.00	25.50	4.00	17.00	—	—	2.00	13.50	[a] Rates indicated are in the year 1956.
15. Uttar Pradesh	22.50	66.00	7.50	40.00	7.50	40.00	—	—	
16. West Bengal	—	—	4.00	15.00	2.25	20.00	—	50.00	

Table 16. Water rates of lift irrigation in various states of India
(Rs. per acre)

Name of State	Sugarcane		Paddy		Wheat		Dry crops		Remarks
	1951	*1978*	*1951*	*1978*	*1951*	*1978*	*1951*	*1978*	
1 2	3	4	5	6	7	8	9	10	11
1. Andhra Pradesh	—	—	—	—	—	—	—	—	i) Meghalaya & Tripura have no Act to charge Water rates.
2. Assam	—	—	—	—	—	—	—	—	
3. Bihar	28.00[a]	74.00	16.00[a]	42.00	12.00[a]	32.00	—	22.00	
4. Haryana	33.00	40.00	19.50	30.00	12.75	25.00	9.75	20.00	ii) Regarding Andhra Pradesh, Gujarat, Himachal Pradesh, Maharashtra and West Bengal, information is not available.
5. Jammu & Kashmir	16.00	20.80	16.00	20.80	16.00	20.80	8.00	10.40	
6. Karnataka	—	360.00	—	90.00	—	36.00	—	36.00	
7. Kerala	6.00[b]	—	6.00[b]	60.00	—[b]	—	—[b]	—	
8. Madhya Pradesh	60.00	80.00	24.00	48.00	20.00	30.00	8.00	24.00	
9. Maharashtra	—	—	—	—	—	—	—	—	[a] Rates indicated are in the year 1965.
10. Manipur	—	—	—	—	—	—	—	—	
11. Orissa	2.00	108.00	2.00	28.80	2.00	36.00	2.00	12.00	[b] Rates indicated are in the year 1956.
12. Punjab	8.25	13.50	4.88	9.75	3.19	5.84	2.44	4.47	
13. Rajasthan	—	20.00	—	14.00	—	10.50	—	10.00	
14. Tamil Nadu	—	—	—	—	—	—	—	—	
15. Uttar Pradesh	1.50 (per 16000 gallons)	—	1.50 (per 16000 gallons)	1.00 (per 16000 gallons)	1.50 (per 16000 gallons)	1.00 (per 16000 gallons)	1.50 (per 16000 gallons)	—	
16. West Bengal	—	—	—	—	—	—	—	—	

III. FARMERS' PARTICIPATION IN OPERATION AND MAINTENANCE OF IRRIGATION FACILITIES IN INDONESIA*

A. RESPONSIBILITIES FOR OPERATION AND MAINTENANCE

The operation and maintenance of the primary and secondary irrigation system are the responsibility of the provincial administration, while the operation and maintenance of on-farm works (in the tertiary block) are left to the farmers concerned. In 1969 the Central Government issued Presidential Instruction No. 1/1969 to the Ministers of Internal Affairs, Public Works and Agriculture to provide the guidance for proper supervision of these activities. The Instruction includes the following points:

* Abstract of a paper prepared by Soediro Sh. and Ir. Soekadarjanto, Directorate General of Water Resources Development, Jakarta.

1. The responsible authority in a region is the Provincial Governor as the single authority to execute the water management and the operation and maintenance for irrigation networks, covering the primary, secondary as well as the tertiary of an irrigation system, assisted by the Provincial Public Works, i.e. Water Resources Division, as the engineering agency. In the daily execution the head of the Provincial Public Works receives supervision and guidance from the Ministry of Public Works.

2. To coordinate the work to be done an irrigation commission could be established in each Regency. It consists of following members:

Head of the Regency — as Chairman

Head of Local Public Works Agency — as Secretary

Head of Agriculture Agency — as member

Head of Agrarian Office — as member

3. The Commission has the authority to issue decrees, which should not be contradictory to the Governor's policy.

4. To ensure that the operation and maintenance of irrigation works are supported by adequate funds, the Governor is authorized to collect fees from the farmers to cover the O & M expenditure. However, it must be agreed to in advance by the Minister of Internal Affairs.

5. Village irrigation networks will be operated and maintained by the village concerned.

B. IPEDA (LAND TAX)

IPEDA is a kind of land tax, which is collected for the development of the country. It is calculated on the basis of land productivity. At present 50 per cent of IPEDA revenue is used for agricultural development and the operation and maintenance of irrigation networks. The other 50 per cent is used for other rural development, such as the repair of rural roads and bridges, rural hospitals and schools. In 1979/1980 the funds from IPEDA for O & M of irrigation systems amounted to Rp 6 billion, while the total O & M expenses for the total irrigated area of 4.47 million ha was Rp 18 billion. The deficit of Rp 12 billion was subsidized by the Central Government. The Provincial Administration has to submit the budget to the Central Government every year. The average annual O & M expenses is calculated to be about Rp 4,000 (or US$ 6.4) per ha.

C. OPERATION AND MAINTENANCE OF TERTIARY SYSTEM

As mentioned above the construction and O & M of tertiary network are the responsibility of the farmers. When necessary the Government provides assistance in the design of intake and distribution structures. However at present the Government builds the tertiary networks under the framework of government assistance to farmers.

The Water Users Associations have been set up to carry out the O & M of the facilities within the tertiary block. The blocks having an area of 75 ha or less are supposed to be merged. The Provincial Governor has the responsibility to supervise the Associations under his jurisdiction. The Chairman of the Association should be a member and elected by the members. The level of contribution collected from farmers to cover the O & M expenses is determined at the members' general meeting.

IV. WATER PRICING SCHEMES IN THE PHILIPPINES*

A. INTRODUCTION

Most of the water utilities serving the population centers of provinces outside Manila were constructed before the Second World War. These systems have not coped up with the demands of a growing population and an expanding economy. Inadequate maintenance led to the deterioration of most systems resulting in inadequate supplies and unreliable service. Studies made show that among the causes of the prevailing conditions are institutional weaknesses. Local governments responsible for the operation and maintenance of the systems were not trained in management techniques for running the utilities and in most cases water rates were unrealistically low to support expenditures.

During the first half of the last decade, the Philippine government made efforts to remedy the problem of providing adequate water supply for its people with the creation of two agencies that were made responsible for the urban centers of the nation. The Metropolitan Waterworks and Sewerage System (MWSS) was created in 1971 to take care of the needs of the Metropolitan Manila area. The Local Water Utilities Administration (LWUA) was organized in 1973 to establish independent, locally controlled water districts that will install, operate, manage, maintain, improve and expand viable waterworks and sewerage systems

* This paper was prepared by Cesar E. Yniguez, Hydrologist, National Water Resources Council, Philippines, and Acting Manager, Engineering Department, Rural Waterworks Development Corporation.

in the large cities and municipalities of the country. Both are government owned and controlled corporations attached to the Ministry of Public Works.

B. WATER PRICING POLICY AND RATE STRUCTURE

The national government follows a socialized pricing policy where those who can afford to pay more must carry a greater load of the revenue requirements of the water utilities. Although water is a prime commodity both for the poor and the rich, and pricing is made to be affordable for the lower income bracket, it must not be too high to make it oppressive to the higher income group.

The rate structure of both MWSS and the water districts under LWUA's jurisdiction allow the utilities to generate revenue sufficient to cover operating expenses, including adequate maintenance and depreciation, expenditures for normal extensions and expansion and to meet repayment of long-term indebtedness the proceeds of which were used in constructing the facilities.

This is in line with the policy of the government of encouraging agencies involved in water supply to attain financial independence, thereby minimizing government subsidy, by increasing their own internal revenue generation capabilities and by providing services within the cost repayment capabilities of the beneficiaries.

Water pricing is based on two basic premises, namely: first, all water drawn from the water system must be accounted and paid for and, second, water rates must be high enough to meet the financial requirements of the water utility, but low enough to be within the paying capability of the majority of the water users.

The manner of arriving at the water rates used by both MWSS and LWUA are based on the determination of revenue requirements to cover the expenditures of the water utility. The items comprising the expenditures include the following:

a. Wages and Salaries
b. Power/energy/fuel expenses
c. Maintenance expenses other than wages
d. Repairs and replacement expenses
e. Debt service, if any
f. Required reserves increment
g. Reserves for expansion
h. Other identifiable outlays

The cost of these items are averaged over a period of time to a monthly value. The basis used is previous expenditures of the utility. Together with the number of connections classified into size and category of consumer and monthly production and consumption, the cost of water sufficient to cover expenditures is determined.

The LWUA recommends two methods of determining rates for their water districts, namely: the revenue unit method and the quantity block method. The MWSS follows a methodology much similar to LWUA's methods.

The methodologies followed by the LWUA and the MWSS will be presented in the following sections together with the background on their respective functions and the funding schemes for their projects.

C. LOCAL WATER UTILITIES ADMINISTRATION

The Local Water Utilities Administration is primarily a specialized lending institution created for the promotion, development and financing of local water utilities. Its objective is to promote the development of provincial waterworks systems through the establishment of water districts. A water district is a geographical subdivision composed of one or more cities/municipalities serviced by one water utility. It is also a non-profit, quasi-public corporation run by a five-man board of directors through a general manager and it is independent from local government.

Water districts are established in the bigger cities/municipalities with a population of at least 20,000. The LWUA provides technical, financial, management and skills training assistance to water districts which include helping the water districts establish realistic water rates.

1. Project funding

The LWUA has an authorized capital stock of ₱500 M subscribed by the national government. Its other sources of funds are from domestic and foreign borrowings. Current projects are funded by the USAID, the World Bank and the Danish Government together with the Philippine Government counterpart.

To attain its objective, the LWUA has embarked on a program of technical and financial assistance to the water districts which number about 125 at present. It extends long-term loans which carry a nine per cent (9%) interest rate per annum and a thirty-year repayment period including a four to five year grace period; and, short-term loans, also at nine per cent (9%) interest rate, with five to fifteen years repayment period including a one to two year grace period.

2. Cost recovery schemes

The water districts operate and maintain the water systems. They expect to recover costs by charging the water users for the water service in full. Under the LWUA Charter, water districts are authorized to formulate and adopt reasonable water rates to attain and maintain financial viability. For the improvement and expansion of their water systems, the water districts are likewise authorized to incur capital loans for their capital improvement and repay these loans from revenues generated from their water sales.

Among the policies that govern this concept are:

(a) Every water user drawing water from and being served by the system must pay; all water drawn from the system must be accounted and paid for.

(b) Cost of new capital improvements, repairs and maintenance will be generated from water revenues; government subsidy should be minimized if not entirely eliminated.

(c) With increased revenue, services will correspondingly be improved through more efficient operation and management. The water system will continually be improved and expanded to meet the growing needs of the communities it serves.

(d) An equitable method of fixing water rates will be devised where every user will share in paying the cost of operation, maintenance and improvement. Such water rates should be high enough to meet the water district's cash needs but low enough to be within the ability to pay of the low income group.

(e) Every water connection will be metered not only to prevent wasteful use of water but also to have an accurate record of production and consumption.

(f) A good collection enforcement program will be effected to minimize delinquency and eliminate illegal connections.

3. Water rate formulation

The LWUA classifies water rate structuring into two, namely: (a) the revenue-oriented approach, which gives prime consideration to financial requirements, and (b) the service-oriented approach which is primarily designed to favor the low income group.

Factors taken into consideration in determining water rate structures in the water districts are:

(a) Ability to pay — socio-economic condition in the district, to sustain financial viability.

(b) Cash requirements of the district — operational expenses and capital investments (amortizations), emphasized in revenue-oriented schemes.

(c) Enforceability — can the rates be justified and made acceptable to the public?

(d) Availability of reliable data — to be the basis of realistic computations.

At present, water districts use two basic methods, namely: (1) the Revenue Unit Method and (2) the Quantity Block Method.

Water users are categorized into the following three major types or classes for purposes of billing:

(a) Residential and Government

(b) Commercial/Industrial

(c) Wholesale/Bulk

Within each category, connections are classified into the size of the service connection. Each user is, therefore, classified by user category and service connection size.

4. Revenue unit method

In many water systems in the Philippines, the number of unmetered connections outnumber the metered connections. The revenue unit method provides a devise of computing water rates applicable to unmetered connections and utilized in combination with acceptable methods of computing rates for metered connections.

The method is based on several assumptions among which are the following:

(a) Under the same condition of pressure, various sizes of pipes will have a corresponding ratio of delivery (discharge) to that of a 3/8″ connection. (A 3/8″ connection is actually a 1/2″ pipe whose flow is regulated to give about a gallon per minute at a pressure of 20 psi). Table 17 gives the conversion factors with a 3/8″ connection as the base size and these factors become the basis for computing revenue units for each user size and category combination.

(b) For unmetered connections, it will be assumed that the smallest connection is 1/2″.

(c) For all unmetered connection, the minimum charge for every type and size of connection will be based on one connection with two faucets. Additional charge for every faucet in excess of two will be made.

(d) For all metered connections, the minimum monthly charge will cover the first 10 cubic meters of water.

Table 17. Conversion factors for computing revenue units

Pipe Size	Ratio to a 3/8"	Factors		
		Domestic/ Government	Commercial/Industrial	Wholesale/ Bulk
3/8"	1.0	1.0	2.0	3.0
1/2"	2.5	2.5	5.0	7.5
3/4"	4.0	4.0	8.0	12.0
1"	8.0	8.0	16.0	24.0
1 1/2" . . .	20.0	20.0	40.0	60.0
2"	50.0	50.0	100.0	150.0
3"	90.0	90.0	180.0	270.0
4"	180.0	180.0	360.0	540.0

The LWUA uses two methods of computing rates for unmetered connections which basically uses the conversion factors to arrive at the total equivalent revenue units (RU) for all connections classed according to size and user category. The average monthly expenditures attributed to unmetered connections is then divided by the total equivalent revenue unit to get the basic charge per revenue unit for a 3/8" connection. The conversion factors are again used on the basic charge for the 3/8" connection to arrive at the rates for other connection sizes and category combination.

In the computation of water rates involving metered connections, there are usually two kinds of charges — the minimum monthly charge and the commodity charge. The minimum monthly charge, also called service charge, is a fixed charge depending on the size of the connection, which charge covers the first 10 (ten) cubic meters delivered. The unit price is uniform for every size and category of connection.

The revenue unit method for metered connections sets a revenue unit of 10 per 3/8" connection to cover the minimum charge. Each other size and category of connection is assessed with their own minimum revenue unit using the factors in table 17. The total equivalent revenue units for the minimum charge is obtained by getting the sum of the product between the corresponding minimum revenue unit and the number of connection under each size and category combination. Likewise, for the commodity charge the revenue units for the difference between the average consumption per connection and the minimum of ten (10) cubic meters is determined for each size and category combination. The sum of the total revenue units for the minimum charge and the total revenue units for the commodity charge is used to divide the total monthly expenditure alloted to the metered connections to get the amount per revenue unit. Collection efficiency is taken into consideration by dividing the amount per revenue unit by the efficiency value and the result is used as the basic charge per revenue unit. Working backwards using the conversion factors, the minimum charge and commodity charge under each size and category combination are determined.

The summary of the above outlined procedure for the Revenue Unit Method is presented in annex I.

5. Quantity block method

The quantity block method is less revenue oriented but more public service oriented. The principle behind this method is that the unit cost of water increases in proportion to water consumption. To facilitate rate computations quantity blocks are used in terms of ranges of water consumption within each category of user and a uniform unit price within each quantity block is determined.

The manner of determining the rates followed by LWUA using the quantity block method may take several trials to be able to arrive at a unit price that is within the estimated capacity of the low income user.

On the basis of the consumption pattern for all domestic connections reasonable quantity blocks, at least four, are determined. Then, the expected volume of consumption corresponding in each quantity block are computed using past records. Factors are assigned in ascending order to quantity blocks starting with the factor 1.0 for the first block to indicate the increase in unit price as the volume increases.

For the other two categories, commercial/industrial and wholesale/bulk, the expected volume per block are also determined and factors for each block in the domestic category are multiplied by 2.0 and 3.0 respectively to get the corresponding factors for the commercial/industrial and wholesale/bulk categories. Multiplying the expected volume of consumption by the assigned factor for each block and category combination will give the equivalent volumes.

The total cash requirement divided by the total equivalent volume will give the unit cost for the first block of the domestic category which is used as the basic charge. The corresponding unit cost for the other blocks are determined by multiplying the basic charge by the assigned factors. Again, collection efficiency can be taken into account by dividing the unit costs by the efficiency value.

If computations show that the monthly cost for the low water consumer is beyond their estimated paying capacity, unit costs are revised downward.

The quantity block method is summarized in annex II together with the procedure for revisions if there is a need for a second or more trials.

Water rates adopted by the water districts are subject to review by the LWUA.

D. THE METROPOLITAN WATERWORKS AND SEWERAGE SYSTEM

The Metropolitan Waterworks and Sewerage System covers a service area of five (5) cities and twenty-two (22) municipalities including Metropolitan Manila with a total land area of 1,470 square kilometers and a present population of about 5.4 million.

The main functions of the system, among others, are the following:

a. To construct, maintain and operate waterworks facilities for the purpose of supplying adequate and potable water to the inhabitants of its territory;

b. To construct, maintain and operate such sanitary sewerage facilities as may be necessary for proper sanitation;

c. To fix periodically water rates and sewerage services fees as may be deemed just and equitable.

The MWSS supports its operations from revenues and it uses borrowed funds from both local and foreign sources for capital outlay. It has an authorized capital stock of ₱3 billion.

The water facilities of the MWSS are currently undergoing improvement and expansion to increase the present capacity of 330 MGD (million gallons per day) by an additional 240 MGD by 1982. The project costing a total of about ₱2,916 million will include the construction of a dam and an intake structure tunnels and aqueducts, a treatment plant, pumping stations and reservoirs and about 1180 kilometers of distribution pipes. Funds are provided by the World Bank (IBRD) and the Asian Development Bank (ADB) in addition to funding by the Philippine Government.

The MWSS follows a policy of full cost recovery for its undertakings. The system has to ensure an adequate level of revenue sufficient to provide and assure the continuous maintenance and development of its facilities.

Thus, the MWSS charter provides for the periodic fixing of its rates and fees in accordance with just and equitable standards. Such rates and fees are fixed such that the rate of net return shall not exceed twelve per cent (12%) per annum, on assets base composed of the sum of its assets in operation as revalued from time to time, plus two month's operating capital.

The method followed by MWSS in pricing water is aimed at recovering full marginal costs of additional supplies while retaining the current social rate structure.

The data requirement needed for rate structuring includes the following:

(a) Water production — this refers to the projected volume of water available for distribution considering the completion of major projects and capacities of physical facilities.

(b) Water consumption — this refers to the projected volume of water consumption after considering the effects of metering, leak detection and repair, and other programs geared toward reducing non-revenue usage and water losses.

(c) Historical data on number of connections, consumption patterns and sizes per category.

(d) Historical data on the cost of water production.

(e) Projected number of water connections — this refers to the classification, number, sizes and average monthly consumption per connection.

(f) Projected maintenance expenses, annual expenditures for repairs and replacement, debt service requirements.

(g) Desired net income to achieve the targeted rate of return — this is arrived at by multiplying the assets base by the targeted rate of return.

Using the data given above, the average water rate is obtained by dividing the summation of fixed costs, variable costs and the desired net income by the projected volume of water consumption.

The rate structure followed by the MWSS are for four (4) categories of consumer consumptions, namely: a) residential or domestic, b) commercial and government, c) industrial and, d) water sold to ships and other sea transport.

For the lower consumption blocks of the domestic category, rates are fixed up to blocks with thirty (30) cubic meters monthly consumption.

Beyond the thirty (30) cubic meter block, consumers are charged with uniform rates per cubic meter within each block. The unit cost increases as the consumption ranges in the higher blocks increase.

The following guidelines are followed by the MWSS in determining the water rates within each block and category of consumer consumptions:

(a) For the domestic sector, lifeline rate for 1-15 cu. m., block rates for 16-20, 21-25, and 26-30 cu. m. are charged fixed rates on an ascending scale. Consumers belonging to these blocks are the low income residential users and are subsidized by higher income groups. Consumers that use more than 30 cubic meters per month are charged a higher unit rate per cubic meter on an ascending scale.

(b) The lifeline block of 1-15 cubic meters is charged with the cost of water production up to distribution. The charge is below full cost for a given minimal quantity of service intended to provide economic relief to low-income customers. The social objective is to make an essential service available to the poor.

(c) Block 16-20 cubic meters is charged with the cost of water production up to distribution including administrative cost.

(d) Block 21-25 cubic meters is charged with the cost of water production up to distribution and sales without administrative cost.

(e) Block 24-30 cubic meters is charged with the breakeven rate.

(f) Consumptions over thirty (30) cubic meters are charged with inverted rates which increases in proportion to water consumption. The rationale behind the inverted rates is to obtain the revenue requirements such that even if consumption patterns of users within each quantity block become erratic, the MWSS still will be able to attain the revenue requirements. The increasing consumption rate block schedule is used as a means to ration water and penalize higher consumptions above what is essential in a situation where the demand for water exceeds available supply.

(g) For the commercial and industrial users, there is a minimum charge which is computed to cover cost in providing service to a customer regardless of the amount of water used. The minimum charge will include all customer cost elements related to meters and billing, the base cost of water used and other associated costs with the minimum use service.

The new water rates being used by the MWSS at present are given in annex III. These are given for metered rates per month.

E. CONCLUSION

At present, the financial position of the MWSS looks good and this will improve further upon completion of its expansion projects. The additional source being developed will bring in new consumers, hence, additional revenue sources.

It is the water districts with smaller number of consumers that are faced with some difficulties. The capital investment required to improve and expand the old systems taken over by the water districts provide the big difference from the previous rates which are already unrealistically low. These are often the causes of the resistance of consumers to rates increases made by the water districts upon taking over of water systems from local governments. In many cases, projections on the increase in the number of new consumers which is a basis for determining viability are not realized adding to the problems of water district management.

The socialized pricing policy can only work to certain limits. Cross-subsidy is possible only if rates remain reasonable to the higher income groups. If rates are not acceptable and are outside the reach of most of the consumers, what alternatives do we have short of going back to government subsidy practiced in the past?

Possible reduction in water rates may be effected through the following means:

(a) Reduction in the lending rates to water districts;

(b) Provision of loans for initial operation of water districts until such a time that more consumers connect to the system;

(c) Review and possible lowering of technical criteria and standards used in the design of the systems with a view of coming up with appropriate technical models at lower costs; and

(d) Lowering of levels of service like using public faucets where acceptable to the low income groups.

These are areas of possible solutions that may merit further study to solve the problem of coming up with rational and realistic rates that will achieve the objective of providing adequate and reliable water service at costs that can be afforded by majority of the population.

Annex I

REVENUE UNIT METHOD

A. For unmetered connections

1. **Data required**

(a) Average monthly expected revenue to be derived from unmetered connections —
₱...............

(b) Number of existing (or projected) connections, classified into

Domestic/Government — size and number
Commercial/Industrial — size and number
Wholesale — size and number

(c) Average number of faucets for each of the existing (or projected) connections

2. **Procedure**

Method No. 1

(a) Tabulate data given under 1.(b).

(b) Convert the number of connections into an equivalent number of 3/8″ connections by using the following conversion factors:

Table of Conversion Factors for Computing Tap Revenue Unit (TRU)

Size Connection	*Government Domestic/*	*Industrial/ Commercial*	*Wholesale*
3/8″	1.0	2.0	3.0
1/2″	2.5	5.0	7.5
3/4″	4.0	8.0	12.0
1″	8.0	16.0	24.0
1-1/2″	20.0	40.0	60.0
2″	50.0	100.0	150.0
3″	90.0	180.0	270.0
4″	180.0	360.0	540.0

(Connections larger than 3/8″ are first reduced to an equivalent number of 3/8″ connections.)

(c) Divide the average monthly expected revenue by the total equivalent 3/8″ connections obtained in preceding step. This is the average charge or monthly rate for an individual 3/8″ connection.

(d) Work back for the various sizes.

Important: The resulting charge for each type and size of connection is the minimum monthly charge for a single connection using only two faucets. Any connection using more than two faucets should be levied an additional charge for every faucet in excess of two.

Method No. 2

(a) Tabulate data, as before, given in 1.(b) and 1.(c).

(b) Compute the total number of faucets.

(c) Assuming two free faucets for the service charge, compute the number of tap revenue units (TRU) corresponding to the service charge by multiplying with the given conversion factors.

(d) Find the number of faucets in excess of the allowable two faucets.

(e) Compute the corresponding tap revenue units for the commodity charge by multiplying by the given factors.

(f) Total the tap revenue units for both the service charge and commodity charge.

(g) Divide the total expected revenue by the total number of tap revenue units (the result will be the cost per tap revenue unit).

(h) Work back and check.

B. For metered connections

1. **Data required**

(a) Average monthly expected revenue from all metered connections — ₱................

(b) Total number of connections and average consumption per connection classified as follows:

Domestic/Government — size and number of connections, average consumption per connection

Commercial/Industrial — size and number of connection, average consumption per connection

Wholesale — size and number of connections and average consumption per connection

2. **Procedure**

(a) Tabulate data given under 1.(b). Use the RU method.

(b) From the given average consumption, get total consumption for each group by multiplying by number of connections.

(c) Compute the service charge first. To get the corresponding revenue units (RUs)/customer for the service charge, multiply the volume of free water (usually 10 cubic meters) given for each type and size of connection by the factors shown in the Table of Conversion Factors.

(d) Compute total RUs for service charge by multiplying by number of connections. (For Group)

(e) Deduct free water from total consumption.

(f) Remaining consumption is subject to commodity charge. To get the corresponding RUs for the commodity charge, multiply by the following factors:

Domestic/Government	— 1.0
Commercial/Industrial	— 2.0
Wholesale	— 3.0

(g) Add total RUs for service charge to total RUs for commodity charge to get total RUs needed.

(h) Divide the average expected monthly revenue by the total RUs to get the cost per RU.

(i) Work back and compute in pesos the service charge per connection according to type and size and the commodity charge per cubic meter in excess of the free water.

(j) Check.

Important: Adjust rates based on collection efficiency.

Annex II

QUANTITY BLOCK METHOD

1. List down the total number of connection showing:
   (a) Category
   (b) Size
   (c) Number
   (d) Average consumption
   (e) Total consumption
2. Determine quantity blocks and spread the total consumption per size and type of connection.
3. Get the total consumption per quantity block, per category.
4. Assign trial factors in the ascending order, beginning with 1.00 for the first block, up to the last block. (For the Commercial/Industrial, double these factors; three times for Bulk/Wholesale.)
5. Determine the equivalent volume (E.V.) for each block by multiplying the total consumption by the assigned factors.
6. Get the total equivalent volume (T.E.V.).
7. Divide the cash requirement by the total equivalent volume (T.E.V.). This is the computed trial unit cost.
8. Divide by the collection efficiency to get the first trial chargeable unit cost.
9. Compute the corresponding unit costs to be charged for each block, and compute the monthly cost for the low water consumer.
10. Evaluate and analyze.

Note: If the evaluation and analysis show that the unit cost to be charged will result in a monthly bill beyond the estimated capacity of the low income user, there will be a need to revise the cost downward. If the revision decided upon will not involve any reduction in cash requirement, but merely a change in the assigned factors, the procedure will be as follows:

11. Determine a second trial unit cost to be charged, such that the resulting monthly bill will be within the reach of the low income group.
12. With this unit cost, compute the derivable income for the 1st quantity block. (In the first quantity block there are no change in volumes and factors.)
13. Using the unit cost in Step 8 and the total equivalent volume in Step 6, compute the total derivable income from the system.
14. From the amount in Step 13, subtract the amount obtained in Step 12. (This is the amount to be raised from the remaining quantity blocks.
15. Divide the amount in Step 14 by the unit cost in Step 11. (The resulting figure will be the required equivalent volume to be produced from the remaining blocks, from the second to the last.)
16. By proportion, distribute this required equivalent volume (Step 15) among the remaining blocks — by quantity block and category of connections.
17. For each block and category, divide the required equivalent volume by the corresponding consumption. The resulting figures would be the new factors.
18. Compute the charges and analyze.

If the resulting evaluation and analysis do not yet give a satisfactory unit cost, apply steps 11 to 18 again until a satisfactory figures is obtained.

Annex III

THE NEW MWSS WATER RATES

(Metered rates per month)

A. Residential

1. Applicability — Applicable to all premises used primarily for living quarters whether self-owned or rented, including those used secondarily as small dry-goods and sari-sari store requiring minimal use of water.

2. Range of Consumption

	Fixed Rate
(a) For those consuming not more than 15 cubic meters per month, a monthly charge of	₱ 4.50
(b) For those consuming 16 cu. m. to 20 cubic meters per month, a monthly charge of	7.40
(c) For those consuming 21 cu. m. to 25 cubic meters per month, a monthly charge of	10.50
(d) For those consuming 26 cu. m. to 30 cubic meters per month, a monthly charge of	15.00
(e) For those consuming more than 30 cu. m. but not more than 50 cubic meters per month	0.60 per cu m.
(f) For those consuming more than 50 cu. m. but not more than 70 cubic meters per month	0.80 per cu m.
(g) For those consuming more than 70 cu. m. but not more than 90 cubic meters per month	0.85 per cu m.
(h) For those consuming more than 90 cu. m. but not more than 100 cubic meters per month	1.10 per cu m.
(i) For those consuming more than 100 cubic meters per month	1.25 per cu m.

B. Commercial and Government

a. Applicability — Applicable to all premises utilized for selling goods or services, including premises partly used for living quarters but predominantly for commerce; government services; and to customers drawing water for re-sale.

b. Rates —

1. For those consuming not more than 1000 cubic meters per month	₱ 1.25 per cu m.
2. For those consuming more than 1000 cubic meters per month	1.40 per cu m.

PROVIDED, that ₱30.00 shall be the minimum charge per month for a minimum consumption of not more than 25 cubic meters.

C. Industrial

a. Applicability — Applicable to all premises utilized for manufacturing or producing goods, materials, chemicals and equipment whether finished or unfinished.

b. Rates —

1. For those consuming not more than 1000 cubic meters per month	₱ 1.85 per cu m.
2. For those consuming more than 1000 cubic meter per month	2.00 per cu m.

PROVIDED, that ₱45 shall be the minimum charge per month for a minimum consumption of not more than 25 cubic meters.

D. Water sold to ships and other sea transport

Consumption regardless of quantity — ₱3.25 per cubic meter.

V. WATER PRICING OF THE BANGKOK METROPOLITAN WATERWORKS AUTHORITY*

A. BACKGROUND AND ORGANIZATION

The waterworks in the area of Bangkok was first established by Royal Command of King Rama V in 1909. The primary objective of such establishment was to provide the people of Bangkok with hygienic facilities without being threatened by epidemics caused by water of poor quality from rivers and canals for domestic purposes. Meanwhile, waterborne diseases were spread mostly during the dry season when water levels in the rivers and the canals were low. Due to the rapid growth of the community as well as the increase of the population the water became polluted increasing the danger from various waterborne diseases.

The first Bangkok water supply system was completed during the reign of King Rama VI and the opening ceremony took place on November 14, 1914 which was recorded as the first day when the people of Bangkok were blessed with a potable water service under modern technical operations. It was named "Siam Waterworks".

The waterworks of Bangkok had been improved both in service and in management since its establishment. In 1967 the Metropolitan Waterworks Authority Act B.E. 2510 was enacted to form the Metropolitan Waterworks Authority (MWWA) by combining the four municipal waterworks of Bangkok, Thonburi, Nonthaburi and Samutprakarn. By MWWA Act B.E.

* This paper was prepared by Prathai Phispoomvidhi, Deputy General Manager for Finance and Administration, Metropolitan Waterworks Authority, Bangkok.

2520 (1977), the MWWA became a state enterprise directly under the Ministry of Interior. It has a General Manager under the general supervision of the Board of Directors.

The service area of MWWA is approximately 3,100 square kilometers with a total population about 5.6 millions. Due to the limitation of its production capacity, MWWA can serve only 2.8 million people in an area of 242 sq. km. or 50 per cent of the total population in its area of responsibility. The total number of customers registered on October 31, 1979 is recorded at 357,472. The water is distributed through 15 service districts and is supplied from two water treatment plants at Samsen and Thonburi supplemented by 143 deep wells. The total production capacity at that time was 1.2 million cubic meters per day.

The Phase I extension was completed on November 1979 with an increased production capacity of 800,000 cubic meters per day, resulting in a total production capacity of 2.0 million cubic meters per day, which would be adequate for the people living in its expanded service area of 273 square kilometers.

B. WATER TARIFFS

The current water rates which have been effective since 1973 are as follows:

Consumption Block	Cubic meters per month	US cents per cubic meter
1st Block	0 - 6	Free
2nd Block	6 - 12	2.5
3rd Block	12 - 25	5.0
4th Block	25 - 50	7.5
5th Block	50 - 200	10.0
6th Block	Above 200	12.5

The overall average rate was about 7.5 US cents per cu. m. sold. The present level of water rates is not sufficient to meet the current operating expenses. The resulting deficits are covered, as in the past, by a subsidy from the Government.

In order to establish a financially self-supporting utility, a new tariff structure has been proposed to the Ministry Council for consideration and approval.

The new tariff structure introduces the concept of differential classes of customer determined by water-use characteristics. The customers are divided into 3 classes:

(a) Residential and non-profit institution;

(b) Commercial and industrial; and

(c) Government.

C. PRICING POLICY

As water is the most essential good for public welfare and daily life of the people, an adequate amount of water of good quality should be supplied. For this purpose, it is necessary for the MWWA to operate and be managed on a financially sound basis.

The following policies for establishing the tariff have been recommended:

(1) The tariff should not be set to a level to gain profit in the ordinary sense, but only to cover the total operation costs and to provide funds for investment in plant facilities;

(2) The tariff should generate sufficient revenue to cover operating expenses and depreciation (to provide for the current renewal and replacement of obsolete property that are no longer serviceable) determined on the basis of efficient management;

(3) The tariff should generate revenue to provide a reasonable part of the capital funds required for its expansion to meet future demand;

(4) The tariff should be classified according to a customer class system determined by its water-use characteristics;

(5) In order to discourage wasteful use of water, the tariff should be set in such a way that higher rates are charged to the customers who consume water in excess of an established level;

(6) The tariff should be revised if necessary in order to maintain the sound financial basis and efficient management of the utility;

(7) The tariff should be established at a level that will be adequate to meet maintanence costs for a period of three years. Fluctuations in annual cash requirement cannot be matched by an annual rate change. Rates should be established at a level that will provide programmed surpluses in the first half of the period to cover the programmed deficit in the second half of the period. The surpluses in the early years can be used to meet cash flow problems that arise from uneven expenditure requirements;

(8) If the Government adopts a policy to lower the water rate to meet the customer's ability to pay, the subsidy should be made by the Government in accordance with certain formulae.

VI. CURRENT PRACTICES OF IRRIGATION WATER PRICING IN THAILAND*

A. INTRODUCTION

Until recently, water in Thailand had never been considered to be a scarce resource. In practice if water is used for a purpose such as irrigation by a group of farmers, it could rarely be claimed that the people downstream are deprived of their right to use water. Ever since the Bhumipol and Sirikit reservoirs on the Nang and Ping rivers were constructed, water has been released for irrigation, navigation, electricity generation and salinity control. Only in extraordinarily dry years do the demands of these uses for water compete. This competition for demand was clearly demonstrated during the dry season of 1980.

At present water is still considered to be a free commodity in Thailand. Although in some cases users pay for the delivery of water, they are not charged for the value of water as a scarce resource. On the other hand, the idea that the user should pay for at least the operation and maintenance of the irrigation system has been a very old tradition in some parts of Thailand. Imposing a water charge has always met with strong opposition. The inhabitants in Bangkok do not pay the full cost for their tap water but only for the expenses to upkeep the supply system.

B. IRRIGATION SYSTEMS IN THAILAND

There are three kinds of irrigation systems in Thailand:

1. the traditional system in the North
2. the pumping projects in the Northeast
3. the Chao Phya Irrigation Improvement Project in the Central Region.

The traditional system in Northern Thailand differs from the other systems in that although the Royal Irrigation Department gives advice, the responsibility for construction, operation and maintenance of the system lies at the local level. Farmers decide among themselves how much each should contribute to the system.

The pumping projects in the Northeast of Thailand are in a different position. The projects are small scale; most pumps are driven by electric engines and the government authorities guarantee the water supply. Farmers pay most of the operation and maintenance costs. In case of failure to pay, it is not difficult for the authorities to apply sanctions.

The Chao Phya Project covers an extensive area. Some parts are liable to flooding and in other parts the irrigation service cannot guarantee a sufficient water supply. With the Land Consolidation project, recovery of part of the costs of on-farm works from the beneficiaries has been proposed but, until now, it has not been placed into effect and the farmers have not been charged for operation and maintenance costs. It is not possible to charge the farmers on the basis of water quantity they use because the system was not designed to measure individual water supply.

1. The traditional irrigation system in Northern Thailand

There are many people's irrigation projects in the north of Thailand. A system on the river Ping is chosen as an example.

After the main crop is harvested, the water level of the river drops. In order to raise the water level a weir made of bamboo stakes, straw and mud is built across the river. Every year the weir is washed away in the flood season. It takes about two weeks to have the whole system rehabilitated. The earthen canal system must be cleared of silt which is deposited by the river flow during the flood stage. The entire system has to be drained before the canal can be cleaned.

These maintenance and repair tasks require a great amount of labour and organization. The leaders need sufficient authority to ensure that each member of the irrigation association fulfills his obligations. Depending on the size of the system there may be different levels of leaders. The headman is chosen by the village heads of all the tambons (sub-districts) served by the irrigation system. He may have one or more assistants and those at the lowest level are the village irrigation headmen. Watchmen are hired to guard and operate the water gates when an order is received from the irrigation headmen. These watchmen are paid in kind which is collected from the farmers who receive water from the system.

The irrigation officials keep records of the size of land farmed by each farmer. Each farmer has to contribute in labour and material for the maintenance of the system and rice for the watchmen.

The irrigation headmen are exempted from furnishing labour and material for the construction and maintenance of the system and may sometimes keep some of the fines levied. Since most of the farmers contribute in kind to the operation and maintenance, it is not possible to calculate the water fee in monetary terms.

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*This paper was prepared by Phadoongkarn Hunghavaisya, Project Manager of the Chaophya Irrigation Development Project, Royal Irrigation Department, Bangkok.

2. Pumping project in Northeast Thailand

The National Energy Authority (NEA) has initiated a number of pumping projects since 1967-68. The NEA has responsibility for the installation of these pumps.

The projects are rather small and farmers are organized in groups. The project organization is responsible for the operation and maintenance of the pumps and main distribution and drainage systems. The farmers are responsible for water distribution and maintenance at the farm level under the supervision of a common irrigator. He is empowered to hire labour or bring in the project maintenance gang to maintain the neglected sections. The costs of this maintenance are added to the farmers' electricity bills. The water management is empowered to withhold water from any subdivision which does not meet its commitments.

Farmers sign a contract with the project management covering rules for the operation and maintenance of the irrigation system. They pay a fixed fee per rai (1 ha = 6.25 rai) for each category of crop. For rice the fee is Baht 60 (or US$ 3.0) per rai.

The rates are high enough to cover the common irrigators' monthly allowance and to provide a small operating budget for the farmers' organization. However the greater part of the fee collected is used to pay the electricity bill.

3. Chao Phya Irrigation Improvement Project

In 1903 the construction of a diversion dam on the main Chao Phya river near Chainat was proposed by the Canal Department (later Royal Irrigation Department). This plan was not implemented because of the high cost of investment. It is interesting to note that as part of the scheme it was proposed to levy a water charge on the farmers for the improved irrigation water supply. However, in those days the idea of a water charge was not deemed realistic.

In the 1950's the Chainat dam and the main canal system were constructed. Large scale dry season irrigation became possible after the completion of the Bhumiphol dam in 1963 and Sirikit dam in 1972. The so-called Ditches and Dikes project was initiated in 1962 to improve water distribution at farm and inter-farm levels.

However, the potential benefits of these water regulation works for the full development of year-round irrigated agriculture have not been fully realized. The need for additional investment to upgrade the existing irrigation network and permit large scale dry season cultivation was recognized. The first step under the programme was the initiation of the Chanasutr Land Consolidation Pilot Project in Bangrachan (1,800 ha), carried out with bilateral assistance from the Netherlands. The pilot project involved the construction of a dense network of farm irrigation and drainage ditches, roads, land levelling, as well as realignment of farm boundaries. The project succeeded in introducing double cropping in over 80 per cent of the area, mainly with high yielding rice varieties, within three years after project completion.

The positive response of the farmers and requests from other areas in the vicinity to carry out the same type of project encouraged the Government to embark upon a ten-year programme to introduce double cropping on an additional 200,000 ha in the Northern Chao Phya Plain.

C. COST RECOVERY

Under Stage I development of the Chao Phya Irrigation Development project the beneficiaries' repayment capacity was assessed. Recommendations were formulated with regard to the level of annual charges and collection procedures.

The following studies were completed:

(a) Appraisal of the Land Consolidation Projects in Chanasutr and Singburi — a Study on recovery of the cost by the Division of Agricultural Economics of the Ministry of Agriculture and Co-operatives.

(b) Some aspects of cost recovery by ILACO-consultants.

1. Study on recovery of cost by the Division of Agricultural Economics

In the study the operation and maintenance costs for the irrigation system and costs of investment on land clearing and levelling were compared with the increase of net income of farming practices at different production levels. Various assumptions of the length of repayment period, interest rate and grace period were used to compare the cost with the increase of net income at different paddy prices and production levels. Two sets of income were considered to measure the farmers' ability to pay: (a) the incremental farm income after the project as compared with the farm income before the project and (b) the net income defined as the farm income after the project and after the deduction of family expenses and farming costs.

Recommendations are made on the period of repayment, interest rate and grace period. However, the report did not mention anything about the imposition of water charges.

2. Outline of the cost recovery study by ILACO-consultants

Firstly, gross and net production values of paddy per rai for different production levels were calculated. On the basis of these calculations the total "factor income" of rice production per rai was determined. Next, the returns to each of the factors — "capital", "labour", "management" and "land" — were calculated.

Under improved conditions the return to the factor "land" is defined as the residual part of the total factor income after deductions of the return to capital, labour and management.

After the introduction of irrigation the factor income will increase and consequently, the returns to the factor "land" will increase accordingly. The amount of increase of the return for the factor "land" which is divided into two parts, "soil" and "water" is attributed to the factor "irrigation water".

In the study the last mentioned incremental benefit attributable to the factor "water" is considered. This increased benefit represents the farmers' repayment capability in the investment of the land consolidation works.

Three categories of charges are distinguished.

(a) for operation and maintenance of the irrigation and drainage system;

(b) for repayment of investment in land improvement; and

(c) for repayment of investment in irrigation improvement.

After the assessment of the beneficiaries' repayment capacity the next question is how much farmers should be charged. The repayment capacity only indicates the maximum chargeable amount, and the question arises whether charging the maximum amount is fair, judicious and justifiable. The beneficiaries should allocate an equitable return to all the resources they possess and use in the production process.

3. Proposal for cost recovery

The Central Land Consolidation Committee of the Ministry of Agriculture and Co-operation has the responsibility to propose regulations on cost recovery and charges for operation and maintenance and to put them into effect. For the Stage I areas costs to be charged were calculated based on the weighted average costs of land levelling and public works. In the Stage II areas costs to be charged were calculated based on the repayment of 50 per cent of the cost of land consolidation (excluding rehabilitation), i.e. 100 per cent of land levelling and part of the public works.

Proposals of cost recovery by the Central Land Consolidation Committee were as follows:

	Stage I area	Stage II area
Cost to be charged (Baht/rai)	1,256	1,750
Interest rate, per cent ..	—	12
Grace period (year)	2	2
Repayment period (year) ..	12	15
Repayment rate (Baht/rai/year)	100[a]	110

[a] In 12th year an amount of B156.0 will be charged.

However, the Committee has not collected any recovery charges from farmers up to now.

D. LEGAL ASPECTS OF CHARGING FOR LAND AND WATER RESOURCES DEVELOPMENT

1. Charges for operation and maintenance

Although there is a legal basis for the collection of fees for the operation and maintenance of state irrigation projects, the government has not collected any of these fees.

The State Irrigation Act of 1942 authorizes the collection of irrigation fees from land which benefitted from Government irrigation projects. At present the rates do not exceed Baht 5 per rai. The Dikes and Ditches Act holds the land owners responsible for the maintenance of the improved irrigation works at tertiary level. These regulations are applicable to irrigation projects and ditches and dikes projects under this Act in Thailand.

In the draft "Water Users Association Act" only a maintenance fee is mentioned. It is not indicated how the salary of employees of the Association in charge of the O & M of the system is financed.

2. Charges for irrigation development

The Land Consolidation Act of 1974 provides a legal basis for the charge of irrigation development i.e. for the recovery of the construction costs of minor irrigation and drainage systems of the Land Consolidation Project.

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