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Policy Paper No. 7

**Sustainable and Productive
Resource Management:
Macro Policies
for Land and Water Resources**

IMPSA

IRRIGATION MANAGEMENT POLICY SUPPORT ACTIVITY

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Preface

THIS PAPER IS a product of the Irrigation Management Policy Support Activity (IMPSA). IMPSA is a programme to assist the Government of Sri Lanka (GSL) in the implementation of its accepted policy of participatory management in irrigation and settlement schemes, in order to improve productivity, profitability and equity in the irrigated agriculture sector.

IMPSA was initiated by the Ministry of Lands, Irrigation and Mahaweli Development in association with the Ministry of Agricultural Development and Research. It is sponsored and financed by the United States Agency for International Development (USAID), through the Irrigation Support Project for Asia and the Near East (ISPAN) and is assisted by the International Irrigation Management Institute (IIMI).

For the execution of IMPSA, the GSL set up an inter-ministerial advisory committee, the Irrigation Management Policy Advisory Committee (IMPAC), to provide broad guidance for the implementation of IMPSA and to institute a mechanism to achieve consensus among the Divisions and Departments of the concerned Ministries on the recommendations to be adopted and implemented by the GSL. IMPAC is chaired by the Secretary, Ministry of Lands, Irrigation and Mahaweli Development, and comprises the Secretaries of State of the relevant Ministries, together with the Heads of the Departments and Agencies under them. IMPAC is assisted by a Working Committee, the IMPAC Working Group, which consists of some of the IMPAC members as well as several other officials drawn from the relevant Ministries and Agencies.

Under the IMPSA Programme, ten Policy Papers are scheduled to be prepared and processed for presentation to the government. Each Policy Paper will be a concise statement of the recommendations of the IMPAC Working Group.

Chapter 1

INTRODUCTION

1.1. Purpose of the Paper

THIS PAPER IS the seventh in a series of ten Policy Papers being prepared under the IMPSA Programme. All of the previous papers address issues directly related to improving the performance of irrigated agriculture, with special reference to institutional issues. This paper and the eighth one on fiscal and trade policies go beyond irrigated agriculture per se, and address broader questions whose solutions would have a great impact on the irrigated agriculture sector.

Thus, the purpose of this Paper is to propose a set of policies on broader land and water resources issues to the extent possible, and to suggest additional issues requiring further work before firm policies can be proposed. Land has been the subject of three high-level Commissions since 1927, and despite the efforts of very learned and experienced people, it continues to be an area beset with serious problems and with no obvious or easy solutions. This Paper does not pretend to be based on as complete an analysis as that carried out by the most recent Land Commission, the time available being very minimal. It focusses on a few issues that are relevant to irrigated agriculture.

Watershed management has been the subject of some research and experimentation. However, perhaps because of the large number of overlapping agencies with an interest in various aspects of watershed management, there is no clear policy and indeed no clear basis for policy. This paper makes a beginning of recommending policy, while recognizing the need for much additional work.

The broader questions of water resources development, conservation, allocation, and use have begun to be addressed only recently. It is only with the completion of some of the major dams on the Mahaweli, rising demands for water for domestic and industrial use, generating electricity, the growth of new irrigation projects and the recognition that preservation of water quality is becoming a serious problem, that it has become clear the country needs to address a number of critical issues. This Paper proposes some policy guidelines which could be used for decision making, and as a guide to the water resources master planning exercise expected to be initiated in the near future.

1.2. Methodology

The following methods were used in the development of this paper.

- i. Synthesis of five Staff Working Papers that cover the key subject areas of land and water resources policy, developed by IMPSA, IIMI-SLFO and consultants.
- ii. Information obtained from the recommendations of consultative workshops held for a selected group of officials drawn from various public and private institutions as well as from a selected number of farmer representatives.
- iii. Recommendations of a two-day, national-level expert consultation on 'Land and Water Resources Development Policy Issues,' organized by IMPSA.
- iv. Consultation with senior government officials through the medium of 'Special Consultation Panels' set up by IMPSA to deliberate on the issues and recommend policies related to land and water resources development.
- v. Discussions between the IMPSA Secretariat, IIMI/SLFO staff in the IMPSA Team and the expatriate consultants.

1.3. Organization of the Paper

THIS PAPER HAS four major sections: Land Policies including land use and land tenure issues; Watershed Policies including discussion of the role of watersheds, the present state of knowledge, and recommended policies; Water Resources Policies, including brief discussions of supply and demand, why a policy is needed, constraints to be overcome, the recommended guiding principles and institutional arrangements, and suggested strategy for developing a master plan; and finally, a summary of the Recommendations.

Chapter 2

LAND POLICIES

2.1. Land Use

THE LAND USE Policy Planning Division of the Ministry of Lands, Irrigation and Mahaweli Development is responsible for the overall land use planning in Sri Lanka. Very important changes in land use, during this century, have been documented. For example, in 1881, forests were estimated to have covered 81 percent of the land in Sri Lanka, and by 1900 they were reduced to about 70 percent. A survey completed in 1961 indicated that about 44 percent of the area was forested in 1956. In 1983, aerial photography showed 27 percent in forest, and extrapolation of these data to 1989 indicates a figure of about 24 percent. Much of this lost forest land was located in critical areas of the watersheds. Similarly, the area devoted to paddy and chena cultivation as well as urban development has increased substantially. Chena cultivation is believed by many to be a significant factor in the reduction of forest cover possibly with attendant increased erosion and siltation of reservoirs, particularly in the dry zone.

Land use policies cannot be separated from water resources policies. In the past, water resources development has been primarily intended for land development through the provision of irrigation. Lands allocated for irrigation were until recently primarily intended to be used for growing rice; but today, farmers are being encouraged to divert the use of some of these paddy lands, particularly with well-drained soils, to other crops. Recently there have been suggestions that water allocated for irrigating lands through gravity could be better used through pumping to the above-command lands. Further research is required to examine the feasibility and costs and benefits of this proposed innovation. Land use policies as they relate to watersheds are discussed.

2.2. Land Tenure

SRI LANKA IS characterized by a wide range of land tenure categories, ranging from deeded private ownership, through various forms of leases, various forms of indigenous rights to land (for example on old tanks) to state ownership. The British colonial government exerted a claim to all of the land not specifically privately owned in the early 19th century; as a result, even today, the Government of Sri Lanka has some form of tenurial control over about 80 percent of the total land area. The watershed areas are characterized by the existence of a multiplicity of land tenure arrangements, complicating any intervention

strategies. Irrigated lands under the smaller tanks are also characterized by several forms of land tenure, some of which lead to minute subdivision of shares and alternating cultivation rights among many shareholders over time. On the other hand, the larger irrigation schemes, being settlement schemes, are characterized by a restricted form of tenure introduced in the Land Development Ordinance (LDO) of 1935.

This "protected tenure" was intended to "protect" or "preserve" the peasantry as a class, giving them access to land for cultivation, while protecting them from non-cultivating classes who may otherwise gain control over the land. The LDO, therefore, includes restrictions on subdivision of holdings, transfer of holdings by sale, leasing, or mortgaging, court seizure of land for payment of debts, or by succession. Subdivision of holdings is also restricted in order to ensure satisfactory productivity. Some of the restrictions have been modified in recent years, but with little visible impact. It has been observed by researchers and land development officials, that there is now a significant gap between the provisions of the law and the reality. Today, the settlement schemes are characterized by serious land problems, including minute subdivision, high rates of sale, mortgages, leasing and tenancy, encroachment on reservations, and increasing levels of landlessness among second and third generation settlers.

These land problems are, in turn, important factors related to poverty, low productivity, low profitability, lack of savings and capital, subsistence orientation of farmers, dependency on the state, underemployment, uncertainty about membership in farmers' organizations, and so on.

There have been two Land Commissions appointed by the Government of Sri Lanka since the first one in the 1920s whose recommendations led to the LDO. The third one submitted its final report in 1990. All three upheld the "need" to maintain a protected form of land tenure in irrigation settlements. This continues to be the accepted policy, and measures for improvement of production and productivity, at least in the short run, may have to be based on this policy. The government has also been experimenting with leasing of land to private firms interested in growing high-value crops in the Mahaweli Project; but these efforts have also not resulted in much increase in investment or production as yet.

In the long run, the only solution to the problem of land subdivision and encroachment will be the provision of employment opportunities in other sectors, to reduce the pressure on land. This is a major focus of government policy. But its effects will be felt only in the long run, i.e., probably after more than a decade. In the meanwhile, there are two basic strategies: increase the productivity of existing small holdings; and encourage operational consolidation.

Doubts have been expressed about the possibility of increasing productivity sufficiently so that small holdings can generate more than a subsistence level income. But evidence from other Asian countries, particularly in East Asia, as well as in certain areas of Sri Lanka, suggests this may be possible. Policies that ensure diversification into higher-value crops to

supplement paddy cultivation; improved technologies that reduce costs and/or increase production; strong farmers' organizations that can manage water resources (including facilitation of production planning), improve marketing of inputs and outputs, and provide opportunities for farmers to profit from value-added activities, could all enable small farmers to improve their incomes very significantly.

Another proposal that has been discussed is the formation of Small Farmer Companies. Under this proposal, farmers in a particular tract, irrigation sub-system, or scheme, would pool their resources and cultivate their land as a single holding, to take advantage of economies of scale. People would own shares in the company proportional to their contribution, i.e., the amount of land and other resources contributed; and people would work for wages as well as share in the profits of the firm.

2.3. Interim Recommendations

BECAUSE OF THE complexity of land tenure issues, the lack of consensus on possible solutions, and the lack of an applied research basis for proposing solutions, it is not practical to recommend any radical changes. The following are suggested as recommended measures in the short term, which could pave the way for more effective long-term policies.

2.3.1. Research

AT PRESENT THERE is a very inadequate research base for implementing land tenure innovations. Further, neither the institutional capacity nor the resources are sufficient to address these important issues adequately. It is therefore proposed that the government seek donor assistance for developing a Land Tenure and Productivity Research Programme, closely linked to the Ministry of Lands, Irrigation and Mahaweli Development, and located within a national research organization or university. This programme would be responsible for developing a long-term applied research programme on land tenure and land use issues the country is facing, and for developing and testing policy alternatives. It would also be responsible for identifying and incorporating lessons from other countries that would be relevant to Sri Lanka.

Some of the research issues that need to be addressed include: 1) the relationship between land tenure, land use, productivity and poverty; 2) strategies for overcoming impediments to land productivity under settlement schemes as well as private lands (such as land titling, land consolidation, etc.); 3) alternative land tenure laws for future development of agriculture; and 4) identifying mechanisms to strengthen local involvement in and control of land tenure and land use policy making and implementation.

2.3.2. *Irrigation Settlement Land Issues*

THE GOVERNMENT SHOULD make a concerted effort to complete surveying of the land under irrigation and the above command, and provide settlers with clear titles and clearly marked boundaries, within the provisions of the present law. It should attempt to regularize encroachments to the extent possible within an accepted land use plan. This suggestion emphasizes the importance of completing work already underway.

2.3.3. *Increase Productivity of Small Holdings*

FARMERS' ORGANIZATIONS CAN play a very important role in increasing productivity of small holdings, through better water management, through support for obtaining credit, facilitating marketing of inputs and outputs, involvement in processing to increase the farmers' share of agricultural profits, arranging for cooperation in planning and implementing agricultural production, and facilitating crop diversification. In other words, even with the present small land holdings, there are possibilities of increasing farmers' incomes.

2.3.4. *Experiment with Consolidation of Production*

CONSOLIDATION OF PRODUCTION, for example on a turnout or cluster of turnouts, would, in principle, enable a more profitable agriculture through economies of scale. Farmers' Organizations could form production companies that go beyond coordination among small holdings. It is therefore suggested that the idea of a Small Farmers' Company be explored and elaborated further, in consultation with interested farmers, for the purpose of experimenting with it. It should be done in a way that would be reversible if farmers find it unprofitable.

Chapter 3

WATERSHED MANAGEMENT POLICIES

3.1. Role of Watersheds

THE TERM "WATERSHED" is used as a synonym for "catchment" in this paper. Catchment refers specifically to the upstream areas of river basins which "catch" the rainfall, store it and release it gradually into the rivers themselves. Its effectiveness in this function depends to a very large extent on the maintenance of the vegetative cover and the soils. This in turn requires appropriate policies and strategies for the long-term management and conservation of watersheds. Implementing such programmes is extremely difficult, particularly in a country with high population densities, high levels of demand for land, and low income levels. People are already living in the catchment areas, and using these areas for various forms of agriculture and livestock; in addition, there are now towns, roads, and other infrastructure that affect the watersheds. Watershed management is clearly a special application of land and water resources management. The discussion of land policies in the previous section is very relevant to watersheds.

The problems of the dry-zone and wet-zone watersheds are quite different. This Policy Paper focusses primarily on the wet-zone watersheds in the hill country, since these are most significant in Sri Lanka; but future policies must also address problems in the dry zone as well.

There are 103 river basins recognized in the country, with the Mahaweli Basin dominating in size (16 percent of the island's area, or 10,327 square km). Ten of the rivers have perennial flow while the remaining 93 are non-perennial or drain into reservoirs. Eighty of the rivers are located in the dry zone. In Sri Lanka, there is an annual rainfall amounting to 120 billion cubic meters of water. Sixty percent of the rainfall becomes surface runoff in the wet zone compared with about 37 percent in the dry zone.

The watersheds are extremely critical for ensuring the country's water resources over the long term. Thus, they must be viewed in a holistic manner, as part of the larger ecosystem of the country. Action should be taken now not only to preserve their condition and prevent deterioration, but also to upgrade them as restoration of highly degraded watersheds may prove extremely difficult and expensive in the future.

3.2. Condition of Watersheds

THE HILL COUNTRY watersheds became seriously denuded of forest within less than fifty years following the Crown Lands Encroachments Ordinance of 1840, under which the control of over 90 percent of the country was given to the colonial government. Hill country land which had been farmed as common property and held by the community was sold to private parties, mostly foreigners, for the establishment of large plantations. When reduced natural vegetative cover resulted in serious soil and nutrient losses, in siltation in tanks and conveyance channels, and in apparently altered runoff patterns, plantation managers adopted physical conservation measures such as contour drains and terracing. Very little quantitative data are available, however, on the relationship between upstream degradation and downstream impacts (e.g., rates of reservoir siltation).

In spite of a wide variety of legislative measures to deal with watershed degradation such as the Soil Conservation Act of 1951, watershed management issues have not been adequately addressed as yet, mainly due to lack of policy commitment. Indicators of watershed degradation -- landslides, soil erosion, siltation, deforestation, flooding and agricultural productivity declines -- continue to be serious issues which have not been adequately addressed either technically or institutionally.

Soil erosion is an important indicator of watershed degradation, which is caused by both natural and man-induced processes. While it is difficult to distinguish between the two, it is generally assumed that a "tolerable" rate (an estimate above natural rates) should not be exceeded. Several Sri Lankan studies suggest that land with an erosion rate exceeding 10 tons/ha/year should require significant conservation practices. But careful interpretation is necessary when applying tolerable erosion rates to specific sites.

Erosion of soil on tea plantations has, on average, greatly exceeded tolerable loss rates, with country-wide average estimates of 40 t/ha/yr over the last century (equivalent to a total cumulative topsoil loss of 30 cm). Tea plantations are exposed to rainfall erosion from short-duration, high-intensity events during planting and pruning periods when little vegetation cover protects soil. Mining for gems is considered to be another major cause of erosion and sedimentation. Cultivation of annual crops on steep slopes without proper land conservation measures is another major cause of erosion in watersheds. Soil is washed into streams and irrigation facilities, harming aquatic life and spawning areas as well as reducing irrigation efficiencies and increasing maintenance costs.

Erosion rates, in themselves, are not the most important issue, but must be interpreted to determine what impacts they cause. Erosion is considered to be one of the reasons for the relatively low productivity of tea in Sri Lanka. On tea plantations with good management (drains, mulches and complementary cover crops), soil losses are as low as 0.3 t/ha/yr.

Several studies have estimated the sediment yield of watersheds (not to be confused with on-site erosion rates) through either the measurement of suspended and bed load sediment transport or by the rate at which reservoirs fill with sediment. These studies

suggest very high rates which could have significant impacts on the life of reservoirs. But little information exists for estimating the sediment delivery ratio of watersheds in Sri Lanka (defined as the percentage of on-site erosion that reaches the outlet of a catchment). Because sediment is deposited en-route to the base of a watershed, sediment yields are always less than average on-site erosion rates on the upper catchment (except for extremely small catchments).

An increase in the ratio of surface water runoff to rainfall has been noted in several studies. This increases flood flows and decreases base flows. This phenomenon is expected as a result of land use changes and increased human interference.

All of these observations require further research to confirm them. Nevertheless, they indicate the potential seriousness of the problem.

3.3. Recommended Policies and Strategies

3.3.1. Integrated Approach

AN INTEGRATED APPROACH to watershed management in specific geographic areas is needed, with a national policy planning group taking the lead in identifying priority sites and giving direction to line agencies implementing watershed management in the field. It is recommended that a "Steering Committee on Watershed Management" be initiated through the Ministry of Lands, Irrigation and Mahaweli Development. This proposed committee would be similar to the Steering Committee on the Environment. As is the case for the latter committee, the proposed committee should meet monthly to provide leadership on watershed management issues, and to monitor progress, receiving technical support from the relevant line agencies. Planning should combine upstream and downstream areas, in terms of both budget and agency personnel.

There is no need for new legislation at this time to deal with watershed management. Existing legislation needs to be used effectively to identify critical sites and implement interdisciplinary programmes through the above Steering Committee at the national level. In 1986, the Land Commission proposed the creation of a "Watershed Management Authority," but this may not be needed. If a major restructuring of the many agencies now involved in watershed management were to take place the creation of a new authority could mean even more overlap and confusion regarding functions.

The Land Use Policy Planning Division (LUPPD) was established in the 1980s, in part, to develop land use plans for the identification of critical areas for watershed conservation. This type of planning is the critical first step in any viable watershed management programme. A project in the Upper Mahaweli Catchment (Forest/Land Use Mapping Project) was initiated in 1989 by the Environment and Forestry Unit of the Mahaweli Authority and the Overseas Development Administration to map 3,400

square kilometers. Excellent progress has been made in the preparation of 1:10,000 scale maps of land use, slope and erosion potential in critical sub-catchments.

Therefore, in the area of land use planning for the identification of critical watershed sites as well, no new agency is required. The mapping project in the Upper Mahaweli Catchment needs to proceed as it is presently functioning to identify sites for watershed conservation implementation. The Survey Department presently proposes land use maps at 1:10,000 scale for priority areas in the country. The LUPPD uses these maps as a basis for the development of land use plans for the areas covered. This activity of the Survey Department needs to continue with more resources, covering areas other than the Upper Mahaweli Watersheds. Eventually, all upland watershed areas in the country need to be mapped at the 1:10,000 scale for land use, slope and erosion susceptibility.

3.3.2. *Analysis of Watershed Programmes*

ECONOMIC ANALYSIS IS an important part of the project planning process, to be undertaken in the project identification stage. It is important to quantify both on-site benefits to upstream farmers and downstream benefits to irrigators in command areas below reservoirs and tanks. In order to establish upstream/downstream links in quantifying watershed conservation benefits (e.g., impacts of erosion control on reservoir sedimentation), it is necessary to quantify costs and benefits. Although there is much discussion in Sri Lanka of conserving uplands to protect downstream investments, almost no economic justification is available on a site-specific basis. Even baseline hydrologic data on tank and reservoir sedimentation rates are unavailable.

Therefore, benefit-cost analyses should be performed in the project identification stage of watershed conservation programme planning. Reservoir sedimentation rates should be measured in the island's major reservoirs and tanks. Alternative project options need to be evaluated and rated so that the most efficient ones can be selected on a priority basis.

Technical and economic linkages between upstream watershed conservation and the protection of downstream investments exist, but they have not been adequately or convincingly demonstrated. Some upstream projects may be justified within the upland catchment on the basis of on-site benefits alone (e.g., productivity increases, as shown for several analyses in Asia), while others may have significant downstream benefits as well. The ratio between upstream and downstream benefits is a significant part of the rationale for deciding how watershed management inputs should be financed. Downstream benefits of upland conservation (e.g., less sediment, higher water quality and higher dry-season flows with lower flood peaks) have not been compared with possible downstream costs in the form of lower average annual discharge into reservoirs and tanks.

The necessary technical, economic and social studies need to be done to demonstrate the extent of upstream/downstream linkages in watershed management projects. Technical information is needed on the impacts on agricultural productivity of soil loss, sedimentation rates in reservoirs and tanks, damages to canals and intake structures, and water quality. Economic analyses of the costs and benefits of upland watershed conservation are needed. Social studies on the acceptability of technical watershed conservation measures and incentives for local participation (including land tenure arrangements) are necessary. Hydrological modeling of water and sediment yields from unaged watersheds needs increased technical attention, particularly regarding downstream water quality and quantity trade-offs with upstream watershed conservation.

It can be presumed that farmers with more secure land tenure will be more likely to participate in a watershed conservation programme which may have benefits that will accrue only in the medium or long term. Land tenure needs to be evaluated in the planning phase of watershed management. Project areas should be chosen in which land tenure is predominantly in private ownership or where tenure and encroachments could be regularized, to increase incentives for participation. Land use mapping information should include classifications of land tenure.

3.3.3. *Incentives for Local Involvement*

IN ADDITION TO land tenure considerations, the probability of a profitable result from watershed conservation is a powerful incentive for farmer participation. Farmer organizations may be instrumental in providing an infrastructure to capitalize on investments in catchment conservation, as they have proved to be in downstream command areas. Although short-term compensation plans may be useful in some cases, the World Bank has concluded that in Asia "experience with subsidy schemes for adopting conservation measures has not been encouraging." However, such schemes should continue to be implemented with modifications as necessary to ensure that any observed defects are eliminated.

There are substantial on-site benefits to farmers who participate in watershed management programmes. Research and demonstration plots to show farmers the profitability of reducing erosion losses (particularly nutrients) are needed to increase incentives to participate. Subsidy schemes should be carefully considered before implementing them because, as the World Bank has recently concluded, they can lead to an overemphasis on construction of structures and neglect of maintenance, thus serving as a disincentive to less expensive measures that would otherwise be adopted by farmers on their own.

Although experience in Sri Lanka with local involvement in watershed projects is limited, results from other Asian countries indicate that "interactive village planning in micro-watersheds" is much more successful than a "top down" approach.

Planning teams have gone into potential project areas using rapid rural appraisals, and have asked villagers to identify land use problems, as well as potential solutions that would be supported sociologically, economically and technically.

Therefore, an approach that involves rural communities from the early planning stages of a potential project is recommended and is preferred to a top-down method with an over-emphasis on structural measures built by the government without local participation.

While the watershed is the natural unit for planning, the village is the basic social unit where implementation must take place. After comprehensive planning is completed, implementation should take place at the village level. Demonstration areas for education and training should be set up as mini-catchment centers. Lessons learned in the centers should radiate to other mini-catchments as successful implementation schemes are demonstrated by extension staff.

Training and education are key components of a successful watershed management programme, both for extension staff and for farmers at the village level. Little training of this type has taken place in Sri Lanka. Training at the extension agent and farmer level should give more emphasis in the planning and implementation phases of watershed projects. Because of the social orientation of many NGO groups, a larger role is recommended for them in raising environmental awareness and training at the village level.

3.3.4. *Biological Watershed Management*

BIOLOGICAL METHODS OF upland conservation, such as planting vetiver grass, are finding more acceptance because of their lower cost, productivity incentives, and maintenance advantages in the long term. Forestry projects in Sri Lanka have relied mainly on reforestation with new species, rather than management of existing forests for increased productivity. But other countries, such as Nepal, have found significant economic benefits from village-owned and managed forests.

Biological measures of vegetative watershed conservation should be used when it is determined they are technically effective and locally acceptable. The measures should focus not only on profitability but also on retaining soil on the land instead of allowing it to wash into irrigation facilities and reservoirs. Emphasis should be on using vegetation which has a productive value (not necessarily trees), and should include a wide variety of grasses, shrubs and vegetables. Forestry projects should shift emphasis from top-down reforestation to management of existing forests on a sustained yield, "village forest" basis, with communities having incentives to own and manage their own forests. This approach was also recommended in a 1984 Strategy Paper issued by the Ministry of Lands and Land Development, so it is not new.

3.3.5. *Monitoring and Evaluation*

MONITORING AND EVALUATION are recognized as very important components of successful watershed projects. As these watershed projects in Sri Lanka are still only in their early stages, it is impossible to analyze monitoring and evaluation. Funding agencies, both national and international, need to know how projects are progressing and what the benefits and costs are (social, economic and environmental). Future funding is largely dependent on past successes, especially because with watershed projects moving to more vegetative field techniques and people-oriented purposes, such as the degree of local involvement, monitoring and evaluation become more difficult and subjective. It is harder to quantify the degree of local acceptance and conservation awareness level than it is to count check dams or plantation trees.

Therefore, monitoring and evaluation budgets and methodologies should be built into projects at the planning level. Trained staff need to be available and there needs to be an institutional commitment to monitoring on a regular basis. External reporting requirements need to be clearly understood and responsibilities clarified. Independent verification of progress should be planned for in the initial budget. It should be understood that well-managed monitoring and evaluation, along with efficient dissemination of success stories to the public and decision makers, have significant public relations value.

An important function of the above-recommended (section 3.3.1.) "Steering Committee on Watershed Management" would be to review the monitoring and evaluation reports to keep abreast of what the major trends are, and for taking necessary action.

3.3.6. *Experimental Watershed Management Research*

VALUABLE RESEARCH INFORMATION on water balances, erosion rates and sedimentation has come from two experimental catchment areas, Hapuwela (near Hanguranketha) and Wewelthalawa (in Nuwaraeliya), both in the Central Province. The Hapuwela and Wewelthalawa sites have been used for experimental watershed research conducted by the Department of Agriculture and the Forest Department, respectively. But the Wewelthalawa area is no longer maintained as a research site.

It is strongly recommended that both research sites be maintained because of the expensive calibration research already invested, and the need for much more information on water and sediment yields from different land treatments. Several types of land treatment should be initiated, and the hydrological impacts investigated. Future emphasis should not only be on the measurement of erosion rates and sediment yields, but more importantly on the impacts of soil loss on agricultural productivity, water quality, hydrologic regimes, bio-diversity, and other environmental indicators. The educational, training and public relations values of

maintaining the sites should not be underestimated. Of special importance is the development of modeling capabilities to reliably predict water and sediment yields from watersheds (shown to be critical in the Kirindi Oya Project). Experimental watershed data will greatly aid in the calibration of models.

Chapter 4

WATER RESOURCES POLICIES

4.1. Water Supply

SRI LANKA HAS a total average annual surface runoff of around 51,800 MCM (42 million acre feet) of water. A considerable proportion of this amount is now utilized for irrigation and what escapes to the sea is less than 33,300 MCM (27 million acre feet). With the development of the Mahaweli Project, a considerable portion of the total runoff has already been utilized. At present, the last of the major reservoirs, Samanalawewa on the Walawe Ganga, is about to come on stream. There is a marked regional variation in surface water potential, i.e., maximum utilizable quantity of water, over the island. This variation is between 21 cm and 253 cm. While Kalutara, Galle, Ratnapura, Kegalle and Colombo districts record over 243 cm, most dry-zone districts have values below 30 cm. The total groundwater availability in the island is estimated to be as high as 7,400 MCM (6 million acre feet) per annum which is about one-seventh of the country's surface water resources; but seasonal variability and annual variability are very high.

4.2. Water Demand

IT IS ESTIMATED that about two-thirds of the water resources in the dry zone and about one-third in the wet zone have already been utilized. With the completion of the Mahaweli Project, only a few favorable sites remain for major irrigation development. In the future, Sri Lanka's water resources development must increasingly focus on augmentation through conjunctive use of surface water and groundwater, rehabilitation of already built structures and improved water management. Government policies have to be directed toward several measures to improve water use efficiency through institutional transformation; crop diversification and introduction of modern technology; rehabilitation of irrigation systems; and through systematic watershed management.

Today, there are about 200 piped water supply schemes in the country serving about 45 percent of the urban population and 5 percent of the rural population. Many of these schemes do not provide services to their expected levels either qualitatively or quantitatively due to poor maintenance. Water demand for domestic and industrial uses increases with population expansion. With the rapid expansion of water supply programmes for domestic and industrial uses, it will become necessary to establish water quality survey programmes

to collect data that could be analyzed and evaluated. These data could also be used in drawing up a future development programme.

4.3. Need for a Policy

LAND AND WATER resources are limited and fixed; but population and human activities increase rapidly over time. Therefore, per capita water resources are decreasing. Water has to be conserved, and used most beneficially and equitably for all. This needs a comprehensive water policy that looks at water use not in a piece-meal manner, but in a holistic way, to put water to the most beneficial use at the least cost, and to conserve it without degrading the environment, sustaining it for future generations as well.

Four important advantages of having a well-thought-out rational policy for development and management of water resources are:

- a. Decisions regarding the allocation of water resources can be made consistent with long-term broad social objectives. Today, the country aspires to achieving a Newly Industrialized Country (NIC) status. This implies a new vision of where the country is going. A rational water resources policy could be used to help achieve the country's vision.
- b. Decisions regarding the allocation of water resources, and investments in their development, can be based on agreed-upon basic values and principles, rather than on ad hoc short-term pressures.
- c. Given the competing demands for scarce investment capital, a clear policy could increase the likelihood that scarce funds are invested wisely and cost-effectively.
- d. With the creation of the Provincial Councils and the devolution of significant responsibilities for water and land resource management to these Councils, inter-provincial allocations of water will become an important issue, for which agreed-upon procedures and principles will be required.

This Paper proposes a broad approach to water resources planning and development, that includes all the surface water and groundwater in the country; the watersheds, natural streams and beds, estuaries and coastal marshes, and lakes; the man-made infrastructure for controlling and using water; and all the potential uses of the water. It conceives of the natural ecosystems and the man-made use systems together as a macro-ecosystem which must be both developed in a cost-effective way and sustained over the long term for the benefit of present and future generations of Sri Lankans. Success in this enterprise will entail making difficult choices.

4.4. Constraints

THE MAJOR CONSTRAINTS to the development and management of water resources are: the data base (information); institutional and legal issues; human resources; and financial resources.

Information. The data on water supplies are scattered among a number of agencies. Though the data in terms of quantity and coverage are adequate to begin a master planning process, further improvements are required in the quality of the data through better supervision and additional resources for maintaining and modernizing data collection, and in the type of data collected. There is also a serious gap in terms of data for projecting future demand for water by the various sectors and regions.

More importantly, there is an urgent need to tie these strands of data into a network or data base that could be used for the development of a national water resources master plan, and for making informed allocation and investment decisions in the future.

Institutional and legal issues. The absence of a comprehensive policy articulated through a Water Resources Law, of a system of clearly defined water rights, and of an institutional framework for planning, implementation, and regulation at various levels is a major impediment. The present fragmentation of functions among many ministries and agencies makes the development and implementation of a water resources policy more difficult than it should be in a country the size of Sri Lanka.

Human resources. Engineering may be the strongest type of expertise available, while economics, planning and management may be the weakest areas. It is also likely that many specific types of advanced skills, for example the latest techniques for computer modeling, economic analysis, and development of policy alternatives to the "normal" regulatory approach, may be in short supply.

Financial resources. While the country is able to attract financial resources for new projects, it is not very successful in generating and allocating sufficient resources for operation and maintenance, planning and policy making, and research and development.

4.5. Recommended Policies, Principles and Strategies

SOME BROAD PRINCIPLES are proposed as a basis for preliminary decision making on water resources policy, and to guide the proposed master planning exercise. Further discussion could examine whether these principles are appropriate or not, and whether there are additional principles that ought to be included. "Principles" here is taken to mean broad goals or values in terms of which alternatives are prioritized.

4.5.1. Human Welfare

FIRST PRIORITY SHOULD go to ensuring basic human welfare, in terms of the provision of safe and adequate water for drinking and for other domestic uses. This

also means that the highest quality water available should be reserved for domestic purposes. Another corollary is that where domestic water quality is not very good, the country should invest in its purification to make it potable. The third corollary is that any activity which will endanger the quality of water should receive the immediate attention of the government.

4.5.2. *Economic Value of Water*

THE HIGHEST ECONOMIC value of water which includes social, environmental and other costs and benefits, should be the major basis for all decisions on water resources investments. This principle would apply to allocations among sectors (agriculture, industry, power-generation, recreation, etc.) and to decisions among potential investments within sectors (for example, returns to improving existing irrigation systems versus construction of new ones). Important decisions are often made based on political, social and other criteria as well, but the decision makers must be given information at least on the economic implications of the choices made. An important corollary is that the calculation of the highest value of water should be done in a way that is consistent with the "vision" of the future direction of the society.

In assessing the highest economic value of water, conserving the country's natural resources should be given a very high valuation, and not discounted at the rates for man-made infrastructure. Thus, conservation of water resources -- both in quantity and in quality -- should have a very high priority, through a well-defined policy and effective regulatory measures. New guidelines for economic analyses are now becoming available from other countries based on work in natural resources economics.

4.5.3. *Efficient Use of Water*

AS A MATTER of principle, the country should strive to achieve a system where cost-recovery is done in a manner that would give strong incentives for efficient use of water resources, and their conservation. This principle recognizes that in the immediate future, full cost-recovery from direct beneficiaries for water resources investments may not be possible in every case. The focus suggested is on incentives for efficient use, not necessarily on full cost recovery.

Where improved efficiency of water use would make scarce water supplies more widely available for other uses, investments should be focussed on increasing efficiency. This would tend to favour research and development for planning, testing and adapting improved technologies, investments in tested efficient technologies, measures to encourage users to shift from high and inefficient uses to more efficient and cost-effective uses, and institutional development to ensure equitable and efficient use.

As the country has already invested in many water development projects and planning exercises for specific river basins and sectors (for example electricity), future investment policies should build on these.

4.5.4. *Participatory Planning and Management*

A PARTICIPATORY APPROACH should be used as the basis for planning, and decision making on investment priorities, and to the extent possible, in operation and maintenance of water resources projects. The principle of participatory management of existing irrigation schemes is well-accepted in Sri Lanka. But decisions regarding allocation of resources among various uses tend to be taken by either politicians or technocrats. It would be preferable to build on fledgling local community mechanisms for planning, including the training of farmers and the provision of materials to enable local-level planning, and to develop mechanisms such as public hearings as used in other countries to maximize the opportunity for interested citizens and relevant organizations to express their views, provide inputs, and as a means to develop a consensus on projects, including very large ones.

4.5.5. *Institutions*

APPROPRIATE INSTITUTIONS NEED to be developed at various levels for water resources planning, prioritizing, monitoring and operations. At present, there is no institutional mechanism for water resources planning and development or monitoring and evaluation. IMPSA Policy Paper No. 1 proposes a "Water Resources Policy and Planning Body" with a small technical secretariat to compile and analyze data, arrange for research, and advise the government. Others have recommended a strong central body with the authority to make decisions. This Paper strongly urges separation of the research, analysis, planning and advisory functions from the decision-making and enforcement functions.

It is recommended that the government establish a National Water Resources Council supported by a strong secretariat. This Council would be a high-level advisory body consisting of representatives of the various government and nongovernment agencies and interest groups concerned with water resources. The exact membership is to be determined, but the irrigation, groundwater, environmental, agricultural, industrial, domestic water supply, public health, and industrial interests, Provincial Councils, and farmers' organizations should be represented. It should be located within one Ministry -- MLI&MD may be most appropriate. It should also have a formal linkage with the proposed National Land Commission, and be represented on the proposed "National Steering Committee for Watersheds." The Council's role would be advisory -- major policy decisions would be made at the political level, based on the Council's recommendations.

The Council would be responsible for the development and refinement of a national water resources policy, Water Resources Law, and the water resources master plan.

The secretariat would develop and maintain an integrated data base as a management information system; monitor trends in terms of water availability, water uses, and water quality, generally using data provided by other agencies, and make these available to the Council and to the various agencies; contract for necessary research and consultancy services; and would have the capacity for data analysis and planning in order to provide policy makers with clear options. It would also be responsible for planning, reviewing, and monitoring new projects as well as for the performance of existing systems. This secretariat would provide its analyses and proposals to the Council for its approval and for further action at the political level.

There are also good reasons to establish water resources planning and development institutions at other levels, such as provincial and river-basin, linked up to the National Water Resources Council. It is necessary to make a firm decision on the kinds of bodies required. There is also an urgent need to further refine as well as to enforce existing regulatory measures to safeguard against environmental degradation.

4.5.6. *Water Rights*

SRI LANKA NEEDS to examine her own experiences as well as other countries' experiences about how to clearly define and enforce water rights, and how to ensure equity and efficiency in the use of water resources. In general, a clear policy of defining and allocating water rights would be a pre-requisite for determining the economic value of water, encouraging private investment, and for adoption of many of the guiding principles and policies proposed in this paper.

4.5.7. *Data Base*

IT IS IMPORTANT to develop an adequate up-to-date data base and water resources management information system to ensure good planning, operation, and monitoring. Development of such a data base, and its maintenance and use as a planning and monitoring tool, would be an important step in improving the capacity for efficient water resources use in Sri Lanka.

As the demand for water by various kinds of users increases, there will be increasing need to plan carefully for multiple uses of water and conjunctive use of surface water and groundwater.

4.5.8. Private Investment

IN MANY COUNTRIES, the private sector plays a very significant role in making major water resources development investments and managing water resources, with the government playing a regulatory role. In future, there will undoubtedly be significant opportunities for private investment in water resources development, for example in generating electricity, irrigation, and industrial uses. The Government of Sri Lanka needs to develop a clear policy for this to happen, but it also must develop a capacity for planning and regulating to ensure that such private investments lead to greater public welfare.

4.5.9. Environmental Impact

THERE ARE CLEAR linkages between water resources development and environment. While water resources development affects environment, other developments in turn have a variety of effects on water resources conditions.

There is increasing evidence of waterlogging, salinity development, water quality degradation, spread of diseases like malaria, diarrhoea and Japanese encephalitis, and adverse effects to aquatic life, resulting from water resources development, particularly for agriculture. On the other hand, there is an increasing danger of both surface water and groundwater quality degradation due to potential contaminants such as human waste, as well as industrial and agricultural pollutants. Future policies should include adequate environmental effects and ensure human health.

4.5.10. Research

FOR THE LONG-TERM development of its capability for efficient management of water resources, a much stronger research and development capability will be required. Far more research is needed on such questions as the economics of alternative uses of water, environmental and health factors, improved technology for making water use more efficient, and more appropriate institutions for water resources planning, development and use. The recommended National Water Resources Council could play an important role in encouraging such research.

It is also important to do further research on flood forecasting, flood warning, and managing floods. Similarly, research on drought forecasting and contingency planning for conservation and use of the limited water supply in the event of drought are needed.

4.6. Proposed Water Resources Study

A THREE-PHASE STUDY for developing a water resources policy, law, and master plan is proposed. Phase I will be devoted to assessing the quality of the data available and organizing it into a usable data base for both the supply and demand aspects; analyzing the

present legal and institutional framework and the human resources available in the field of water resources planning and management; assessing projects presently underway or in planning to see how they fit into the emerging pattern and whether they involve any serious trade-offs affecting future benefits; identifying the data gaps that need to be filled in order to develop the master plan; developing and initiating a research and data collection effort to fill the serious gaps identified, if any, in both water resources data and in terms of institutional capacities and framework; and preparing a "Terms of Reference" for Phases II and III of the study by elaborating and revising the original draft.

Phases II and III would be initiated simultaneously. Phase II would be a data collection activity to fill the data gaps identified in Phase I. Phase III would be an interactive process of developing a water resources policy, law, and a master plan. The focus would be on refining and finalizing the overall water resources policy and institutional framework, including a water resources law, developing a national water resources plan, and developing an overall methodology and framework for preparing more detailed plans on river basin and/or regional levels. Two basin or regional plans would be developed during this phase, in order to demonstrate and transfer the methodologies involved. Planning on different basins or regions would thus continue beyond the period of the proposed master plan study, through the National Water Resources Council secretariat. Phase II would take about six months, and Phase III about a year. An approach that emphasizes consultation with a variety of concerned persons, consensus building, and building local capacities for continuing the planning exercise is strongly recommended.

The proposed National Water Resources Council would be responsible for managing the study.

Chapter 5

RECOMMENDATIONS

5.1. Land Policy

BECAUSE OF THE complexity of land tenure issues, the lack of consensus on possible solutions, and the lack of an applied research basis for proposing solutions, it is not practical to recommend any radical changes. The following are recommended measures in the short term, which could pave the way for more effective long-term policies.

5.1.1. *Research*

IT IS PROPOSED that the government seek donor assistance for developing a land tenure and productivity research programme within a national research organization, but closely linked to the Ministry of Lands, Irrigation and Mahaweli Development. This programme would be responsible for developing and implementing a long-term applied research programme on land tenure and land use issues facing the country. It would also be responsible for identifying lessons from other countries that would be relevant to Sri Lanka.

5.1.2. *Irrigation Settlement Land Issues*

THE GOVERNMENT SHOULD make a concerted effort to complete present efforts to survey the land under irrigation and above command, and provide settlers with clear titles and clearly marked boundaries, within the provisions of the present law. It should attempt to regularize encroachments to the extent possible.

5.1.3. *Increase Productivity of Small Holdings*

FARMERS' ORGANIZATIONS CAN play a very important role in increasing productivity of small holdings, through support for obtaining credit, facilitating marketing of inputs and outputs, involvement in processing to increase the farmers' share of agricultural profits, arranging for cooperation in planning and implementing agricultural production, and facilitating crop diversification. In other words, even with the present small land holdings, there are possibilities of increasing farmers' incomes.

5.1.4. *Experiment with Consolidation of Production*

IT IS SUGGESTED that the idea of a Small Farmers' Company be explored and elaborated further, in consultation with interested farmers, for the purpose of experimenting with this idea. This should be done in a way that would be reversible if farmers find it unprofitable.

5.2. Watershed Management Policy

5.2.1. *Integrated Approach*

AN INTEGRATED APPROACH to watershed management in specific geographic areas is needed, with a national policy planning group taking the lead in identifying priority sites and giving direction to line agencies implementing watershed management in the field. Eventually, all upland watershed areas in the country need to be mapped for land use, slope and erosion susceptibility through the existing institutions.

5.2.2. *Institutions*

IT IS RECOMMENDED that a "Steering Committee on Watershed Management" be initiated through the Ministry of Lands, Irrigation and Mahaweli Development. This proposed committee would be similar to the Steering Committee on the Environment. The creation of new watershed institutions is not recommended.

5.2.3. *Legislation*

THERE IS NO necessity for new legislation at this time to deal with watershed management. Existing legislation needs to be used effectively to identify critical sites, enforce regulatory measures and implement interdisciplinary programmes through the above Steering Committee on Watershed Management.

5.2.4. *Economic Analysis and Research*

ECONOMIC ANALYSIS OF the costs and benefits of upland watershed conservation for both upstream and downstream beneficiaries should be an important part of the watershed project planning process, to be undertaken in the project identification stage. Technical, economic and social research are required to assess the severity of watershed degradation and its impact on the natural and man-made bio-physical infrastructure, and to quantify technical, social and economic linkages between upstream watershed conservation and downstream benefits.

Biological measures of vegetative watershed conservation should be used when it is determined they are technically effective and locally acceptable. More research is needed to appropriate methods in this regard. Future emphasis should be not only on the measurement of soil erosion rates and sediment yields, but more importantly

on the impacts of soil loss on agricultural productivity, water quality, hydrological regimes, bio-diversity and other environmental indicators.

It is also strongly recommended that the existing experimental watershed management research sites at Hapuwela and Wewelthalawa in the Central Province be maintained for further experimental research.

5.2.5. *Planning Watershed Projects*

IT IS PROVEN that 'interactive village planning in micro-watersheds' is much more successful than a 'top-down' approach in planning for watershed conservation. While the watershed is the natural unit for planning, the village should be considered the basic unit where implementation must take place.

5.2.6. *Incentives for Local Involvement*

FARMERS WITH MORE secure land tenure are more likely to participate in watershed conservation programmes which may have only medium- and long-term benefits. Therefore, land tenure needs to be evaluated in the planning phase of watershed conservation programmes. Also important is the evaluation of communal land as an important resource for increased productivity and watershed conservation.

The probability of a profitable result from watershed conservation is a powerful incentive for farmer participation in watershed management. Farmers' Organizations could be instrumental in providing an infrastructure to capitalize investments in catchment conservation, as they have proved to be in the downstream command areas. Subsidy schemes should be carefully considered before implementing because they can lead to an overemphasis on the construction of physical structures, which can act as a de-facto disincentive.

5.2.7. *Training and Education*

TRAINING AND EDUCATION should be considered key components of any watershed management project, but more emphasis should be given to training at extension agent and farmer levels. Demonstration areas for education and training should be set up at mini-catchment centers.

5.2.8. *Monitoring and Evaluation (M&E)*

M&E OF THE implementation of projects and their impact should be considered as very important components in watershed management projects. Budgets and methodologies for M&E should, therefore, be built into projects at planning level. Review of M&E findings will be an important function for the proposed 'Steering Committee.'

5.3. Water Resources Policies

5.3.1. Human Welfare

FIRST PRIORITY SHOULD go to ensuring basic human welfare, in terms of the provision of safe and adequate water for drinking and other domestic uses. This also means that the highest quality water available should be reserved for domestic purposes. Another corollary is that where domestic water quality is not very good, the country should invest in its purification to make it potable. The third corollary is that any activity which will endanger the quality of drinking water should receive the immediate attention of the government.

5.3.2. Economic Value of Water

THE HIGHEST ECONOMIC value of water, which includes social, environmental and other costs and benefits should be the major basis for all decisions on water resources investments. This principle would apply to allocations among sectors and to decisions among potential investments within sectors. An important corollary is that the calculation of the highest value of water should be done in a way that is consistent with the "vision" of the future direction of the society. Even when decisions are made based on other criteria, decision makers should be given information on the economic implications of the choices made.

In calculating the highest economic value of water, however, conserving the country's natural resources both in quantity and quality, should be given a very high priority and valuation, and not discounted at the rates as for man-made infrastructure.

5.3.3. Efficient Use of Water

AS A MATTER OF principle, the country should strive to achieve a system where cost-recovery is done in a manner that would give strong incentives for efficient use of water resources, and their conservation. This principle recognizes that in the immediate future, full cost-recovery from direct beneficiaries for water resources investments may not be possible in every case. The focus suggested is on incentives for efficient use, not necessarily on full cost recovery.

Where improved efficiency of water use would make scarce water supplies more widely available for other uses, investments should be focussed on increasing efficiency.

5.3.4. Participatory Planning and Management

WATER RESOURCES PLANNING should be primarily a "bottom-up" process beginning at small watersheds or river basins, and aggregating upward to large river basins, adjacent small basins, agro-climatic regions or zones, and finally to the national level.

A participatory approach should be used as the basis for planning, and decision making on investment priorities, and to the extent possible, in operation and maintenance of water resources projects. It would be preferable to build on fledgling local community mechanisms for planning, including training of farmers and the provision of materials to enable local-level planning, and to develop mechanisms such as public hearings as used in other countries to maximize the opportunity for interested citizens and relevant organizations to express their views, provide inputs, and as a means to develop a consensus on projects, including very large ones.

5.3.5. Institutions

APPROPRIATE INSTITUTIONS NEED to be developed at various levels for water resource planning, prioritizing, monitoring and operations. At present, there is no institutional mechanism for water resources planning and development or monitoring and evaluation.

It is recommended that the government establish a National Water Resources Council supported by a strong secretariat. This Council would be a high-level advisory body consisting of representatives of the various government and nongovernment agencies and interest groups concerned with water resources. The exact membership is to be determined, but the irrigation, groundwater, environmental, agricultural, industrial, domestic water supply, public health, and industrial interests and Provincial Councils, and farmers' organizations should be represented. It should be located within one Ministry -- MLI&MD may be most appropriate. It should also have a formal linkage with the proposed National Land Commission and be represented on the "National Steering Committee for Watersheds." The Council's role would be advisory -- major policy decisions would be made at the political level.

The Council would be responsible for the development and refinement of a national water resources policy, Water Resources Law, and the water resources master plan.

The secretariat would develop and maintain an integrated data base as a management information system; monitor trends in terms of water availability, water uses, and water quality, generally using data provided by other agencies, and make these available to the Council and to the various agencies; contract for necessary research and consultancy services; and would have the capacity for data analysis and planning in order to provide policy makers with clear options. It would also be responsible for planning, reviewing, approving, and monitoring new projects as well as the performance of existing systems. This secretariat would provide its analyses and proposals to the Council for formal approval and further action at the political level.

It is also recommended that water resources planning and development institutions be established at other levels, such as provincial and river-basin, linked to the National Water Resources Council. There is also an urgent need to further refine as well as to enforce existing regulatory measures to safeguard against environmental degradation.

5.3.6. *Water Rights*

SRI LANKA NEEDS to examine her own experiences as well as other countries' experiences about how to clearly define and enforce water rights, and how to ensure equity and efficiency in the use of water resources. In general, a clear policy of specifying and allocating water rights would be a pre-requisite for determining the economic value of water, encouraging private investment, and for adoption of many of the guiding principles and policies proposed in this paper.

5.3.7. *Data Base*

IT IS IMPORTANT TO develop an adequate up-to-date data base and water resources management information system to ensure good planning, operation, and monitoring. Development of such a data base, and its maintenance and use as a planning and monitoring tool, would be an important step in improving the capacity for efficient water resources use in Sri Lanka.

As the demand for water by various kinds of users increases, there will be an increasing need to plan carefully for multiple uses of water and conjunctive use of surface water and groundwater.

5.3.8. *Private Investment*

IN MANY COUNTRIES, the private sector plays a very significant role in making major water resources development investments and managing water resources, with the government playing a regulatory role. In future, there will undoubtedly be significant opportunities for private investment in water resources development, for example in generating electricity, in irrigation, and in industrial uses. The Government of Sri Lanka needs to develop a clear policy for this to happen, but it also must develop a capacity for planning and regulating to ensure that such private investments lead to greater public welfare.

5.3.9. *Environmental Impact*

FUTURE WATER RESOURCES policies should include adequate, specific provisions to minimize negative environmental impacts and to ensure safeguarding of human health. This is because there are clear linkages between water resources development, and water quality, human health, waterlogging and other environmental issues.

5.3.10. Research

FOR THE LONG-TERM development of its capability for efficient management of water resources, a much stronger research and development capability is required. Far more research is needed on such questions as the economics of alternative uses of water, environmental and health factors, improved technology for making water use more efficient, and more appropriate institutions for water resource planning, development and use. The proposed National Water Resources Council could play an important role in encouraging such research.

It is also important to develop a capacity for flood forecasting, flood warning, and for planning and implementing efforts to manage floods. Similarly, drought forecasting and contingency planning for conservation and use of the limited water supply in the event of drought are needed.

5.4. Proposed Water Resources Study

IN ORDER TO further refine the country's long-term water resources policies, develop an effective and comprehensive Water Resources Law, and prepare a master plan to guide future investments, a three-phase study has been strongly recommended. Phase I would be devoted to assessing the quality and quantity of data available, organizing a data base, analyzing the present legal and institutional framework and human resources available, and identifying the data gaps that need to be filled. Phase II would be a data collection activity to fill the data gaps identified in Phase I. Phase III, to be initiated simultaneously with Phase II, would be an interactive process of developing the water resources policies, law, and a master plan. The proposed National Water Resources Council would be responsible for managing the study.