RESEARCH
REPORT

87

# Economics and Politics of Water Resources Development

## Uda Walawe Irrigation Project, Sri Lanka

François Molle and Mary Renwick

International Water Management Institute

COMPREHENSIVE Assessment of water management in agriculture

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# Contents

# Summary

This report examines the history of water resources development and investment decisions for the Uda Walawe Irrigation and Resettlement Project (UWIRP), located in the southern dry zone of Sri Lanka. The project was initiated in the early 1950s just after Sri Lanka gained independence. UWIRP was part of Sri Lanka's new postcolonial vision for economic development and modernization; a vision that was supported by multilateral and bilateral funding agencies because irrigation was seen as an engine for growth in the 1950s and onward. The original plan for UWIRP is most aptly described as a highly ambitious social, economic and physical engineering project aimed at creating a modern and profitable agriculture sector. This plan envisioned bringing 32,780 hectares (81,000 acres) of arid land into highly efficient agricultural production by constructing a reservoir and irrigation facilities, and moving landless farmers to the newly developed lands.

The description of over 50 years of progressive development shows a wide range of difficulties that constantly undermined the efforts made to implement the plan. They range from design failure and shoddy construction to poor maintenance, from agricultural diversification constraints to administrative inertia, and from massive land encroachment problems by squatters to political upheavals. What is striking is the contrast between the (sometimes blunt) assuredness of the hypotheses made in feasibility reports and the reality on the ground, and between the simplistic technological and social engineering drive of the consultants and the complexity of regional development.

Rather than adaptively adjusting to these unforeseen changes, planners continued to return time and again to the original plan and launch successive attempts at development. For each phase, investment was justified based on specified outcomes. Typical ex post irrigation assessment performance measures (projected versus actual capital costs, implementation schedules, and achievement of objectives such as irrigated area and crop output) were used to identify the extent of divergence between planned and actual outcomes. These measures underscored the rather poor performance detailed in the historical analysis. However, a comparative analysis of performance measures from UWIRP with other developing-country irrigation projects reveals that UWIRP's relatively poor performance, as measured by typical indicators, was on par with many other projects. These results support research from earlier comprehensive studies (e.g., WCD 2000) that ex ante irrigation plans tend to systematically overstate proposed outcomes.

The rather grim history of UWIRP, coupled with poor performance measures, is met with some unanticipated results in the preliminary analysis of costs and benefits for UWIRP. Despite rapidly escalating cumulative project costs, the growth in cumulative direct benefits from agricultural production has outstripped costs. The growth in benefits from agricultural production stemmed primarily from two factors—a surge in international rice prices in the late 1970s and early 1980s, which boosted the value of rice produced, and the establishment and expansion of highly profitable banana production in the area. The successful dissemination of banana cultivation and associated marketing channels were due to the vision and efforts of both farmers and local agricultural extension agents. Since the UWIRP irrigation system is used for many other purposes than crop irrigation, the report provides preliminary estimates of these other noncrop benefits, such as inland fisheries, home gardens, hydropower, drinking water supply and tourism.

These benefits need to be compared to other costs imposed by the project beyond capital investment costs, such as environmental and social costs. Although only limited information exists on the environmental costs of UWIRP, the social costs of UWIRP have been relatively low in comparison to other large-scale dam and irrigation projects, which frequently involve reallocation of local populations. The UWIRP project area was sparsely populated before development and those living in areas designated for development (including later squatters) were made into project beneficiaries as settlers. Further research is needed on indirect project costs, such as human health effects due to unsafe drinking water and bioaccumulation of agrochemical byproducts.

The report seeks to understand the decision-making processes of various interventions over the years and the outcomes of these decisions. The analysis includes the identification of the various decisions that have influenced the project's evolution, the rationale behind these decisions, and how these decisions were implemented. It shows, in particular, the interplay between how projects are perceived, planned, implemented and managed by various actors (donors, government, implementing agencies and consultants), all characterized by their respective strategic interests and accountability. Particular attention is given to the gap between planners' vision and reality on the ground, and to the ability of implementers to effectively bridge this gap.

Overall, this research illustrates the difficulties of assessing not only project performance but also project outcomes; the outcomes of a project are governed by the evolution of the behavior and choices of the different actors concerned, in which their interests, mindsets and strategies are embedded. It uncovers underlying processes that shaped the evolution of the project and highlights the limitation of viewing development as a mere set of technical and social engineering endeavors.

# *Economics and Politics of Water Resources Development: Uda Walawe Irrigation Project, Sri Lanka*

*François Molle and Mary Renwick*

## Introduction

Irrigation projects promise substantial benefits at the outset. While they have made substantial contributions to economic development, the price paid to secure these benefits has often been higher than expected, not only in terms of capital outlay but also in terms of social and environmental costs. Questions are being raised about the distribution of benefits and costs from irrigation projects and their real contribution to meeting development needs.

This report examines the history of water resources development in the lower Walawe river basin, located in southern Sri Lanka. It seeks to tell a comprehensive story of "what happened" and "why," by examining planned versus actual outcomes of successive phases of development since the 1950s. A variety of qualitative and quantitative measures are used, including a detailed historical account of activities, quantitative performance measures, estimation of project costs and benefits, and an analysis of decision-making processes. The overarching objective is to look at the history of Walawe river basin development as an object of research and to identify some of the features of "development" in the making, thus learning from past experience and practice.

### Structure of the Report

The report includes the introduction and six other sections. The second section is mainly descriptive and recounts the successive phases of water resources development in the lower Walawe basin during the twentieth century, focusing on the Uda Walawe Irrigation and Resettlement Project (UWIRP), which was initiated after Sri Lanka's independence. Construction work under UWIRP began in the 1960s and the final expansion is scheduled for completion by 2005. The original visions for UWIRP have not been realized as yet.

The third section assesses the performance of successive phases of investment using typical quantitative measures employed in ex post analyses of development projects. Some of the performance measures employed include projected versus actual capital costs, implementation schedules and achievement of objectives, such as irrigated area and crop output. The performance measures for UWIRP are compared with other irrigation projects to evaluate its relative performance. The fourth section provides estimates of UWIRP benefits and costs. Measures of both crop production and noncrop production benefits (fisheries, domestic water, home gardens, tourism and economic multiplier effects) are presented, and the evolution of cumulated costs and benefits are compared.

The fifth section seeks to understand the decision-making processes for various interventions over the years and the outcomes of these decisions. It identifies the various decisions that have influenced the project's evolution, the rationale behind these decisions, and how these decisions were implemented. It discusses the interplay between how projects are perceived, planned, implemented and managed by various actors (donors, government, implementing agencies and consultants) given their strategic interests and accountability. Particular attention is given to the gap between what the planners envision and reality on the ground, and the ability of implementers to effectively bridge this gap.

Overall, this research illustrates not only the difficulties of assessing project planning, implementation and performance, both ex ante and ex post, but also that the outcome of the project is governed by the evolution of the behavior and choices of the different actors concerned, in which their interests, mindsets and strategies are embedded. It highlights the serious shortcomings of viewing development as a set of technical and social engineering endeavors, and uncovers underlying processes that shape the evolution of the project.

## Walawe River Basin and its Physical Characteristics

The Walawe river basin[1] covers an area of approximately 3,000 km$^2$ and extends from the ridge of the central highlands of Sri Lanka, at an altitude of over 2,000 meters, down to the southern coast (figure 1). The basin offers a clear contrast between, on the one hand, its highlands and its intermediate mountainous association of ridges and valleys and, on the other, the lowland plain itself. Precipitation varies significantly in the basin from over 3,000 mm in the northwestern tip to around 1,000 mm along the seashore. Approximately half the precipitation is transformed into runoff and the remainder is either used by vegetation or evaporates. Some of the runoff percolates into shallow groundwater aquifers located in the plains but aquifer levels fall quickly after the rainy season ends. The highlands are cut by many valleys in which small streams, often perennials, can be found. They feed the Walawe river, which has an average discharge to the sea of 1.1 billion cubic meters per year.

Agriculture in the basin is mainly rainfed and includes plantations (tea and coconut), afforestation and *chena* (slash-and-burn) cultivation. Irrigation is practiced in the mountainous areas through diversion of small streams (see Molle et al. 2003). In the plain, there are 600 small tanks (reservoirs) dating back a thousand years or more, that currently provide only limited irrigation because many are silted, breached or in disrepair.

The Uda Walawe Irrigation and Resettlement Project (UWIRP) is located in the lower part of the basin. The Uda Walawe reservoir is located in the middle of the basin and supplies water to downstream areas through two main canals known as the Right Bank Main Canal (RBMC) and the Left Bank Main Canal (LBMC) (figure 2).

[1]The Kachchigala and Karagan oya basins, which are small basins adjacent to the lower Walawe basin, have been hydrologically linked with the Walawe basin under the Uda Walawe Project.

FIGURE 1.
Layout and physiography of the Walawe river basin.

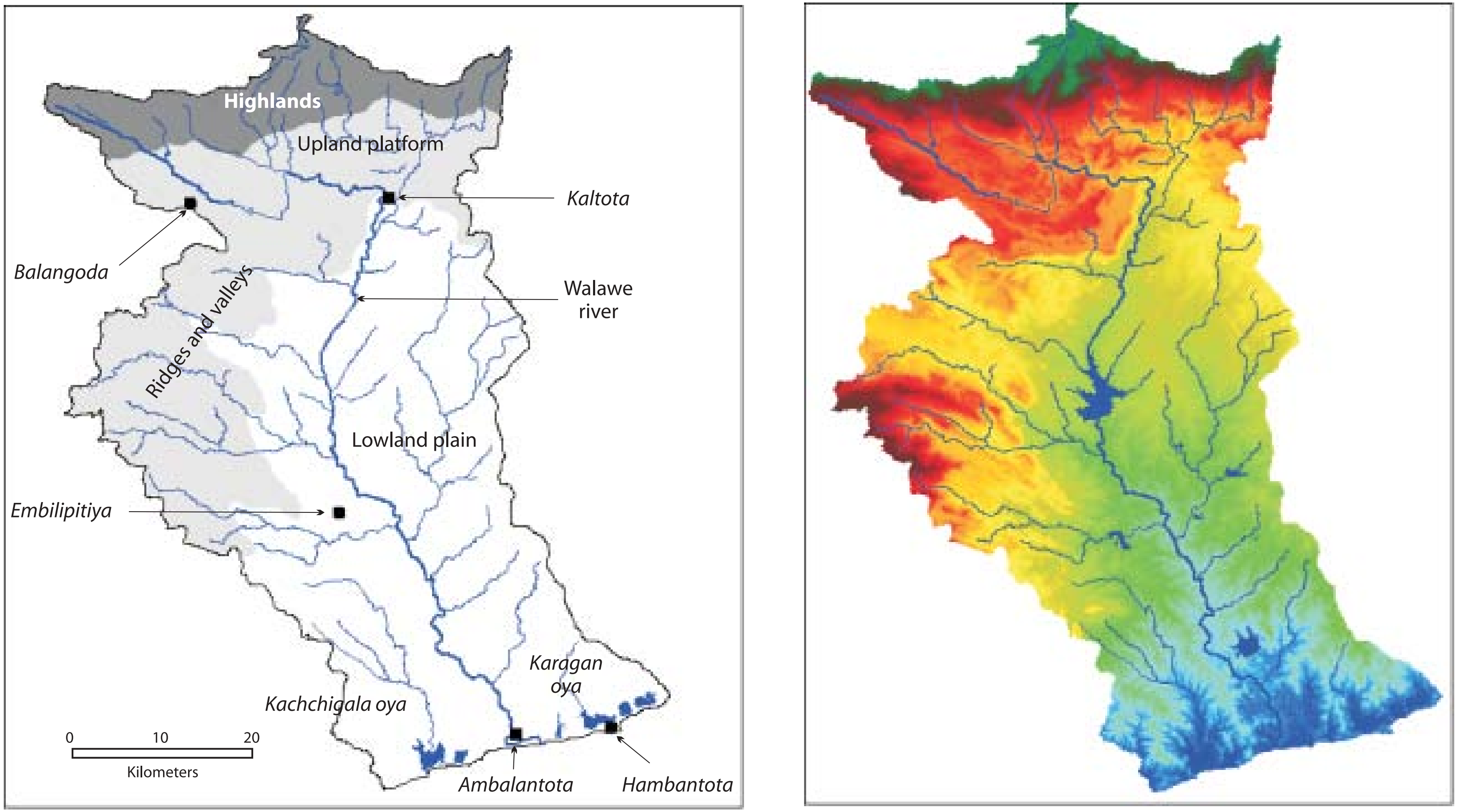
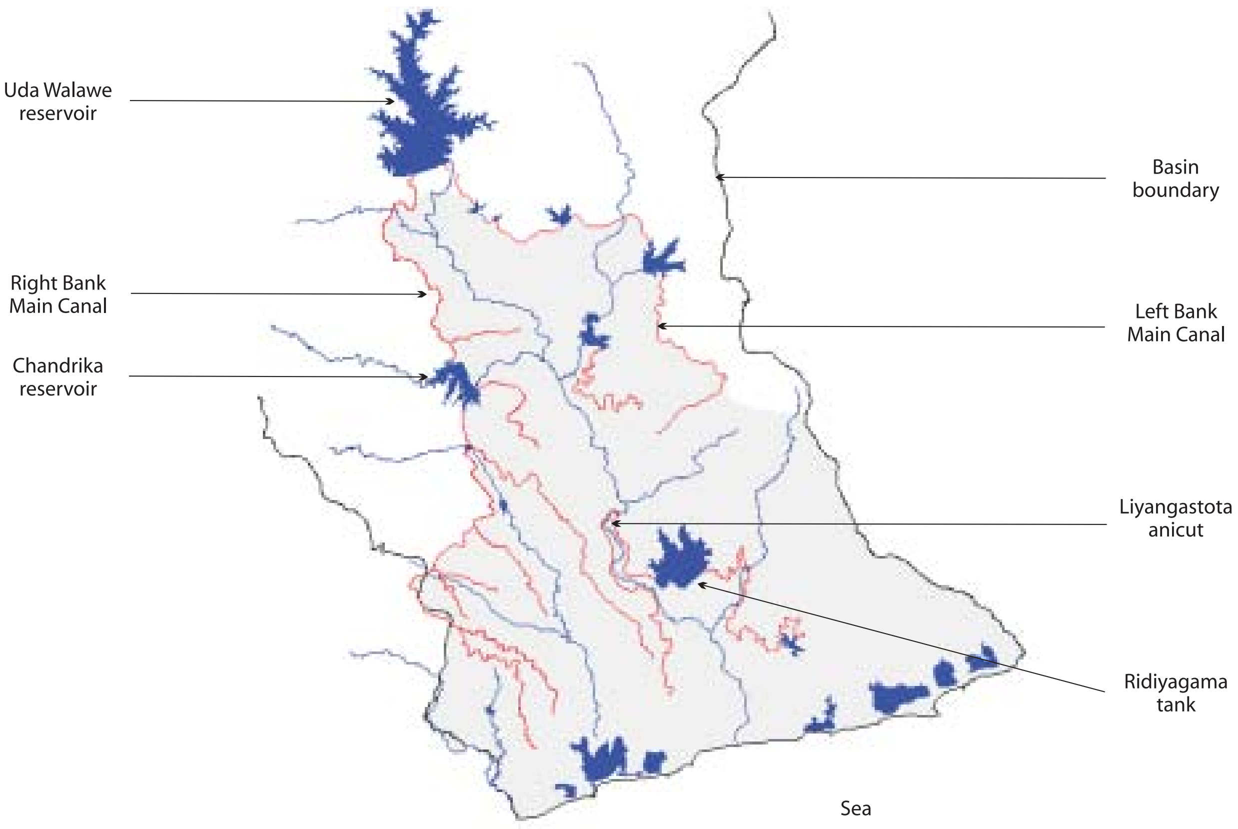


FIGURE 2.
Uda Walawe irrigation area.




## History of Uda Walawe Irrigation and Resettlement Project

The natural, social and economic landscape of the Uda Walawe basin is a living legacy of a complex myriad of interactions between humans and the natural environment. The story of Uda Walawe contains a rich ancient history of irrigation that dates back about 2000 years to the days of the *Ruhuna* kingdom, which is followed by a long period of abandonment. In the late nineteenth century, British colonialists initiated agricultural development activities in the basin, including irrigation, but the area remained relatively sparsely populated. In the postcolonial period, one of the first acts of the government was to initiate plans for the development of the Uda Walawe basin. A centerpiece of the plan was a large-scale irrigation and rural-development project that eventually became known as the Uda Walawe Irrigation and Resettlement Project (UWIRP).

The postcolonial independence period of Uda Walawe was a period of rapid change. To facilitate the discussion, this period is subdivided into the following four phases of development in the basin.

- Phase I: From independence to the construction of headworks (1948-1967)
- Phase II: Downstream development of the Right Bank (RB) area (1969–1978)
- Phase III: Improvement and rehabilitation of the RB area (1984–1994)
- Phase IV: Rehabilitation and extension of the Left Bank (LB) Project area (1995 onwards)

Before examining the successive phases of UWIRP, a brief history of the area up to the colonial period is presented.

## Ancient History

Modern water resources developments in the Uda Walawe basin are superimposed over a rich history of water control and irrigation in the region. Archaeological studies indicate that the Walawe river valley was populated several thousand years ago and known archaeological sites date back to 6,500 B.C. (Deraniyagala n.d.). *Magama*, an important city of the once powerful ancient Ruhuna kingdom mentioned in the *Mahawamsa* as early as 246 B.C., was located in the middle of the present UWIRP project area (Fernando n.d.; Collins 1932). Because of its location in the dry zone of Sri Lanka, tanks and irrigation systems were paramount to the survival of ancient civilizations and many ancient kings devoted significant efforts to the creation and maintenance of anicuts (small diversion weirs) and tanks (Ghanawimala 1942; Narada 1992). As a result, there are hundreds of small irrigation tanks and anicuts scattered throughout the Walawe basin. The density of ancient irrigation tanks in some areas is one of the highest in Sri Lanka, with approximately 1 tank per 2 $km^2$ area (Mendis 1967). Some of these tanks are still in use, especially in the lower part of the basin.

The exact chronology of these developments is unknown but it is believed that the basin was a prosperous area from the second century B.C. and began to decline around the thirteenth century. Until the mid-twentieth century, the population in the Walawe plain dwindled. The mountainous area retained denser populations but underwent significant depopulation after the 1818 insurrection against the British. A number of factors likely influenced the collapse of communities in the plains, including repeated attacks from enemies, malaria (Ghanawimala 1942; Ghanawimala 1967; Narada 1992) or the attraction of better opportunities in the wet zone (Obeyesekere 1984).

## British Rule: 1815-1948

By the time the British arrived, the Walawe basin was sparsely populated. Those who lived in the area relied on the ancient tanks for water for domestic and agricultural purposes, although most people in the area practiced slash-and-burn agriculture known locally as *chena.* In 1818, a Government Agent visited one of the main villages and described it as a thick jungle area infested with malaria and populated with only 18 persons (Abeyratna n.d.).

Until the extreme drought of 1866, which caused a high mortality and elicited strong calls for the development of large-scale irrigation projects, the British had only undertaken a few minor settlement and rehabilitation works on the ancient tanks and anicuts in the Walawe basin (Steele 1867). The first large-scale intervention by the British was in the southernmost part, in Hambantota district, starting with the rehabilitation of the Liyangastota anicut in 1889. Figure 2 provides a visualization of these and future works. The Liyangastota anicut, which is part of the present UWIRP, diverted water to a canal on the RB of the river to irrigate about 3,000 hectares a few miles further south. The government sold 75 percent of the irrigable land, with a theoretical maximum of 2.02 ha (5 acres) per person, and reserved the remaining 25 percent for poor people (GOC 1889). Other minor interventions included the development of Hingura and Embilipitiya village tanks around 1890 and construction of the Ridiyagama tank in

1922. More irrigated land was developed downstream of this tank in two phases (1925 and 1941), with 3,000 hectares of crown land sold to local people. The investments in irrigation were justified in dual terms—improving health and livelihoods of the poor and earning income for the Crown (Bastiampillai 1967).

By the early 1940s, the British initiated more ambitious plans for the Walawe River Basin Scheme. These development plans laid out schematic "blue prints" for a large-scale irrigation and rural-development project (eventually known as UWIRP), a large upstream reservoir (*wewa*) for hydropower called *Samanala*, and numerous other dams. Planning efforts were discontinued because of the Second World War and the coming grant of independence to the colony.

## Phase I: From Independence to the Construction of Headworks—1948-1967

Shortly after independence, the Government of Ceylon continued the earlier efforts by the British in the Walawe river basin. The government rehabilitated some ancient tanks[2] and continued survey work and feasibility studies for the Walawe basin scheme. The settlements in Walawe were some of the first in the wave of agrarian settlements of the post-World War II period. The government sought to establish settlements in the dry zone in response to a perceived population explosion and agrarian crisis. Settlements were construed as a type of social engineering, whereby poor farmers from the wet zone were given equal access to land and the threat of land concentration and division was combated by limiting the transfer of ownership—allowing only one successor to inherit an allotment, despite the contradictions with culturally sanctioned expectations of families.[3] Efficiency concerns were supposed to be addressed by setting a rationalistic procedure in the selection of settlers that took into consideration data on farm size, land endowment, "farming skills" and experience.

Throughout the 1950s, numerous surveys and studies of the Walawe basin were carried out. The Government of Canada supported a Survey of the Land and Resources of Ceylon that was published in 1960. This document provided the basic factual information on soils, land use and water resources for formulation of plans. It also outlined a "plan for the development of a large part of the lowland plain of the Walawe Basin," which included the Uda Walawe reservoir and the Samanala reservoir and eight other dam locations. Concurrently, other plans were developed for the basin, including one published by the U.S. firm, Engineering Consultants, Inc. (ECI). ECI envisioned a scheme composed of five dams, including Samanala and Uda Walawe dams. The plan focused on water requirements, economic benefits and the potential for hydroelectricity (ECI 1960). The ECI Plan was later used as a basis for the Ceylon Irrigation Department Plan of 1963.

While plans for the Uda Walawe progressed, in 1956 the government rather hastily initiated and implemented a more moderate-sized irrigation and resettlement project that would ultimately become part of the UWIRP, known as the Chandrikawewa irrigation scheme. The Chandrikawewa scheme was one of the first settlement schemes and included the construction of the Chandrikawewa reservoir across a right bank tributary of the Walawe river (*Hulanda* river) and the settlement of a total of 1,800 farmers on 2,023 ha (5,000 acres) of jungle. Each family received a lot of 2.02 ha (5

[2]The Mahagama tank on the LB was among the tanks rehabilitated after the Second World War. This work included the irrigation of 580 hectares of rice land and the resettlement of farmers around the tank.

[3]This resulted in families keeping strong ties with their original villages, and they militated against the emergence of a new local solidarity and society.

acres; 3 acres of rice land and 2 acres of highland for homestead[4]). The rights to some of the land blocked out for the Chandrikawewa scheme were held by a few *purana* (indigenous) villages (Amunugama 1965). Most villagers were absorbed into the scheme as settlers but some village elders had over 6 ha (15 acres) of land each and refused to cede their land for redistribution. Their allotments were eventually excised from the blocking-out plan. In addition, a group of people who had settled 10 years earlier in 3 villages had been left out of the initial selection of settlers for the Chandrikawewa scheme and they refused to move. Disputes between "official" *de jure* settlers and *de facto settlers*, including encroachers, were frequent.

While the Chandrikawewa scheme was being implemented, planning efforts continued in the basin. In 1963, the Irrigation Department unveiled a plan[5] for the Uda Walawe reservoir based on design work by ECI that eventually became known as the UWIRP. The plan focused on the engineering design details for the project headworks, with the goals of generating electricity and providing irrigation. The plan was to irrigate 15,378 ha (38,000 acres) in *yala* and 20,234 ha (50,000 acres)[6] in *maha*[7] along the right and left banks of the Uda Walawe river, and provide supplemental irrigation water for approximately 6,070 ha (15,000 acres) in the Liyangastota anicut command area. The plan of the Irrigation Department focused only on the design of the infrastructure and made it clear that the main concern of the moment was to go ahead with the construction of the dam. Plans for downstream development were left for a later date when "the system of land development to be adopted and the type of agricultural crops to be grown" would be determined. The plan included two main components: (i) a 4-kilometer long and 36-meter high earth-filled storage dam and reservoir of 240 million cubic meter live storage, with electrical plants for a combined power generation of 5.4 megawatts; and (ii) two irrigation sluices with channels to supply the right and left banks.

The project implementation schedule envisioned invitation for tenders in 1963, construction beginning in 1965 and completion of the entire project, including irrigation channels for 20,234 ha (50,000 acres), by 1974. In early 1964, the government invited construction bids and construction began later that year. The River Valleys Development Board (RVDB) served as the local implementing government agency. Shortly after construction began, the RVDB began allocating land for settlement in Tracts 2-7 (see Appendix B), known as the Embilipitiya block, in advance of the design of the irrigation system, a procedure referred to as "advance alienation" (ADB 1995).[8] The RVDB brought settlers to the land without the preparation of blocking-out plans; a process of land planning that takes into consideration the topography and future location of canal networks.[9] The RVDB engaged in advanced alienation based on the idea that the settlers could clear and level their land so that they would be ready for production by the

[4]This area of plot was less than what the colonists were given, 5 acres of irrigated land and 3 acres of dryland, before 1952 (IEC 1954). The allotment of 3 acres of rice land was reduced to 2 acres in 1964 (1 acre = 0.405 ha).

[5]Irrigation Department, 1963: "Development of the Uda Walawe Basin: Proposed Uda Walawe Reservoir Irrigation and Hydropower Project."

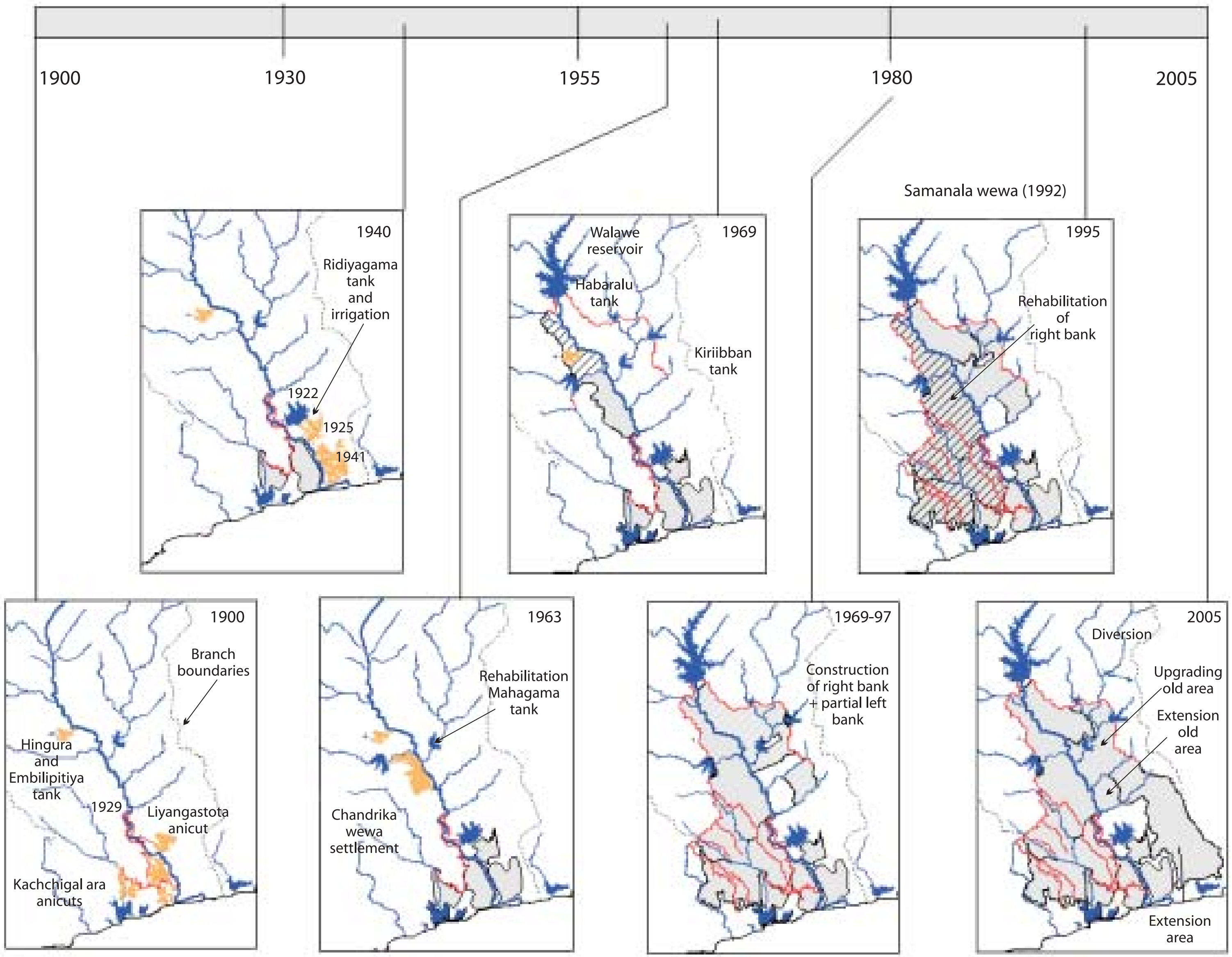
[6]There is inconsistency in the values given for the total area to be developed, partly because some plans include existing development and others do not. Later plans identify a goal of 32,780 to 34,398 hectares (81–85 thousand acres) of irrigable land. This estimate includes 27,114 ha (67,000 acres) to be developed downstream plus existing development in the Chandrikewewa area (about 2,025 ha or 5,000 acres) and Liyangastota anicut area (about 5,062 ha or 12,500 acres).

[7]*Maha* is the "wet season" from October to March and *yala* is the "dry season" from April to September.

[8]Tract 1, in the upstream area on the LB, was allocated for a sugar research station and factory, with a small section set aside for the establishment of a hatchery for inland fisheries. Subsequently, the sugar research station was handed over to the Sevanagala Sugar Corporation (ADB 1995).

[9]This resulted in difficulties with future canal networks. Proposed canals intersected some lots, others had to be irrigated from two or more offtake points, and others did not have frontage to field canals that necessitated construction of ditches through the land of other farmers.

FIGURE 3.
Evolution of water resources development in the lower Walawe basin: 1900-2005.



completion of the headworks and would also earn an income assisting with construction activities (ADB 1995). Between 1964 and 1967, about 800 ha of land on the RB were cleared and various settlement infrastructures were constructed (ADB 1979).

Initially settlers were selected based on the prevailing government policy that relied on predominantly social criteria—landlessness, family size and unemployment. However, local members of Parliament eventually reviewed the lists of candidates giving way to alleged patronage. The RVDB provided each settler with approximately 1.0 ha of irrigable land and 0.4 ha of highland for homestead. Along with authorized colonists (and even before them), a large number of encroachers began to move into the area in anticipation of future land grants. Hunting Technical Services later estimated that by 1968, nearly 60,000 people were living in the area. In addition to the 23,000 *purana* villagers, there were 9,900 legal settlers (located primarily in the Embilipitiya area of the RB), 18,000 illegal encroachers (scattered throughout the project area) and 1,100 RVDB employees. Thus, by the time downstream planning began, almost one-third of the population in the area consisted of illegal settlers whose presence ultimately put enormous pressure on the settlement process.

Advance alienation, coupled with other issues, meant that farmers received little, if any, assistance in crop selection and production methods. So they engaged in what they knew best—subsistence-based agriculture—and cultivated rice using traditional methods. Plentiful and continuous free-flowing water allowed them to cultivate rice even in highly permeable RBE (reddish brown earth) soils. Such high water duties and infiltration losses created serious problems later on, when downstream development occurred.

The reservoir was completed in 1968, “in record time” according to Mendis (1967) at a cost of US$9.46 million (Rs 46 million). Contractors completed the canal and network systems in Tracts 2–7 along the RB (up to Chandrikawewa reservoir). Construction on the LB focused on connecting the new system to the existing village tanks and the newly constructed Habaralu tank, and by 1968 the LB canal was 17 km long (figure 3). Further details of the construction are in Appendix A.

## Phase II: Downstream Development of the RB Area—1969-1978

### *Planning efforts*

It was not until the headworks were completed and the irrigation system was well underway that plans for a system of land development and a type of agricultural production were initiated.[10] The first comprehensive feasibility study of the project was done in 1967/68 by Hunting Technical Services (referred to as “Hunting” hereafter), commissioned by The British Ministry of Overseas Development at the request of the Government of Ceylon. The Hunting Plan was a highly ambitious social, economic and physical engineering project aimed at creating a modern, highly efficient agriculture sector. It increased the project area by over 10,117 ha (25,000 acres) to 32,172 ha (79,500 acres) by including the area upstream from the command that would be rainfed.[11] It included detailed plans for such factors as cropping patterns, production practices, water use and settler selection.

In formulating their plan, Hunting took into account the prevailing macroeconomic policies of import substitution and food self-sufficiency that were to be achieved through modernization of the agriculture sector. The Hunting Plan also relied heavily on the earlier survey work carried out by the Canadian Government in the 1950s and previous reports issued by government

[10] The 1969 ADB Appraisal Report on Walawe notes that “the investigation and planning of agricultural development in the area started much later than those of the engineering side” (ADB 1969).

[11] Both the Hunting Plan and the earlier Irrigation Department Plan included 10,117 ha (25,000 acres) of existing development, the areas under Liyangastota anicut and Chandrikawewa.

agencies and international engineering consultants. The soil composition of the command area favored the production of other field crops (OFCs). Soil surveys of the area had revealed two primary soil types—heavy low-humic gley soils (LHG) in the lowland areas covering about 30 percent of the land, which are suitable for swamp rice, and relatively porous reddish brown earth soils (RBE) in the upland areas covering the remaining 70 percent, which are suitable for a variety of field crop such as cotton, sugar, chili and onion (HTS 1968b, 13).[12]

Soil and water survey data were used in conjunction with government macroeconomic policies to devise a cropping pattern. The Hunting Plan states that "within the limits imposed by technical and social constraints, development plans for Uda Walawe should aim at the efficient production of rice, cotton, sugar, dairy products, chilies and onions." With cropping patterns determined, the whole design and planning process unfolded. The plan that emerged assumed that all aspects of the project could be "engineered." For example, it was assumed that all irrigated land would be double-cropped annually, that the area under each crop would be fixed, that "farmers will apply the recommended inputs," and that 12,000 settler families would be selected based on their potential to become efficient modern farmers. The plan also assumed that the 18,000 squatters, who had moved into the area in hopes of securing land, would be removed.

The very feasibility of the project itself depended, among other things, on *efficient* production of OFCs on the RBE soils. This, in turn, required the selection of the "right" settlers, adoption of the "right" practices (including modern chemical inputs and efficient water use), and eviction of large numbers of squatters currently on the land. Failure to achieve this objective would endanger the economic, environmental and social outcomes of the proposed project. In order "to reduce growing foreign exchange costs," targeted crops included rice, cotton, sugar, chili and onion on 70 percent of the irrigated land, which amounted to all the land with RBE soils. Hunting stressed that these RBE soils "should on no account be used for swamp irrigation because puddling is likely to destroy their structure," and result in erosion and other problems (HTS 1968b, 18). The plan also stressed the importance of evicting squatters "as their continued occupation is bound to prejudice the ordered settlement and could compromise the whole concept of the project."

Taking into consideration the Hunting Plan and additional research conducted by a FAO/UNDP Mahaweli team, the government published a Plan of Development and Estimated Costs for the Walawe Project (GOC 1969). This plan was based largely on the Hunting report but reduced the command area and cropping patterns to accommodate higher water duties suggested by the FAO/UNDP Mahaweli team. On the basis of these revised water duties, the Government Plan estimated the total irrigable area available for development as 27,357 ha (67,600 acres). This area included 3,432 ha (8,480 acres) of developed land (see Appendix C) to which 2,133 ha (5,270 acres) of land under irrigation from Chandrikawewa were later incorporated.[13]

The Government Plan estimated the cost of the integrated development project, including all infrastructure, at US$73.6 million (Rs 438 million in 1969 prices). However, the cost-benefit analysis was based on US$58.8 million (Rs 350 million) to be distributed between 1964 and 1972. This later estimate excludes the construction costs of main roads, hospitals, schools and police stations because, the plan argued, many of these would have been provided regardless of the project. The reduced cost estimate also excludes the cost of establishing industrial units (sugar, brick, cottage, and sawmill

[12]The proportion of red soils was about 70 percent in both areas already developed and in the area proposed to be developed, based on the estimates provided by Hunting.

[13]The Liyangastota anicut command area was excluded from this estimate.

industries) and anticipated benefits thereof. Of the US$58.8 million allocated for 1964-1978, US$22.86 million had been spent by September 1968.

### *Full development of the RB*

In 1969, the Government of Ceylon approached the Asian Development Bank (ADB) to obtain financial assistance for the development of the Uda Walawe Irrigation and Resettlement Project (ADB 1969). As it would be ADB's first integrated rural-development project in Sri Lanka, ADB opted to finance development of the RB initially and to consider the LB upon completion of the RB work. The ADB appraisal document largely reflected the 1969 Government Plan with one critical exception—it allowed for the production of rice on a portion of the area previously devoted to OFCs that contained RBE soils. This decision and its implications are discussed below.

The area of the ADB project included the entire RB area (12,369 ha) articulated in the Government Plan. This area included the two areas that were already settled—Chandrikawewa area (2,134 ha) and Tracts 1-7 (1,520 ha)—and Tracts 9-21 (8,715 ha) that were to be developed (see Appendix E for further details). The goals of the project were to develop and settle Tracts 9-21, improve agricultural productivity on existing land, rehabilitate the existing irrigation infrastructure and construct new irrigation facilities on Tracts 9-21, and construct village centers and other support infrastructure, including an agricultural experiment and extension center.

Following the Government Plan, the ADB project sought to provide water supplies to ensure double cropping and enhance yields. It also sought to accommodate about 3,440 new settlers for intensive farming and to improve the agricultural productivity and living conditions for the 3,100 earlier settlers. Due to high water usage in the existing RB command areas, improving water-use efficiency in already developed areas was paramount to further development in the LB area. The ADB deviated from the 1969 Government Plan (GOC 1969) in one critical aspect; it permitted an expansion of rice production on to the RBE soils. According to Nijman (1991), around the time ADB became involved "the government decided that rice would be grown on the well-drained soils of the area upstream of Chandrikawewa reservoir. The decision was taken on the 'insistence' of a then Minister." Visvalingam (1986) cites this as a "disastrous example of the misapplication of ministerial omniscience," although one may wonder whether farmers would have refrained from growing rice, had this decision not been taken. This expansion in rice area threatened an already fragile project on a number of fronts by taxing available water supplies, limiting economic profitability and diversification plans, damaging fragile soils and causing erosion.

At appraisal, the estimated cost of the proposed work was about US$26.45 million, with a government share of US$17.46 million and US$8.99 million foreign financing from ADB. The RVDB continued to serve as the implementing agency. The project commenced in 1970 with an estimated completion date of October 1973. However, because of a variety of problems the project was extended to January 1977, when it was about 90 percent complete.

The project suffered delays from the onset, beginning with a lag in hiring consultants to oversee development of project design and implementation. Finally, it was launched in late 1970 and construction began in early 1971. However, the rushed time frame between the hiring of consultants and engineers and implementation resulted in "inherent deficiencies in the original engineering design" (ADB 1979). One major design limitation was a single-bank canal system rather than the conventional double-bank canal system. Others included poorly designed control structures, lack of provision to recapture return flows, an inadequate number of cross regulators and measuring devices, and limited live storage of the Chandrikawewa (ADB 1979). These design flaws were constraints to proper water management.

In 1971, shortly after construction began, three events—of the many in a long series of events to come—occurred that impeded implementation. First, political upheavals caused severe disruptions in construction. Second, the Gal Oya project was completed and a political decision was made to transfer 5,000 unskilled workers from that project to Uda Walawe. The massive labor force, which could not be absorbed, financially crippled the RVDB. Third, political tensions crept into the RVDB resulting in changes in its top management, an occurrence that would become common in the history of the RVDB. Over the 10-year period between 1969 and 1979, the RVDB had nine different chairmen.

Flawed design plans coupled with ongoing changes in top management, a shortage of experienced technical staff and a surplus of unskilled labor, resulted in poor-quality construction of irrigation infrastructure and ongoing delays resulted in a number of unintended, but serious, consequences. For example, water use by settlers on previously developed lands in Tracts 2-7 and Chandrikawewa (who were used to receiving and using the supply of water intended for the entire project area) was so high that a 1972 ADB review of the project determined that the planned irrigable area would have to be scaled back. This resulted in a decision to drop Tracts 20 and 21 (676 ha) from the originally planned project area (see Appendix B).

Project delays and lack of administrative control also created problems in land allocation and settlement. Altogether, 3,300 new settlers were projected to settle in Tracts 9-21. The size of a holding was 2.02 ha (5 acres; 4.5 acres of irrigable land and 0.5 acre for a homestead). Settlers were to be selected based on their potential to become efficient farmers using an "objective" point system. Land allocations initially followed the plan. Settlers were to be provided with training to ensure they complied with recommended cropping patterns and actively cooperated in system operation and maintenance (O&M). The plans also called for construction of housing for new settlers.

Despite the plans to select settlers based on economic criteria, political and social considerations crept into land allocation decisions very early on, partly as a result of the tremendous demand for land by the large numbers of encroachers in the project area. As a result, "irrigable land allotments were reduced successively from 4.5 acres (as originally recommended) to 3 acres and again to 2.5 acres; homestead lots were reduced from 0.5 acres to 0.25 acres" (ADB 1979). By 1979, the number of new settlers who were provided land under the project was 4,143 (compared to the projected number of 3,300), in addition to about 2,800 settled earlier in the Chandrikawewa area and Tracts 2-7.

Delays in placing legal settlers on the land further fueled encroachment and early efforts to evict the encroachers proved ineffective. The problems of encroachment were further aggravated by the lack of land surveys and markings for allotments and delays in issuing land permits to legal settlers. Encroachment created disputes among settlers regarding rights to land and water use but no legal action was taken. The illegal status of the encroachers prevented their access to irrigation water, institutional credit and other agricultural support services. As a result, encroachers resorted to force and water theft. These actions frequently caused damage to the irrigation structures and tended to disrupt attempts to introduce effective water management and agricultural development activities in the project area. The RVDB largely ignored encroachment, which compounded the problems over time.[14]

Due to mounting pressures for land and the rather chaotic allocation process, settlers were

[14]Encroachment problems were not addressed until 1982 when the management of the project was transferred from RVDB to the Mahaweli Authority of Sri Lanka (MASL). By that time, some encroachers had been on the land for well over 15 years.

allocated land faster than the RVDB could supply housing. The original plan to provide frame-and-roof houses for all settlers was abandoned by 1972 and in lieu of a house the RVDB provided a subsidy of US$50.25 (Rs 300). Only 933 of the targeted 5,380 housing units were constructed. This decision had ramifications for future community development plans—it led to scattered development and defeated the objectives of cluster-style development, including the planned provision of shared infrastructure, such as water on tap and promotion of community cohesion.

The hasty and uncoordinated land-allocation process also resulted in a total lack of training and education to settlers, to ensure their compliance with planned cropping patterns and system O&M. Proposed agricultural extension efforts, subsidies for chemical inputs, and development of marketing channels for OFCs occurred only on a limited basis, if at all. By the end of the project period, the average consumption of fertilizers was only about 20 percent of the recommended quantities. The lack of marketing channels created severe problems for some settlers who produced OFCs, particularly cotton. There are many stories of farmers who followed the advice of extension officials and grew cotton only to find themselves with no buyers and piles of rotting cotton.

The uncoordinated settlement process, in combination with other factors (including credit shortages, lack of marketing channels and inexperience with OFCs), created an environment where farmers opted for what they perceived as the least risky approach. They focused almost exclusively on rice production using traditional production practices without regard for soil types. This resulted in higher-than-anticipated water usage, which exacerbated the systemwide water-management problem as the irrigable area expanded, particularly for downstream water users.[15] Thus, the decision to expand (or tolerate the expansion of) upstream rice production combined with poor water management created substantial inequities among project beneficiaries. Without water, downstream settlers began to abandon the land, which further fueled the encroachment problem as encroachers often moved onto these lands once they were abandoned.

Due to all these problems, the project faced repeated delays. The original project completion date of October 1973 was repeatedly extended until January 1977, when the project was closed with about 90 percent of the anticipated work complete. Due to these delays and higher-than-anticipated costs for construction equipment and material, the project faced substantial cost overruns. The project cost at appraisal of US$26.45 million (US$8.99 million foreign funds and US$17.46 million local funds) escalated to US$33.63 million (US$8.82 million foreign funds and US$24.81 million local funds), resulting in a cost overrun of 27 percent. The government bore the full brunt of the overrun, which increased its share of the cost by 42 percent. Escalating project costs, combined with the loss of potential benefits of Tracts 20 and 21, were offset by an unanticipated surge in international rice prices. Between 1968 and 1979, increased rice production combined with higher prices yielded higher-than-estimate returns per unit area (per acre) and resulted in foreign exchange savings estimated at US$35 million. Thus, the short-run economic sustainability of the project depended precariously on continued high rice prices.

By 1979, structural deficiencies, poor water management and inequitable distribution of available water supplies continued to seriously threaten project objectives. The original plans anticipated that the Uda Walawe reservoir would provide sufficient water resources to irrigate a command area of 32,937 ha (comprising 12,662 ha on the RB and 20,275 ha on the LB).

[15]By 1979, of the 6,680 hectares in Tracts 9-19, the irrigated area never exceeded 3,846 hectares in maha and 2,834 hectares in yala. Planned versus actual cropping patterns also diverged significantly. The plan envisioned that 59 percent of the land in Tracts 9-19 would produce OFCs (cotton, chili and red onion in yala, and maize and groundnut in maha); however, the actual area devoted to OFCs ranged only between 2 and 7 percent.

However, the entire supply of the reservoir was devoted to only 39 percent of the planned project area, on average[16] (ADB 1979).

According to the ADB Project Completion Report (ADB 1979):

> "… irrigation water use in the project area far exceeds original expectations and threatens to curtail further development on both banks. Only about 70% of RB area envisioned for irrigation at the time of appraisal is actually served and this area is consuming 3 times the water proposed for the entire RB area. Only the lack of development on the LB has permitted this excessive use."

## Phase III: Walawe Irrigation and Improvement Project—1984-1994

### *Planning of rehabilitation works*

The rather abysmal outcome of ADB's first integrated rural-development project in Sri Lanka ushered in planning for a subsequent phase of rehabilitation on the heels of the first project. According to the 1979 ADB report, the "irrigation system has deteriorated to such an extent as to require immediate rehabilitation and improvement in order to attain full utilization of the available land and water resources." Over the next couple of years, the ADB continued to strongly advocate a rehabilitation project aimed at improving system performance and was ready to start a rehabilitation project in 1980. Nijman (1991) argues that the Government of Sri Lanka showed little interest in rehabilitation and only agreed to the rehabilitation in April 1982 because ADB made rehabilitation of Uda Walawe a precondition to funding several other high priority government projects.[17]

When the government agreed to rehabilitation, there was no rehabilitation plan in place. The UWIRP was far from reaching the goals of the original plans to develop and settle about 32,000 ha (79,000 acres) on both banks of the Walawe river. As of 1982, only 56 percent of the planned command area had been developed, which included 12,000 ha in the RB command area and 6,000 ha in the LB command area.[18]

Due to poor performance, the management of the project was transferred from the RVDB to the Mahaweli Authority of Sri Lanka (MASL) in 1982. MASL took a number of actions. It increased agricultural productivity by establishing two distinct growing seasons—maha and yala—and instituting a mandatory fallow season, which disrupted the reproductive cycle of pests and disease agents resulting in increased yields and improved water management.[19] MASL introduced rotational irrigation schedules, as originally planned, in some areas of the project to make water available for downstream users who had previously been denied irrigation supplies. This was strongly opposed by some upstream users. However, MASL took measures to improve data collection and operation and maintenance, strengthened agricultural support services and initiated a crop diversification program.

MASL also began to address the encroachment problem, which had essentially

[16]An average of 8,502 ha on the RB and 4,412 ha on the LB.

[17]According to Nijman, "First, the Appraisal Mission for supplementary funding for Kirindi Oya made such funding to Kirindi Oya conditional to the willingness of the government to rehabilitate Uda Walawe. In addition, the donor would consider funding of a road construction project in the Accelerated Mahaweli Program only if the government was willing to agree with rehabilitation of Uda Walawe. Another incentive for the government to accept rehabilitation of Uda Walawe was the donor's explicit willingness at that time to consider future loans for the development of the Walawe Left Bank. The latter was envisaged to boost the EIRR of the donor's overall investment in Uda Walawe" (see Nijman 1991, 119 for further details).

[18]The LB command area included about 4,000 ha of existing rice lands and about 3,000 ha being developed under a state sugar project. The command area of the Walawe project excludes an additional 5,000 ha developed under the Liyangastota diversion dam.

[19]Prior to MASL's involvement, farmers planted rice throughout the year, so at any point in time one could observe rice fields in various stages of maturation.

been ignored by the RVDB.[20] By 1982, an estimated 4,100 illegal encroachers had usurped land and many had been there since the project's inception (ADB 1995). Encroachment also caused disputes among settlers regarding rights to land and water use. The illegal status of the encroachers prevented their access to irrigation water, institutional credit and other agricultural support services. As a result, water thefts became a common practice. Some encroachers resorted to use of force and often damaged irrigation structures in the process. They also disrupted attempts to introduce more effective water management and agricultural development activities in the project area. Although MASL gave the issue of regularizing encroachers top priority, work progressed slowly because of numerous legal and administrative problems.

In a relatively short period of time, the MASL efforts showed impressive results. Through better water management, MASL increased the annual irrigated area from about 11,000 ha to 16,000 ha by 1984. By creating two distinct growing seasons and other extension efforts, paddy yields increased from 3.6 tons per hectare to 4.0 tons per hectare during the same period. Through a culmination of these efforts, overall rice production increased from 40,000 tons to 60,000 tons, resulting in a one-percentage increase in the economic internal rate of return (EIRR) from 7 percent under the earlier ADB project to 8 percent.

These improvements were well received by ADB. However, they argued that the project was yielding only about 60 percent of estimated benefits and these were too inequitably distributed, with farmers in the upstream areas receiving most of the benefits at the expense of those downstream. ADB (1984) argued that these improvements were "ad hoc and temporary, entail high recurring costs that could not be sustained over time without a systematic and well-designed improvement and rehabilitation program to rectify design and construction deficiencies of the existing system." From ADB's perspective, "because of the project's current unsatisfactory performance, it would not realize its long-term objectives unless a carefully designed rehabilitation and improvement program was undertaken to rectify the physical and institutional problems encountered with the project" (ADB 1982; Project Performance Audit Report).

In 1983, ADB financed a mission to identify rehabilitation priorities. The findings from the mission revealed that "[the] major problems faced by the Walawe irrigation system can be attributed to a past lack of management rather than to inherent design or construction defects" (Wolf 1983, iv quoted in Nijman 1991, 120). While they considered major rehabilitation works infeasible, they did suggest minor improvements and rehabilitation to the irrigation system and cited the need to consider potential supply-augmentation options. ADB disagreed with the mission's findings, according to Nijman, and in 1983 hired SOGREAH, an international engineering consultancy firm, to prepare a feasibility study for rehabilitation.

By 1984, SOGREAH completed a feasibility study for rehabilitation. It presented a detailed proposal that involved "a major rehabilitation within all distributary-channel subsystems combined with a program of organizing the water users by means of institutional organizers" (Nijman 1991, 120). According to Nijman, "The feasibility study thus proposed an engineering solution for the excess water use in Uda Walawe, without giving further project objectives which would tackle the managerial performance of the managing agency apart from training and an operation and maintenance manual" (Nijman 1991, 120).

Several months later, ADB submitted a Project Appraisal for the Walawe Irrigation and

[20] A number of factors fueled encroachment. The primary cause was delays in placing legal settlers in possession of allotments. The abandonment of land by legal settlers, especially in the tail-end areas that received little or no water, resulted in more encroachment. Encroachment was further aggravated by the lack of allotment surveys and land marking and the failure by the RVDB to issue land permits to legal settlers. Prevention of encroachment was difficult because no legal action was taken as soon as encroachment occurred.

Improvement Project (WIIP) based on the SOGREAH plan. According to this document, the primary objectives of the rehabilitation project were to work towards realizing the goals of the original 1969 plan for Uda Walawe in a manner "consistent with the Government's sectoral development objectives of increasing agricultural production, farm income and employment opportunities" (ADB 1984). The overriding objective was to increase agricultural production and water-use efficiency in the RB command area and use resulting water savings for further development planned for the LB area. In short, rehabilitation was needed to take the project to where the 1969-79 construction phase was expected to take it. The project included (ADB 1995): the rehabilitation of the RB irrigation system, including the main irrigation system and on-farm distribution systems; construction of wells for potable water supplies to scattered settlements and village centers; rehabilitation of roads; provision of essential equipment and vehicles to sustain O&M of the system; consulting services and training; and plans to strengthen ongoing adaptive research to promote crop diversification.

While these were the explicit project objectives, the project also contained implicit objectives for MASL, including implementation of intensive training programs in irrigation management at system level and farm level, and increasing the involvement of farmers in irrigation scheduling decisions, regularizing encroachers, adjudicating water conflicts and collecting irrigation fees. The ADB Appraisal report states, "it is believed that under the project, the improved irrigation system with an assured and adequate irrigation supply, regularization of encroachers, intensive training in irrigation management and involvement of farmers in decision making regarding irrigation scheduling, adjudication of water conflicts, and collection of the irrigation service fee will provide the necessary impetus for strong and stable water user groups" (ADB 1984, 16-17).

The estimated cost of the 5-year project at appraisal was US$13.7 million with US$11.0 million in financing from ADB. The project commenced in October 1984 with an estimated completion date of October 1989.

### *Implementation of the rehabilitation works*

The project suffered delays from the onset. More than a year passed before the international consultant, Sir M. MacDonald and Partners (MMP in what follows) was hired and had arrived at the site. MMP was responsible for advising and assisting the local engineering consultants—Central Engineering Consultancy Bureau or CECB—who would do the actual design work. CECB was also responsible for supervising construction. The design work took over 2 years to complete due to a number of factors, such as poor topographical information, problems with earlier plans, and CECB's lack of experience in design works for rehabilitation of irrigation infrastructure. Thus, detailed design plans were not completed until 1988, one year before the planned completion date of the project.

Beyond technical difficulties with project design, work was delayed due to civil disturbances associated with insurgent activities of the JVP (*Janatha Vimukthi Peramuna* or People's Liberation Front) related to the upcoming presidential elections. Insurgents harassed contractors by demanding financial assistance and killed employees of the engineer and contractors. Field staff became reluctant to undertake survey work and hold discussions with farmers about design plans.[21] This difficult situation was compounded by the limited availability of local funds and regular shortages of cement. The Government Treasury did not

[21]JVP insurgents engaged in widespread intimidation of project staff. Curfews were imposed in the project area and that disrupted work. In July 1987, insurgents used a contractor's bulldozer to damage the Mahaweli Economic Agency (MEA) manager's office. Shortly afterward, insurgents burned down the design consultant's office, which resulted in the loss of field notes and survey and design work for Tracts 12-14. Under the guise of security operations, field staffs were stopped and their vehicles seized. A number of field-staff houses were also seized. This created a climate of poor morale and distrust (ABD 1994).

release funds as stipulated in budgetary provisions. The situation was aggravated by SOGREAH's failure to properly estimate costs and incorrect expenditure forecasting that created a higher-than-anticipated demand for local funds. It soon became clear that the actual cost of the project would vastly exceed initial expectations.

In March 1988, the government estimated that to complete the rehabilitation project it would require an additional US$11.6 million in addition to the originally planned US$13.7 million (Nijman 1991). Of this amount, ADB agreed to allocate an additional US$3.8 million to cover the depreciation of the dollar and the government financed US$2.2 million (Nijman 1991). The government approached ADB for a supplementary loan of US$5.5 million but it was declined because of the anticipated low economic return. ADB estimated that, with the supplemental loan, the EIRR for the project, including sunk costs, would be about 7.5 percent. Without the supplemental loan, the downstream tracts of the RB command area would not be rehabilitated. After much discussion, the government applied for and received a loan through the Agricultural Loan Program, which did not contain EIRR requirements. At that time, ADB indicated it would not be willing to fund future work in the LB area.[22]

Beyond rehabilitating the irrigation system, the ADB appraisal report planned for the construction of 100 shallow and 150 deep tubewells for scattered developments. Shallow wells were quickly abandoned because they were recharged from return flows of surface-water irrigation and tended to dry out during the dry season. Little attention was paid to deep-well development early in the project and it was not until June 1990 that a contract was tendered for drilling. Although a 1984 feasibility study by SOGREAH suggested water-quality problems might be an issue (especially salt and fluoride problems), a careful analysis was not completed until 1992 when 186 wells had been drilled. Of these 186 wells, only 40 complied with World Health Organization (WHO) drinking water quality standards; excessive levels of fluoride were identified as a particularly acute problem in addition to high levels of iron. Signs were posted at wells that did not meet WHO water-quality standards stating that the water should not be used for drinking purposes. However, anecdotal evidence collected by International Water Management Institute (IWMI) field staff suggested that many people continued to use these wells for drinking water due to lack of alternative sources.

While the engineering side of the project sputtered forward haphazardly, the Mahaweli Economic Agency (MEA) worked towards creating active water-user groups. In the project area, as elsewhere in Sri Lanka, farmer organizations had been tried in the past with limited success. Government policy required all legally settled farmers to join water-user groups. So officially some 530 water-user or farmer groups existed in Uda Walawe, and they were largely inactive.[23] In late 1986, MEA established a subcommittee charged with the creation, organization and training of more active water-user groups. By 1988, 173 groups were organized and trained (ADB 1995). Despite the efforts, many of these groups quickly became inactive. In 1987, IWMI was asked to provide technical assistance to MEA on how to improve existing irrigation institutions and to propose structural and management innovations to improve project performance (ADB 1995). After an extensive study of the Chandrikawewa Branch Canal, IWMI concluded that the shortcomings of MEA's early initiative with water-user groups was due to: (i) lack of an integrated approach to the water-user group program, (ii) lack of resources to achieve high expectations, (iii) delays in commencing rehabilitation, (iv)

[22]As a result, the government initiated discussions with the Bank of Japan about financing future rehabilitation and development in the LB area of UWIRP.

[23]Encroachers were forbidden from joining water-user groups.

political disturbances, and (v) lack of autonomy among farmers in their relationship with MEA officers (IIMI 1990a). IWMI made two principal recommendations in its report. The first was to improve integration and coordination among various technical divisions operating in the project area and, the second, to create stronger farmer organizations with effective communication channels to MEA staff.

IWMI also highlighted the lack of farmer involvement in the design process (IIMI 1990b). Up to this point, farmers were effectively excluded from the design process for the project because of the marked tendency towards centralized decision making that characterized project planning and implementation in Uda Walawe from the onset. In an attempt to rectify the situation, CECB consultants held discussions with farmers once construction began to explain rehabilitation plans, obtain suggestions and make changes if possible. These discussions continued through the remainder of the implementation period and "substantially improved the establishment of distributary and field canal farmer groups by the MEA" (ADB 1995).

Farmers also became involved in the construction process when, in 1990, MASL moved away from large-scale contracts toward medium- and small-scale contracts for construction projects, and farmer groups were allowed to bid for small-scale projects.[24] The choice of involving farmer groups in small-scale contracts was motivated by two additional compelling factors: "to foster a sense of ownership amongst the farmers and a recognition of mutual responsibility for repairs and maintenance, and to develop technical and organization skills amongst the group" (ADB 1995). This concept, which evolved from IWMI's research on farmer organizations, envisioned that farmer organizations along each canal would participate in the rehabilitation of their canal while earning additional income. Initially, the concept worked well. However, farmers became disillusioned because payments were made to farmer organization leaders and many of them skimmed unusually high "overhead costs" before dispersing payments to other farmers.[25]

Between 1990 and 1993, IWMI worked collaboratively with MEA to develop and demonstrate systems for strengthening farmer organizations and for planning preseason maintenance and water deliveries in the Moraketiya branch canal (the main branch canal of the upper right-bank area). This process fostered mutual understanding on both sides. Based on this case study, a carefully structured program for establishing and strengthening farmer organizations was launched in 1993. A major impetus for this work was the strong political opposition to the 1984 government policy that significantly increased per unit area (per acre) assessments for system O&M and stepped up collection efforts. By 1988, the national irrigation O&M policy was repealed and replaced with one that required farmers to share in system O&M. Under this program, the O&M of the distributary and field canals were to be handed over from MEA to farmer organizations (FOs).

The 1994 ADB report anticipated that FOs would take full responsibility for the O&M of distributary and field canals by the late 1990s. This was a very optimistic assessment since many of the FOs had still not become self-sustaining and autonomous. Like elsewhere, the effectiveness of the participation process was constrained by the lack of real control by users over water allocation and distribution, the latter

[24]During the same period, MASL terminated the services of CECB as a cost-saving measure and opted for in-house engineering services from the Mahaweli Engineering and Construction Agency (MECA).

[25]However, there were exceptions in the distribution of profits among farmer organizations. In the Moraketiya branch canal area near Embilipitiya, farmers worked on a *shramadana* (voluntary labor) basis and used the profits to set up a fund to lend money to lower-income farmers for fertilizers (ADB 1995).

being partly constrained by structural limitations resulting in supply uncertainties. One overriding obstacle to the turnover of O&M to farmers was the system of patronage developed at Uda Walawe.

In addition to organizing and engaging farmer and water-user organizations, MEA extension staff made a tremendous effort to increase crop diversification. MEA instituted a mandatory fallow period and introduced faster maturing rice varieties. In 1988, MEA began an aggressive diversification program that included training, field demonstrations, and provision of seeds and seedlings for OFCs (ADB 1995). This worked to increase production of OFCs. In 1984, OFCs were cultivated on only 5-6 percent of irrigated land. By 1994, this proportion had increased to roughly one third of the area, due to the expansion of banana cultivation. It is hard, however, to separate the combined effects of extension efforts, declining rice prices and occasional water shortages.

Banana production was a great crop diversification success. Banana was cultivated in the lower part of the project area in the 1980s, but extension efforts mediated by influential pilot farmers and technicians from MASL led to a spectacular spread of its cultivation. The results were remarkable. By 1994, bananas grew on approximately 1,500 ha (14%) of the 10,500 ha under production in the RB area (ADB 1995) and reached 4,333 ha (out of 14,000 ha) in 2003. The adoption of this high-value crop significantly boosted farm income and the whole economy of the Embilipitiya town. While other diversification efforts resulted in short-term conversion to OFCs, very little land converted to bananas reverted to rice, although this has not been uncommon during the past two years.

## Phase IV: LB Rehabilitation and Extension—1995-2005

Prior to completion of the RB rehabilitation and improvement project, the Government of Sri Lanka approached the Government of Japan for assistance to conduct a feasibility study for upgrading and extending the LB command area. The Government of Sri Lanka initiated these discussions in 1987 after ADB indicated it was no longer interested in financing further work in the LB area. Despite the poor operational and financial performance of past investments in UWIRP, the Government decided to further develop the LB and complete the project as originally planned in 1969. This decision was made “in order to fully utilize and recover past investment and ease the ever increasing population pressure in the south of the country” (Nippon Koei and MASL 1995).

In 1991, the Japan International Cooperation Agency (JICA), working with MASL, commenced a feasibility study for agricultural development in the LB area, which report was issued in 1992. The plan involved three basic structural elements: (i) rehabilitation of existing irrigation facilities in the “Old” area, (ii) construction of new irrigation facilities in the “Extension” area, and (iii) improvements in rural infrastructure (Nippon Koei and MASL 1995). In 1993, the Government of Sri Lanka requested financial assistance from the Government of Japan to implement the LB Irrigation and Upgrading and Extension project.[26] The Overseas Economic Cooperation Fund of Japan conducted an appraisal in 1994 and agreed to provide financing for the engineering aspects of the project (Nippon Koei and MASL 1995).

[26]In 1993, Sri Lanka asked Japan for an aid grant to provide “urgently required development components” of the LB project, including road improvements, water-supply facilities at Suriyaweva, and procurement of water tankers to deliver drinking water to scattered settlers (Nippon Koei and MASL 1995). The grant was approved in 1993. With design work by JICA, construction began in 1994 with completion expected in 1995.

In 1995, Nippon Koei was hired to review and update the 1991/92 feasibility study conducted by JICA.[27] From their perspective, the objectives of the rehabilitation and extension project were to increase food self-sufficiency by increasing rice production, increase production of OFCs, increase employment opportunities, mitigate environmental degradation, boost regional economic development, and alleviate poverty (Nippon Koei and MASL 1995). The scope of the project conformed to the earlier feasibility study; however, the review suggested changes in cropping patterns, rural infrastructure development and implementation schedule.[28]

Nippon Koei estimated the complete cost for the project at US$144 million (1995 prices), which included US$34 million for the rehabilitation and upgrading of the “Old” area and US$110 million for the development of the “Extension” area. The implementation schedule included two phases. The first phase involved rehabilitation of the Old area with construction beginning in 1997 and completion in 1999. The second phase involved development of the Extension area with construction commencing in 1999 and completion by 2003.[29]

Nippon Koei concluded that the project was “technically feasible and economically sound, and the adverse environmental impacts could be minimized by mitigation measures” (Nippon Koei and MASL 1995, p. S-6). The economic justification for the project included an estimated EIRR of 17.8 percent and a cost-benefit ratio of 2.16, using a project period of 50 years and a 10 percent discount rate. The estimated EIRRs for the Old area and Extension area were 11 percent and 22 percent, respectively. Estimates of benefits were based on a projected tenfold increase in farm income from US$293 to US$2,927 (Rs 15,000 to Rs 150,000) per hectare per year, which seems overly optimistic at best (Nippon Koei and MASL 1995).

In 1996, rehabilitation and modernization works began in the Old area. In 2003, the rehabilitation within the Old area was completed and construction of infrastructure for the Extension area was begun with hopes for a first irrigated cropping season in yala 2004 (in at least half of the area). It is too early to know what will be the impact of the inclusion of this new area on the management of the whole project.

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[27]The terms of reference for Nippon Koei’s work included several objectives: (1) ensure that proposed cropping patterns are based on realistic assumptions; (2) identify the impact of the crop diversification policy on water requirements, water supply and canal/structure designs; (3) conduct a domestic and international marketing study for agricultural products; (4) study the feasibility of establishing an agricultural credit system; (5) estimate the price elasticity of demand for agricultural products; (6) examine the potential for constructing marketing infrastructure for agricultural products; (7) conduct a detailed environmental study; (8) review and update the proposed settlement plan; (9) review and update the previous study on water and land resources, including hydrological analysis; and (10) design a concept for on-farm development accounting for O&M of irrigation facilities (Nippon Koei and MASL 1995).

[28]The proposed changes to cropping patterns involved the replacement of sugarcane with other OFCs because the government had failed to find a private buyer for the Sevanagala sugar mill. The review also suggested changes in rural infrastructure development. Based on findings by MASL, Nippon Koei recommended consolidating the number of village settlements, from 22 to 12, and increasing the number of families per settlement area. They also recommended increasing the role of international consultants in the implementation process due to MASL’s decision to play a reduced role in construction management and supervision.

[29]The implementation has been delayed by 2 years.

## Project Performance

This section examines planned versus actual outcomes for a number of key variables, such as costs, implementation period, irrigated area, irrigation intensity and yields. To place the experience of UWIRP in context, these findings are compared to the performance of other irrigation projects, where possible.

### Capital Costs: Actual vs. Predicted

From its inception and through successive phases of investment, UWIRP experienced substantial cost overruns.

Table 1 shows the estimated cost at appraisal and actual cost at completion for various phases of investment. In 1969, the estimated cost of the entire UWIRP was US$269.6 million (Rs 13,479 million in 1995 prices) for the headworks, irrigation facilities and downstream development of 32,937 hectares. Actual investment costs from 1964 to 1995 were US$322.92 million (Rs. 16,146 million in 1995 prices) plus the proposed costs of the LB upgrading and extension project, which yielded an estimated total cost of US$466.9 million (Rs 23,345 million), resulting in a cost overrun of 73 percent. This estimate assumes that the entire project is completed as envisioned. If investments are tallied through 1995, the cost overrun escalates rapidly.

While the costs of the project were 73 percent higher than anticipated, the irrigable command area for the project fell significantly short of what was planned. By 1995, only 55 percent of the planned command area was irrigable. Thus, in 1995 the actual cost per irrigable unit area was roughly double what was anticipated in 1969. These data suggest that not only did costs substantially exceeded expectations, but actual benefits—measured by command area—fell far short of those anticipated.

Cost overruns characterize each phase of development in UWIRP, with overruns of 27 percent and 85 percent, respectively, for the ADB-financed RB downstream development project and the subsequent rehabilitation project. A number of factors contributed to cost overruns over the years, including poor estimation of costs, design and construction problems, implementation delays, difficulties with

TABLE 1.
Cost performance by phase of development (1995 prices).

| Project | Cost at appraisal | Cost at completion | Overrun (%) |
|---|---|---|---|
| | | Million | |
| Entire project: 1969-2005 (estimated)[a] | US$269.5 (Rs 13,479)[b] | US$466.9 (Rs 23,345)[c] | 73 |
| ADB-RB downstream: 1969-1978 | US$26.45[d] | US$33.63[d] | 27 |
| WIIP: 1984-1994 | US$13.7[e] | US$25.3[e] | 85 |
| LB upgrade and extension | Upgrade: US$33.5[f]<br>Extension: US$110[f] | Project ongoing | Project ongoing |

[a] “Entire project” as defined by the 1969 Government Plan, which estimated the total irrigable area available for development as 27,357 ha (67,600 acres). This area included 3,432 ha of already developed land.

[b] Appraisal cost equals 1969 total plan of development costs of Rs 430 million expressed in 1995 prices (GOC 1969).

[c] Completion cost equals total stream of actual investment costs from 1964 to 1995 plus expected costs of LB upgrade and extension project expressed in 1995 prices (*Source:* Nippon Koei and MASL 1995).

[d] *Source:* ADB 1979.

[e] *Source:* ADB 1995.

[f] *Source:* Nippon Koei and MASL 1995. June 1995 prices (US$1.00 = Rs 50.00).

contractors and unanticipated external factors such as the civil war disruptions.

A review of available literature on other dam and irrigation projects suggests a marked tendency towards cost overruns. A meta-analysis of nine different projects conducted by the World Commission on Dams (WCD 2000) revealed an average cost overrun of 54 percent. To verify the validity of these findings, WCD conducted a survey of 81 dam projects and found the average cost overrun was 56 percent. However, cost performance varied substantially. Of the total sample, 25 percent cost less than anticipated and 75 percent experienced cost overruns. Multipurpose dams, like the Uda Walawe reservoir, showed substantial variability ranging from a cost underrun of 22 percent to a cost overrun of 180 percent. Performance was worst in South Asia with average cost overruns of 138 percent. A similar exercise by ADB revealed an average cost overrun of 16 percent for 23 projects completed between 1968 and 1999 (Lagman and Aylward 2000). Another comprehensive study conducted by the World Bank's Operations Evaluation Department found that large dams financed by the Bank experienced an average cost overrun of 39 percent (World Bank 1996).

Another measure of project performance is the economic internal rate of return (EIRR). The EIRR or cost-benefit analysis (CBA) or both are typically used to provide economic justification for an investment. From the perspective of most multilateral development banks or agencies, economic viability requires an EIRR of at least 10 percent.

Table 2 shows the EIRR for various phases of investment in UWIRP at appraisal and completion. The EIRR at appraisal, which ranged from 10 to 17.8 percent, plummeted to about 7 percent upon completion. This suggests that, based on the EIRR threshold criterion of 10 percent used by ADB, none of these investments were economically viable. The importance of the EIRR in decision making is discussed in the section on the Decision-Making Process (page 38).

## Implementation Schedules

The planned versus actual amount of time to implement a project also provides an important performance measure. Delays in implementation lead to escalations in costs and reductions in benefits. UWIRP experienced substantial delays in all aspects of the project except the construction of headworks at the initiation of the project (see table 3).

The implementation delays in UWIRP generally concur with experience in many other irrigation and rural-development projects, suggesting a systematic bias in underestimating the project implementation period. A 1995 review of 57 ADB-funded projects in the rural-development and irrigation sector found that "all except two programs and one project, experienced delays averaging three years … projects in the irrigation subsector had the longest

TABLE 2.
Economic internal rate of return (EIRR) and cost-benefit analysis (CBA) at project appraisal and completion.[a]

| Project | At appraisal | At completion | Overestimate |
|---|---|---|---|
| ADB-RB downstream | EIRR = 12%[b] | EIRR = 7%[(b)] | 5% |
| WIIP: 1984-1994 | EIRR = 10%[c] | EIRR = <7.5% | >2.5% |
| LB upgrade and extension | EIRR = 17.8 (17.4)[d] | Project ongoing | Project ongoing |

[a] An EIRR was not estimated at the inception of UWIRP.

[b] ADB 1984, Appendix I, page 46.

[c] This is the most pessimistic EIRR as it includes "sunk" costs of investment since 1964. However, it *only includes* 60 percent of the cost of the dam.

[d] The revised value appearing in Nippon Koei (1997) is 17.4. The EIRR for each area of the LB is 12.7 for the "Old" area and 19.9 for the "Extension" area.

TABLE 3.
Planned and actual implementation period by phase of investment.

| Project | At appraisal | | Actual | Overrun |
|---|---|---|---|---|
| | Period (years) | | | |
| Entire project | | 11 | To be completed | 38 (245%) |
| Headworks | | 3 | 3 | 0 |
| ADB-RB downstream | | 3 | 7 | 4 (133%) |
| WIIP: 1984-1994 | | 5.5 | 10 | 4.5 (82%) |
| LB upgrade and extension | Phase I: | 2 | 6 | 4 (200%) |
| | Phase II: | 4 | Project ongoing | Project ongoing |

average time overrun of 3.7 years" (ADB 1995). A similar evaluation of 99 projects by the World Commission on Dams (WCD) found that only half were completed in the estimated period of time. Of the remaining 50 percent, about 30 percent had delays of 1-2 years, 15 percent had delays of 3-6 years and the remaining 5 percent had delays of over 10 years (WCD 2000).[30]

## Irrigated Area: Planned vs. Actual Outcomes

Table 4 shows the planned versus actual command area for UWIRP for successive phases of investment. Only half of the originally planned command area was developed by 2000.

The actual irrigated area provides a better measure of performance than the project command area, which is the potential irrigable area under the project.

Table 5 shows the planned and actual changes in irrigated area for various phases of investment. The actual irrigated area has consistently fallen substantially short of project plans. For the ADB-funded RB downstream development project, actual irrigated area fell 47 percent short of the planned area.[31] For the subsequent Walawe Irrigation and Improvement Project (WIIP), actual irrigated area fell 17 percent short of planned irrigated area. Although irrigated area has fallen short of expectations, it has increased steadily since 1971.

Figure 4 shows this change by season, including three seasons with severe water shortage when cropping areas were drastically reduced (yala 1977, yala 1992, and maha 2000/2001).

A WCD survey of 76 dam irrigation projects found that poor performance, as measured by irrigated area, was particularly pronounced in the early years of a project. Over time, irrigated area generally increases, usually beginning around the 5th year of the project continuing to the 30th year (WCD 2000). These findings are consistent with those experienced in UWIRP and with observations by Berkoff (2002) that irrigated area and cropping intensity targets are often overstated by significant amounts but that over time the gap between planned and actual irrigated area tends to narrow.

[30]The most commonly reported causes of implementation delays include shortage of funds, institutional deficiencies including poor coordination among executing and implementing agencies, optimistic assumptions about implementation schedule at appraisal, repair and remedial works, changes in project scope and design, lack of farmer participation during implementation, and other external factors such as civil disturbances, political instability, inadequate capacity of local contractors, and shortage of local supplies and materials (WCD 2000).

[31]The improvement in water duty shown for the 1982-84 period, when MASL took over the management of the scheme is quite high and is said to result from stricter definition of calendars and scheduling. However, there is some doubt on the validity of the data (Nijman 1991). In particular, cultivated areas seem to have been overrated.

TABLE 4.
Planned and actual command areas of the phases of UWIRP.

| Project | At appraisal | At completion | Deviation |
|---|---|---|---|
| | Command area (ha) | | |
| Entire project | 32,793 | 17,615[a] | –15,178 (–48%) |
| ADB-RB downstream | 12,369 | 10,978 [b] | –1,391 (–11%) |
| WIIP: 1984-1994 | ~12,000 | 11,901 | Small |
| LB upgrade and extension | Phase 1: 2,900 | Phase 1: Ongoing | |
| | Phase 2: 6,380 | Phase 2: Ongoing | |

[a] Command area as of 2000.

[b] RB Tracts 20-21 (1,391 ha) were dropped from the project after a 1972 review due to lack of sufficient water resources.

TABLE 5.
Actual and planned irrigable areas at project appraisal and completion.

| Project | At appraisal | | At completion[c] | Change at completion against: | |
|---|---|---|---|---|---|
| | Actual[a] | Planned[b] | | Actual[d] | Planned[e] |
| | Area (ha) | | | % | |
| Entire project | M: 2,750 | M: 32,793 | | | |
| | Y: 2,750 | Y: 32,793 | N/A | N/A | N/A |
| | T: 5,500[f] | T: 65,586 [h] | | | |
| ADB-RB downstream | M: 3,017 | M: 12,369 | M: 7,024 | M: +132 | M: –43 |
| | Y: 2,309 | Y: 12,369 | Y: 6,036 | Y: +161 | Y: –51 |
| | T: 5,326 [g] | T: 24,738 | T: 13,060 | T: +145 | T: –47 |
| WIIP: 1984-1994 | M: 8,632 | M: 12,000 | M: 10,447 | M: +121 | M: –13 |
| | Y: 7,607 | Y: 12,000 | Y: 9,494 | Y: +125 | Y: –21 |
| | T: 16,239 | T: 24,000 | T: 19,941 | T: +123 | T: –17 |

[a] Actual irrigated area at appraisal

[b] Planned irrigated command area at appraisal.

[c] Actual irrigated area upon completion of project.

[d] Percentage change in actual irrigated area before and after project.

[e] Percentage of actual to planned irrigated area upon completion of project.

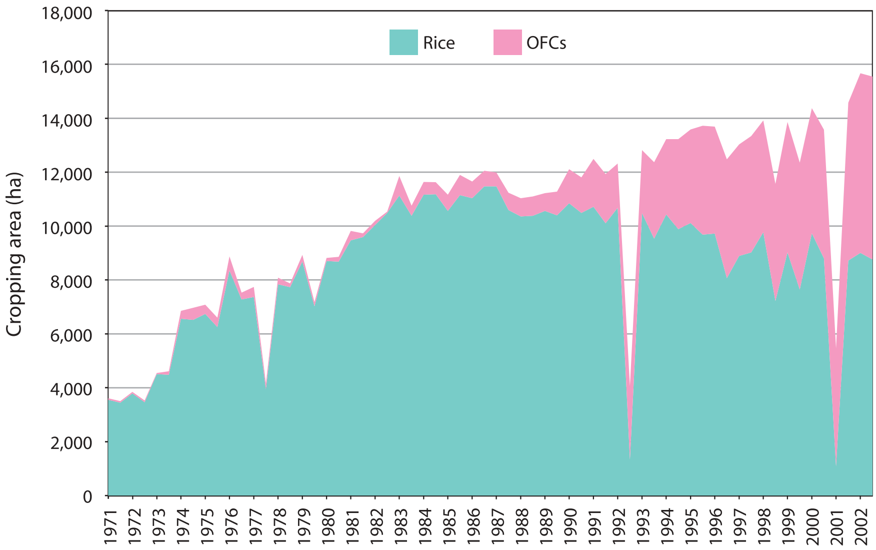
[f] From ADB (1969).

[g] 1970/71 average for RB command area only (ADB 1979, Appendix 10).

[h] From Hunting (1968a).

*Note:* M = maha; Y = yala; T = total; N/A = not available.

FIGURE 4.
Irrigated cropping area of UWIRP, 1971-2000.




### *Cropping Intensity*

Table 6 shows cropping intensity[32] at appraisal—both planned and actual—and at completion for two phases of investment. In both phases, the actual cropping intensity fell short of the planned cropping intensity. (Average irrigation intensities declined under the ADB-funded RB downstream project because per hectare water deliveries did not keep pace with expansions in the command area.)

TABLE 6.
Cropping intensity, actual and planned.

| Project | At appraisal | | At completion | Change (%) | |
|---|---|---|---|---|---|
| | Actual | Planned | | Actual | Planned |
| Entire project | N/A | 2 | Project ongoing | Project ongoing | Project ongoing |
| ADB-RB downstream | 1.69[a] | 2 | 1.21[b] | –28 | –61 |
| WIIP: 1984-1994 | 1.34[c] | 1.85 | 1.68[d] | +25 | –11 |

[a] Actual estimated, based on command area in Tracts 1-7 and Chandrikawewa of 3,679 ha (9,091 acres) and actual irrigated area for 1971, which was chosen because irrigated area in 1970 was unusually low with an irrigation intensity of 1.2.

[b] Average intensity for rehabilitated area (Tracts 1-7 and Chandrikawewa) and new area (Tracts 9-19). However, there was wide variation in irrigation intensity between upper and lower areas. The upper areas had irrigation intensities ranging from 1.46 to 1.78 and the lower areas had intensities ranging from 0.43 to 0.90 (ADB 1979; PRC 1982, Appendix 8, p. 2).

[c] RB only. There was wide variation in irrigation intensities between the upper and lower command areas ranging from 200 percent in upper areas to 40 percent in lower areas.

[d] ADB 1995; PRC 1982.

*Note:* N/A = not available.

[32] Cropping intensity (CI) is the ratio of the total crop area cultivated during one year to the command area (e.g., CI = 2 indicates full double cropping).

## Costs and Benefits of UWIRP

At the outset, irrigation projects promise substantial economic benefits, including increased value of agricultural production and boosts to the local economy through demand for agricultural inputs, marketing and transport of outputs, and increased employment opportunities. Estimates of these benefits, particularly the value of agricultural output, have been used in conjunction with capital costs to justify project investments through cost-benefit analysis (CBA). Generally, cost-benefit analyses, as practiced to justify investments in UWIRP over the last 50 years, have been limited to an assessment of direct benefits generated by increases in cropping area, cropping intensity and yield and direct investment costs. This section examines some of the benefits and costs of UWIRP. Beyond measures of direct benefits, preliminary estimates of some indirect benefits are provided, including domestic use of water, indirect irrigation of home gardens, fisheries, hydropower generation, the National Park, and economic multiplier effects. Estimates of cumulative capital costs are also provided. Because estimates of indirect costs—negative externalities—are not captured in this analysis, a full social cost-benefit analysis is not provided.

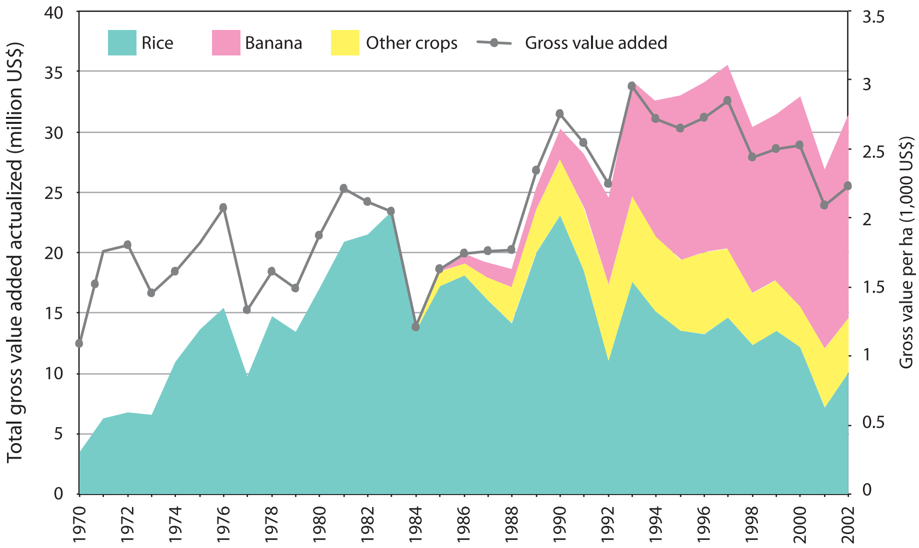
### Crop Production

The primary intended economic benefit of an irrigation scheme is, of course, the increased value of agricultural production due to increases in cropping area, cropping intensity and yield. Figure 5 shows the gross value of agricultural crop production over the period 1970-2002, expressed in 2002 US$ prices using the agricultural GDP as a deflator. It shows an upward trend in the gross value of rice until 1984. In the 1990s, the value of rice decreases both in absolute and relative terms, due to the expansion of banana cultivation. The expansion of banana—a high-valued crop—substantially increased the total value of agricultural output. Other OFCs also contribute significantly to that change.[33] In 2002, the gross value of banana was US$18.8 million (Rs 1,790 million) against US$11.2 million (Rs 1,066 million) for rice and US$4.9 million (Rs 474 million) for other crops. Figure 5 also shows the gross value of output per hectare. The 1990s show a gain in the gross value added per hectare of approximately 50 percent from the 1970s, due to both rehabilitation and expansion of banana cultivation.

The net benefit attributable to the project is the gross value of agricultural output less production costs. The question of whether family labor and hired labor used must be assigned an appropriate opportunity cost is debatable. In the case of an open economy with alternative economic activities this is probably the case. But when there exists high levels of unemployment (approximately 30% in Hambantota district, despite the project and other similar ones in the Kirindi Oya basin) it cannot be assumed that in the absence of the project the whole labor force would have readily shifted to alternative activities. In the case of a settlement such as UWIRP, which relieves local agrarian pressure by providing occupational opportunities that are lacking in the locality, the opportunity cost can be hypothesized to be quite low. A review of different assessments of production costs in rice production since the beginning of the project did not yield a clear picture of the evolution of the relative weight of the different categories of costs. On average, production costs amounted to 45 percent of the gross added value, 40 percent of these costs being ascribed to labor, including both family (30-50%) and hired labor (50-70%). To

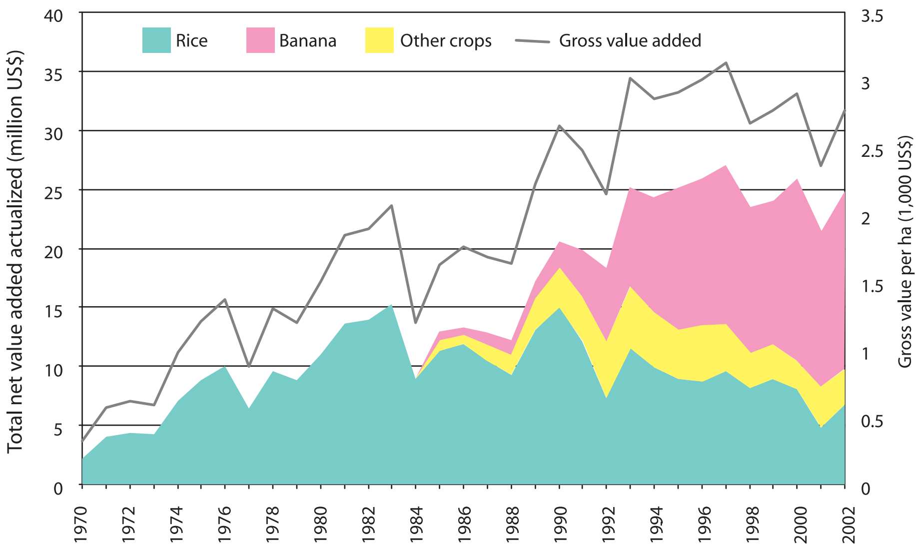
[33]Insufficient information is available on OFCs prior to 1984, but the area was very limited (e.g., less than 405 ha or 1,000 acres). OFCs include sugar cane, the current area of which has been taken at 3,000 ha based on remote sensing evidence. This is almost twice the official area but the latter number is admittedly understated in order to reduce the per area water charges to MASL.

FIGURE 5.
Gross value added of crop production of UWIRP in 2002 US$ values.




*Notes:* US$1.00 = Rs 95.40 in 2002.
Insufficient information is available on OFCs prior to 1984, but the area was very limited.

FIGURE 6.
Net value added of crop production of UWIRP in 2002 US$ values.




*Notes:* US$1.00 = Rs 95.40 in 2002.
Insufficient information is available on OFCs prior to 1984, but the area was very limited.

strike a balance between these different approaches, we have tentatively chosen to value labor costs at half of the opportunity cost taken as the daily wage.

Cost-benefit analyses should not compare before- and after-project situations but with- and without-project situations. This means that even if the project is not implemented, changes are going to take place. In the case of UWIRP, one may assume that the sugar cane area would have developed under rainfed conditions (just as it did outside the boundary of the project) and that part of the area under UWIRP would have been cultivated under chena (or permanent rainfed crops). We must therefore deduct from the net benefit of the project the net benefit from such rainfed agriculture, assuming tentatively that it would have expanded gradually from pre-project conditions up to 60 percent of the total UWIRP net area in 2002. Figure 6 shows net economic value added for agricultural production from 1970 to 2002, which equals the gross value of agricultural output less the costs of production (including labor) and benefits that would have occurred in absence of the project (e.g., the "without-project" benefits).[34]

## Domestic Water Use

The homesteads of settlers are dispersed throughout the project area. An undulated relief with many intermittent small streams and quick-dropping shallow aquifers characterizes the Walawe plain. This means that in the absence of small tanks no permanent source of water is available to humans. Infiltration of water from the canal network and rice fields has replenished shallow aquifers supporting scattered development in the project area (Meijer 2000). Along main canals and along riverbeds, people obtain water from shallow wells that are used primarily for drinking purposes. Boelee and van der Hoek (2002) have found that in one location along the left bank project area, groundwater levels closely followed changes in canal water releases and that canal seepage accounted for 74 percent of groundwater recharge.

Since the great majority of the settlers within UWIRP use wells for drinking water, understanding its value is important for future decision making. The value of drinking water is estimated using a replacement cost approach. An Irrigation Department study found that water users obtained about 20 liters per day per capita from shallow wells and other "nonprotected" sources. The minimum basic need for water from a human rights perspective has been estimated at 50 liters per day per capita (Gleick 1996). The benefits derived from the wells can be valued by estimating the cost of providing an amount of water equivalent to the volume abstracted. Recent communal water supply projects in the region, mostly based on wells, showed a cost of Rs14/$m^3$, assuming a project lifetime of 20 years. To estimate the value of drinking water in the project area an average cost of Rs 15/$m^3$ is used. This estimate seems reasonable especially when one considers that the Lunugamwehera Water Supply Scheme, in the neighboring Kirindi Oya basin, provides drinking water at a cost of Rs 21/$m^3$, including amortization and operation and maintenance costs.[35]

Based on an average replacement cost of Rs 15/$m^3$, an average current usage of 20 l/capita/day and a population estimate of 120,000,[36] the economic value of drinking water is conservatively estimated at US$0.14 million (Rs 13 million in 2002 values).[37]

[34]The value from rainfed cultivation has been deducted from all crop categories proportionate to the planted area.

[35]For a project lifetime of 20 years, a daily production of 5.2 $m^3$ provided to approximately 45,836 beneficiaries with running costs of Rs 0.74/$m^3$.

[36]Only one third of the population in the basin has access to pipe water. 120,000 corresponds to two thirds of a population of approximately 180,000 people in the lower Walawe basin.

[37]This estimate can be considered very conservative as it uses a relatively modest per cubic-meter rate and 20 liters/capita rather than 50 liters/capita as the basic necessity usage.

In addition, project canals are widely used for other domestic uses such as for laundry and personal hygiene that have economic value. They also serve important social functions. A tour of the canals in the late afternoon demonstrates their widespread use, particularly for social interaction and recreation for the children. Although these uses clearly have economic value, these values have not been measured.

## Home Gardens

The homesteads of settlers are spread over all the highlands bordering the irrigated areas. Recent remote sensing imagery shows that most land in the project area is now developed and that while settlements are, in general, not very dense they include significant areas of home garden. The settlers highly value these home gardens for their produce, shade and aesthetic value. Most home gardens have varied fruit trees (coconut, mango, jackfruit, breadfruit, areca nut, etc.), vegetables, bamboo groves, and shrubs and trees that provide building materials, firewood and material for handcrafts and medicinal use (Renault et al. 2000). These home gardens also provide shade and additional communal living space.

The development of these gardens around homesteads would not be possible without project water. This is proven by observations made in areas where canals have been lined. Lining reduces the recharge of the aquifer, hence reducing water availability in the root zone of trees, resulting in smaller fruits that often fall before reaching maturity (Meijer 2000). The link between irrigation canals and trees is also evident from the expansion of home gardens. Figure 7 shows the extent of home gardens in the UWIRP area in 1999. These gardens, which are now a prominent feature of the landscape, constituting 28 percent of the land use (18,000 ha), were virtually nonexistent prior to the commencement of the project, as indicated in the 1956 land-use map.

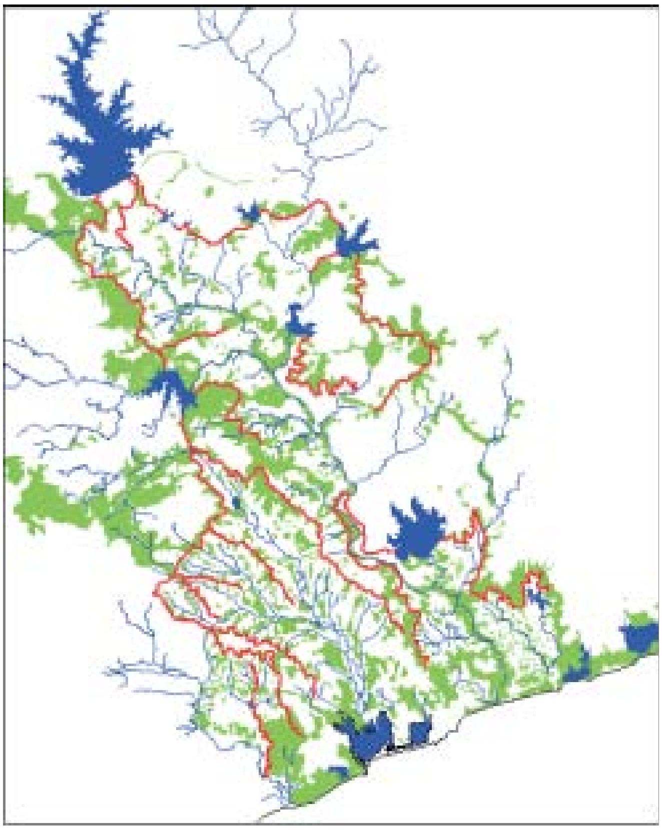
This “unanticipated” development of home gardens and their fruit trees that feed on the water table replenished by infiltration from canals and rice fields, is generally overlooked. Research carried out in the neighboring Kirindi Oya basin (Renault et al. 2000) found that as much as 55 percent of the total evapotranspiration in the Kirindi Oya irrigation scheme came from noncrop vegetation (against 28% from crops).

To assess the production of these homestead gardens, a survey of their composition and production has been carried out on a sample of 19 different plots averaging 0.24 ha (0.6 acre). The survey measured the composition and quantity of different home-garden products including medicinal herbs, fuel wood, bamboo, fruit trees and timber. Home-garden products are both consumed at home and sold in local markets. The value of total production, whether consumed or sold, was estimated at prevailing local-market prices.

The results of this analysis suggest that the productivity of 0.405 ha (one acre) of home garden is extremely high and the average gross product of fruits was recorded at US$248 (Rs 23,611) per year, including US$185 (Rs 17,600) for marketed produce and US63 (Rs 6,011) for the produce consumed at home.

In addition to fruit, timber is another valuable home-garden product. The value of timber found in the garden surveyed was estimated at US$4,965 (Rs 473,700) on average, based on the size and number of trees and market prices. Trees are cut at an average age of 25 years. Allocating the value of timber produce over 25 years yields an additional gross value of US$198.6 (Rs 18,948) per year for home-garden produce.

FIGURE 7.
Home gardens (in green) in the UWIRP area: 1999.



To estimate the value of home-garden produce for the entire UWIRP project area, we used 70 percent of the homesteaded area as appearing on satellite images to account for roads, houses, and other non planted areas, giving us a net area of 13,000 ha. The total fruit production is therefore worth about US$8 million (Rs 762 million) per year, to which can be added a timber value of US$6.40 million (Rs 611 million; considering a 25-year lifetime), giving a total value of US$14.4 million (Rs 1,373 million) per year.[38]

It can be argued that in the absence of the project some rainfed home gardens would have been developed and that even though their composition would have been different, their value should be deducted from the full benefits assessed above. Given the limited occurrence of home gardens in fully rainfed areas in the dry zone and the lack of data to assess their value, these have not been considered in this analysis.

## Reservoir Fisheries[39]

Fisheries located in project reservoirs are often a neglected benefit of rural-development projects (Renwick 2001). Fisheries provide alternative income-generating opportunities and needed sources of protein for the rural poor without

[38]Production costs (seeds, possible treatments, etc.) are neglected here. This may compensate for the non-consideration of home gardens located along the main canal out of the command area.

[39]This section is drawn from Perera 2003.

consuming any water. They also may provide indirect malaria control, as fish consume mosquito larvae, and support piscivorous bird species. This section examines the economic contribution of fisheries in project reservoirs and canals to UWIRP.

In 2003, IWMI carried out a survey of reservoir fishery activities in UWIRP. This survey revealed the important role of fisheries in the project area. Over 1,600 families are involved in inland fishing in UWIRP, of which about 660 families are involved on a full-time basis and the rest use fishing as a means to supplement family nutritional needs or incomes. In addition, about 140 "middlemen" such as "bicycle fish sellers" and other retailers depend directly on fishing for their livelihood.

Survey work and related studies by Perera (2003) showed that in UWIRP an abundant fish catch is obtained from a diversity of water sources, amounting to a yearly aggregate of 1,600 metric tons (table 7). The largest catch is from the Uda Walawe reservoir, which accounts for about 35 percent of total production. An estimated 86 percent of the total catch is sold to retail markets and the remainder (14%) is used for home consumption. The estimated gross annual value of fish equals annual market sales of approximately US$691,000 (Rs 67 million) plus the value of fish consumed at home of US$103,000 (Rs 10 million; see table 7), amounting to roughly US$794,000 (Rs 77 million) per year. Including only the catch that is contained within the UWIRP project areas (e.g., Walawe, Chandrika and Kiri Ibban reservoirs and production in small tanks and irrigation canals within the UWIRP project area[40]) the gross value of the reservoir fishery catch is approximately US$567,000 (Rs 55 million) a year.

The economic contribution of fisheries equals the gross value of the total catch less costs incurred in catching fish. In a detailed survey of fishing costs in the nearby Kirindi Oya project, Renwick (2001) found that monetary costs of fishing are relatively uniform among fishers and roughly equals 20 percent of the value of the catch. Deducting 20 percent of the value of fisheries within UWIRP to cover production costs from above estimate, the net economic value of inland fisheries is US$454,000 (Rs 44 million) per year.[41]

This value is augmented if we consider the economic activities of well-organized middlemen in fish markets, notably in the Embilipitiya town. Like the fish vendors on bicycle who buy fish from fishers and sell it in towns, these middlemen also make handsome profits. But, in contrast to the revenue accruing to fishermen, this revenue is appropriated by only a few operators who tend to agree and fix prices among themselves. This type of market failure seems to be quite common in the area and it also concerns other agricultural products. Since these middlemen usually buy fish at US$1.03 (Rs 100) per kilogram and sell it at US$2.06 (Rs 200) per kilogram, we may tentatively take half of the profit as value added, allowing for both costs of marketing and the likely non-competitiveness of the market. Then the final rough estimate for the yearly net added value is US$743,000 (Rs 72 million), with benefits spread across households (home consumption), fishermen and middlemen.

Despite the importance of present production, there seems to be significant scope for improvement of fisheries. Management and control of fisheries are totally lacking in most of the tanks, with the exception of the Uda Walawe reservoir and one small tank. Most fisheries societies are declining mainly due to lack of necessary guidance and assistance from the implementing agency—the National Aquatic Development Authority. The lack of institutional infrastructure for fisheries stems from a history

[40]Of the small tanks 47% are within Uda Walawe. The most productive tanks are in fact those located within UWIRP and which benefit from the return flow of irrigation areas (or sometimes direct releases from main canals).

[41]If noncash costs (including depreciation of owned boats, household labor used for maintenance and repair of boats and nets, etc.) are included, total costs amount to 33%, leaving a net benefit of Rs 36 million.

TABLE 7.
Reservoir fisheries in UWIRP: Production and gross value.

| Water sources | Total production (t) | CPUE (kg) | Home consumption (kg/day) | Total consumption (kg) | Quantity sold (t) | Selling price (Rs) | Value of sales (Rs) | Monthly income (Rs) |
|---|---|---|---|---|---|---|---|---|
| Small tanks | 311.1 | 8 | 1.3 | f5.5 | 255.6 | 52.00 | 13,530,421 | 6,065 |
| Medium tanks | 157.5 | 15 | 1.5 | 30.7 | 126.8 | 59.00 | 7,541,460 | 8,174 |
| Mau ara | 120[a] | 13.3 | 1.5 | 13.5 | 106.5 | 50.00 | 5,325,000 | |
| Kiri Ibban tank | 12.9 | 7.5 | 1.0 | 3.4 | 9.5 | 50.00 | 475,200 | 3,645 |
| Ridiyagama tank | 241.9 | 23 | 1.01 | 18.3 | 223.6 | 45.00 | 9,980,507 | 8,881 |
| Rakwana river | 1.9 | | | 1.9 | | | | |
| Walawe river | 21.3 | | | 5.2 | 16.1 | 50.00 | 835,200 | |
| Beragama | 12.5 | | | 2.5 | 10 | 55.00 | 551,650 | |
| **Subtotal** | **879** | **67** | **Average, 1.3** | **131** | **748** | **Average, 52** | **38,239,438** | |
| Chandrikawewa | 44.9 | 9.83 | 1.5 | 7.2 | 37.7 | 50.00 | 2,109,184 | 5,493 |
| Uda Walawe tank | 588.2 | 29.47 | 1.21 | 37.4 | 550.8 | 45.00 | 24,785,235 | 12,416 |
| RBMC–1 | 51.2 | | 1 | 13 | 38.2 | 50.00 | 1,911,600 | 4,425 |
| RBMC–2 | 0.7 | | | 0.7 | | | | |
| LBMC | 4.9 | | 0.75 | 1.1 | 3.8 | 50.00 | 190,800 | 3,975 |
| Ridiyagama MC | 36.8 | | | 8.4 | 28.4 | 40.00 | 113,600 | |
| **Grand total** | **1,606** | | **Average, 1.2** | **199** | **1,407** | **Average, 50** | **67,350,000[b]** | |

[a] Estimate. [b] Rounded value.

*Notes*: t = metric ton (= 1,000 kg); CPUE = Catch per unit of effort (per boat per trip); In 2003, US$1.00 = Rs 96.91.

*Source*: Perera 2003.

of intermittent government support. During the 1980s, the inland fishery industry achieved considerable growth with the support of the government. The government provided extension services, fishing crafts and gear at subsidized prices, free stocks of fingerlings, training and legal support for fishers, made regulations for better control of fisheries, established fisheries societies and implemented community development programs (De Silva 1988). As a result of government support, the highest inland fish production (39,800 tons) was recorded in 1989 (Amarasinghe and De Silva 1999).

However, in 1990 the government withdrew its subsidies and support for inland fisheries, and discontinued all regulatory and stocking programs, which seriously affected inland fisheries and led to their sharp decline over the next several years (Amarasinghe and De Silva 1999). In the late 1990s, the government reinstated its financial and institutional support for inland fisheries and since then the fisheries have gradually recovered (Amarasinghe 2003). When the government resumed its support with the Fisheries and Aquatic Resources Act No. 1996, it conferred control and management of fish resources to Fisheries Management Committees instead of local fisheries societies. Only the Uda Walawe Reservoir Fisheries Society is effectively functioning at present because of good catches in the reservoir and the active supporting role played by the National Aquatic Development Authority and the Department of Wildlife Conservation.

## National Park

The Uda Walawe reservoir is a central feature of the Uda Walawe National Park (30,821 ha). Herds of elephant and other wildlife congregate along the shores of the reservoir. While the value of the park in terms of wildlife and biodiversity preservation is beyond the scope of this research, its value as a tourist spot is important to the local and regional economy. A relatively simple gauge of its importance is the number of tourists visiting the park each year. Although the area was declared a park in 1971, it was only at the end of the decade that villagers were moved out and resettled and poaching and logging were curbed (Alwis n.d.). The problems, however, remain endemic and even include the cultivation of *ganja* (cannabis) within the park and in its vicinities.

Available data on admissions to the park and fees collected[42] were obtained from park officials and DWLC-FAO 1997 (see Appendix F). In the 1994-2001 period, 452,000 persons, 20 percent of whom were foreigners, visited the park. The average revenue for the 1998-2001 period was US$280,000 (2002 values). The park employs 60 persons full-time and there are 20 guides who work in association with a 4x4 vehicle company placed under the control of the Provincial Council. The revenue should include the benefits generated by these two additional activities, while the O&M costs of the park should be subtracted. In the absence of such data, we may consider that these additional costs and benefits cancel each other and retain US$280,000 as an order of magnitude of the yearly benefit generated by the park.

## Energy Generation (at the Uda Walawe Dam)

Both water towers delivering water to the right and left bank main canals are equipped with turbines and electricity is generated as a byproduct of irrigation water release. These turbines produce an average of 15 GWh per year. To estimate the value of energy generated we use the least-cost alternative to hydroelectricity in Sri Lanka, which is thermal energy. Based on Somatilake (2002), the average cost of purchasing thermal energy from a private source

[42]In Sri Lanka, most tourist locations charge two-tier entrance fees—one for locals and the other for international tourists. Current fees are at US$0.23 (Rs 23) for nationals and US$15.00 (Rs 1,500) for foreigners.

is Rs 7/kWh. Using this estimate the value of energy generated at UWIRP is US$1.1 million per year (Rs 105 million per year; 2002 prices).

## Backward/Forward Linkages and Other Multiplier Effects

Apart from farmers themselves, many other actors thrive on the development of irrigated agriculture. Backward linkages include economic activity generated as a result of agricultural production through expenditures on such items as seeds, fertilizers and machinery. Forward linkages refer to post-harvest economic activities such as storage, transportation, marketing, exports, etc. Economists measure economic activity through backward and forward linkages by “multipliers.” For example, a multiplier of 2.50 implies that for each US dollar generated in agricultural output, another US$ 1.50 is generated through backward and forward linkages.

Although the concept of economic multipliers is well understood and accepted, calculating multipliers is an extremely involved process. Bhattarai et al. (2003) conducted a review of the literature and found multipliers for irrigated agriculture that ranged from 1.87 in Malaysia (Bell et al. 1982), through 1.87-2.18 in North-Arcot, India (Hazell et al. 1991) to 2.2-3.2 in South Africa (Hassan 2003).[43] In their study of irrigation in India, Bhattarai et al. (2003) estimate two different types of irrigation multipliers, per crop season and per hectare/year (including livestock). The first irrigation multiplier value is 4.5, which implies that an increase of US$100 per hectare per crop season in the gross value of crop outputs in an irrigated area would generate another US$350 of indirect benefits (or secondary benefits) in the local economy. The per hectare irrigation multiplier was estimated at 3.15, meaning that only 32 percent of the total benefits of irrigation is actually obtained by Indian farmers, the rest of the benefits spilling over to the regional economy.

No attempt to estimate backward/forward and consumption linkages has been made so far for UWIRP. Although the above studies are not fully comparable in terms of methodology, they suggest that a significant part of the benefits of an irrigation project accrue to other sectors and activities of the region, prompting questions on the limitation of historical approaches used to estimate direct benefits.

## Impact on Poverty

The impressive growth of the population in the area from 2,000 in the 1950s to 200,000 presently is in itself a telling illustration of the employment and income-generating opportunities produced by UWIRP. The impact of irrigation development on poverty has been recently studied in the Left Bank area of the project where a detailed household survey instrument was used to compare poverty measures for households with and without access to irrigation infrastructure (Hussein et al. 2002; Hussein et al. 2003; Hussein et al. 2004). Relying on survey data from 858 households, study results revealed large discrepancies in terms of chronic and transient poverty between households in typical rainfed and irrigated areas. Table 8 exemplifies some of the differences found between irrigated, rainfed-typical, and rainfed-nontypical (sugarcane) areas. Household income in irrigated areas is 80 percent higher than that in rainfed areas. However this income discrepancy is reduced in rainfed sugarcane areas, with income from irrigated cropland 42 percent higher than that in rainfed sugarcane land. Irrigated agriculture is also much more labor absorbing than rainfed agriculture.

[43]Studies in developed countries have found higher values: 5 in New South Wales, Australia (Powell et al. 1985) and 6 in Canada (Hill and Tollefson 1996).

TABLE 8.
Socioeconomic indicators in three settings, Walawe Left Bank area.

| Indicator | Irrigated area | Rainfed-typical area | Rainfed-nontypical area (sugarcane) |
|---|---|---|---|
| Average family size | 5.05 | 4.9 | 4.75 |
| Average land size (ha) | 1 | 1.47 | 1.59 |
| Annual net value of product (Rs/ha) | 63,192 | 15,060 | 52,620 |
| Labor use (person-day/ha/year) | 67.2 | 28.0 | 58.3 |
| Annual household income (Rs) | 108,542 | 60,295 | 76,134 |
| Crop income (% of total) | 52 | 33 | 51 |
| Ratio of food to nonfood expenditures | 0.56 | 0.62 | 0.62 |

*Source:* Hussein *et al.* 2004.
*Note:* US$1.00 = Rs 97.50 (January 2004).

## Other Positive and Negative Externalities

In addition to the benefits described above, other positive externalities can be added, such as flood control (reduction of damage in Hambantota)[44] and nonagricultural water use (factories). However, it is also necessary to consider negative externalities of the project. Since Uda Walawe is a settlement project based on the reclamation of lands hitherto little used (some lowland rice fields and some chena cultivation) the impact on existing populations has been limited. On the contrary, residents in the area were in general selected as settlers and were given land. Two categories of people have nevertheless seen their livelihoods threatened by the successive developments of the project, i.e., those living on fisheries in the coastal lagoons and the cattle farmers who need extensive areas for pasture (Birner 1996).

Approximately 500 families relied on shrimp production in the coastal lagoons before they became flooded with drainage water from the lower RB. This ecological change modified aquatic resources as well as flora, with a spectacular colonization of the lagoon by the mangrove tree *Sonneratia caseolaris* (Jayatissa et al. 2002). Villagers in the area reported that only 25 families are now deriving their main revenue from the lagoon. Most of the remaining families are said to have shifted to marine fisheries (Senaratna and Clemett 2003).

Other possible externalities refer to environmental changes and their impact on wildlife and biodiversity, as well as health impacts of malaria or consumption of unsuitable groundwater (fluoride). Perhaps one of the great, potential, hidden costs is human health risk from unsafe drinking water and bioaccumulation of agrochemical byproducts through regular consumption of reservoir fish in the project area.

These different externalities have not been assessed in detail for lack of means but they must be cited here, even in qualitative terms, to illustrate the variety of impacts that should be factored in to achieve a more comprehensive view and impact assessment.

## Cumulated Costs and Benefits

The cumulative costs of all capital investments in UWIRP from its inception in 1964 through 2001 are shown in figure 8. As of 2001, the total capital investment costs of the project reached US$251.6 million (Rs 24 billion), while O&M costs exceeded US$52.4 million (Rs 5 billion),

[44]For example, extreme flood events in 1912 and, particularly, in 1940 provoked extensive damage in the lower parts of the basin.

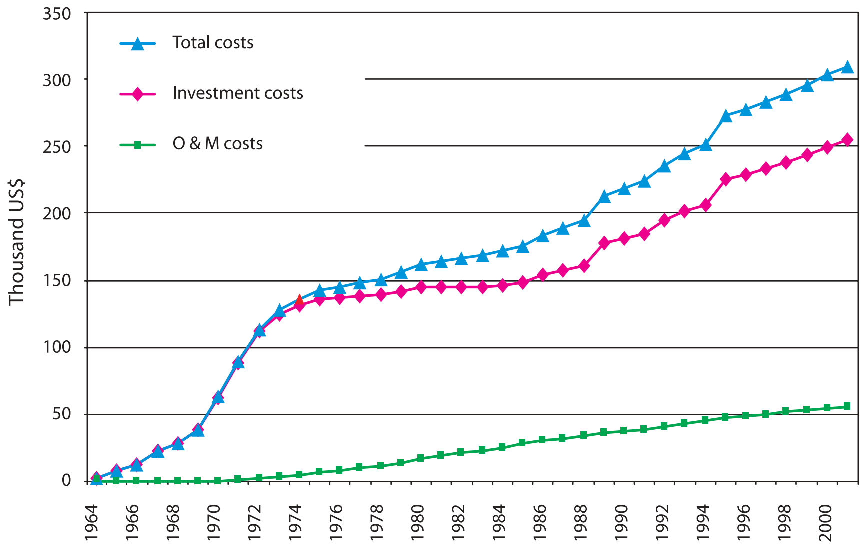
expressed in 2002 prices.[45] These costs should be compared to cumulative direct benefits from agricultural production. Depending on whether or not labor costs are included, these benefits range from US$392.0 million (Rs 37.4 billion) when all labor costs are included, through US$448.6 million (Rs 42.8 billion) when half of labor costs are included, to US$505.2 million (Rs 48.2 billion) without labor costs (see discussion above for further details). This gives a benefit-cost (BC) ratio of 1.63, 1.43 and 1.24, respectively. It must be noted, however, that the costs considered here do not include replacement of infrastructure.

Figure 9 shows both cumulated costs and benefits. It can be seen that the year in which benefits begin to exceed costs is 1987 when labor is excluded, 1990 with labor costs estimated at 50 percent of their opportunity cost and 1993 with 100 percent labor costs.

Banana production plays a critical role in bolstering project benefits. Banana production involved fairly low production costs relative to its gross value. If we assume that all the area converted to banana had remained under rice cultivation, then the BC ratio in 2000 would only be 1.15 (with 50% of labor considered).

Altogether, it may be more straightforward to compare actual benefits for the current year, rather than for a long series, as many factors and conditions have changed. The current annual net benefit of irrigated agriculture in the UWIRP project area is approximately US$25 million (Rs 2,380 million). Other water-related benefits include: US$0.75 million (Rs 72 million) for fisheries, US$0.28 million (Rs 27 million) for Uda Walawe National Park, US$1.1 million (Rs 105 million) for energy generation, US$14.4 (Rs 1,370 million) for home-garden produce (45% of this in timber capital), and US$140,000 (Rs 13 million) for domestic water.[46] Indirect benefits other than that from home gardens, therefore, amount to approximately 9 percent of crop benefits. Figure 10 summarizes all these primary and secondary benefits and shows that home-garden products other than timber generated more benefits than rice production.

FIGURE 8.
Cumulative capital and O&M costs for Uda Walawe: 1974-2001 (in 2002 US$ values).




*Note:* US$1.00 = Rs 95.40 in 2002.

[45]Detailed cost data were gathered from the Mahaweli Authority and supplemented with data from the Asian Development Bank (1969 and 1994). Costs are expressed in 2002 prices using the agricultural GDP deflator series. Using the consumer price index yields very similar results.

[46]Considering a lifetime of 25 years for the foregone investment.

FIGURE 9.
Cumulative crop benefits and costs for Uda Walawe: 1974-2002 (in 2002 US$ values).

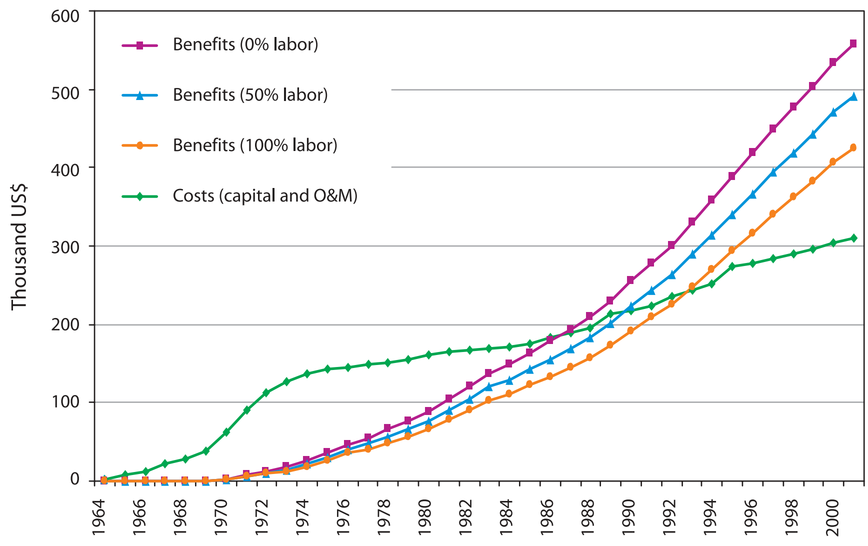
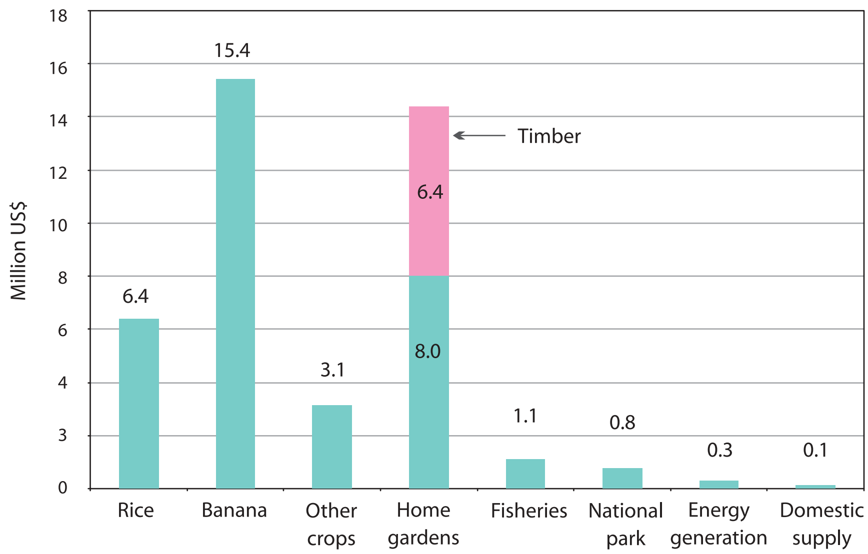



FIGURE 10.
Summary of crop and noncrop benefits derived from UWIRP (in 2002 US$ values).




*Note:* US$1.00 = Rs 95.40 in 2002.

# Decision-Making Process

The investments made in the twentieth century in the Walawe river basin have been based on technical, economic, social and political grounds. This section reviews the most salient justifications of decision making emerging from the descriptions of the preceding sections. It then focuses on how cost-benefit analysis and concerns for cost recovery have been factored in, and on the role they play in decision making. Last, it attempts a wider reflection on the interests and strategies of the different actors involved in planning and decision making.

## Chief Justifications and Ideologies

The goals and means of development during the British rule were clear. Colonial administrators sought to protect and uplift the poor people, and to involve them in productive capitalistic investments that would yield net revenues to the Crown. A good example of these twin goals can be found in the following report (Steele 1867) on the Hambantota province:

> "Much might be done, and ought to be done, in utilizing the streams which run through the district, pouring into the Indian Ocean their, not superfluous, but inappropriate waters which, rightly directed, should replenish and invigorate the thirsty land and people. By a well-devised system of anicuts, sluices and channels, this would be feasible enough; and the day is, I trust, not far distant which we will see this simple, but magnificent and really noble and philanthropic, enterprise accomplished. Nor will it be a barren philanthropy, I mean, in point of pecuniary profit even."

The postwar and postindependence investments in the area were clearly part of the larger policy of resettling populations in the dry zones of the country, both in the north-central and southern parts of the island. The policy was motivated by a growing population and inadequate access to land and water resources, generating a demand for land, which was already acute in colonial times. Sri Lanka was still an exclusively agricultural economy and was bent on achieving self-sufficiency in rice. Settlements were modernist pieces of social engineering aimed at building up a self-reliant and independent farming population provided with decent socioeconomic infrastructures. Selection of settlers was supposed to follow a mix of efficiency (e.g., emphasis on modern agricultural production) and equity (e.g., providing land to landless poor, prohibiting land concentration and land fragmentation) objectives.[47] The postcolonial state built part of its legitimacy on taking over the "development mission." The 1954 International Engineering Company (IEC) report on Walawe (IEC 1954) provides a good description of the host of aspirations that were supposed to be fulfilled through settlements:

> "It is demonstrated that the colonists on the project would be given an opportunity to enjoy a decent standard of living, have a nutritional diet, and have money available for luxuries, savings and rent. The project would provide appreciable social and economic benefits to the people of Ceylon… including, electricity at reasonable costs, increasing food production thus reducing imports, improvement of the external trade balance, [and] providing additional jobs as a result of the labor required."

[47]See Farmer 1976 for more general considerations.

Likewise, the 1960 ECI report on the Uda Walawe scheme (ECI 1960) emphasizes that "there exists in the Walawe basin a large, unbroken area of lowland plain that appears to merit agricultural development and yet, at present, is very sparsely inhabited. It is clear that such a development would help alleviate Ceylon's economic problems."[48] Since the area is in the dry zone, "the irrigation system must be designed and constructed in such a way that the cultivator is protected completely against famine resulting from drought." The report also addresses crop diversification, envisioning extensive areas of cotton and sugarcane, since "the possibility of diversifying and balancing the agricultural economy by the growing under irrigation of commercial crops and other food crops in addition to rice has not received enough attention in Ceylon."

The 1968 Hunting report epitomizes technical hubris and the paternalistic or authoritarian planning typical of the time. The three main stated objectives of the project were "to attain a highly productive cash agriculture generating income-earning opportunities and to promote maximum alternative employment to farming,"[49] and to reduce imports of agricultural products. The plan is presented as rigorous and technically sound, the options taken as self-evident and indisputable, and cropping patterns as evident. The technical recommendations would be compulsory, squatters would be evicted and farmers would benefit from "sympathetic advisory services." Their social cohesion would be ensured by adequate grouped settlements.

This flamboyant plan was not fully endorsed by the ADB feasibility study (in particular, irrigated areas to be developed were disregarded in the plan and attention was focused on the RB only), but it retained much of its modernist and paternalistic drive. The Uda Walawe project was promoted as an "Integrated Development Scheme," a fashionable concept at the time. It befits the "pseudo-comprehensive-programs" described by Hirschman, with extravagant claims that give decision makers the "illusion that the 'experts' have already found all the answers to the problems and that all that is needed is faithful implementation" (Hirschman 1967).

The settlement policy and need to create jobs were emphasized: "In view of the overcrowding in the 'wet zone' and the prevailing high rate of unemployment and underemployment, the project will alleviate considerably the acute man/arable land ratio and generate significant economic and social benefits to the country" (ADB 1969). While early settlements were centered on subsistence and poverty reduction, the new project was "production-oriented" and would erase traditional farming systems. We have seen earlier what became of these grand plans.

Despite the disquieting facts that necessitated rehabilitation only 4 years after the completion of the project, the proposal for rehabilitation was packaged attractively; it was "low cost and quick yielding" (disregarding earlier costs). And it was "highly justifiable" because it would remove "constraints which have inhibited the full realization of benefits under the original projects." Since water management had failed to distribute water evenly, the project would "contribute to an increased and more equitable income distribution among settlers in the project area."

The objectives of the rehabilitation were easily shown to be in line with the government's sectoral development objectives: increasing agricultural production, farm income and employment opportunities in the project area. In agreement with the then emphasis of international agencies on turnover, cost recovery and service provision, it was envisaged that MASL would provide a "demand-driven advisory service to farmers where farmer organizations request assistance in support of self-defined

[48]See Hirschman (1967): "A specific gift of nature [must] be fully developed and utilized. The argument that a 'free' natural resource is there waiting to be harnessed exerts a continuing attraction on engineers, politicians, and the public."

[49]Employment was the most pressing issue in the implementation of the Mahaweli Project (Wickremaratne 1995).

objectives." The vision of subsidized, indebted and hand-to-mouth peasants transmuted into small entrepreneurs picking up and paying for services, allowing them to achieve maximization of production, is probably the most pervasive, resilient and appealing Holy Grail of development agencies. Unfortunately, if this vision helped presenting projects in orderly, efficient and attractive attires, it did not materialize in the Walawe basin.

After 25 years of persistent dominance of rice cultivation, conflicts in the selection of settlers, and dismal efficiency of water distribution, everything pointed toward a lull in the pace of investment. The development of the LB seemed unwarranted by the very high amount of water used in the RB. The ADB contested the opportunity to embrace a new phase of development before management was brought in line with acceptable standards. The combined willingness of MASL and the Japanese development agencies to pursue development, however, prevailed. The new project did not depart much, in its style, from earlier top-down, engineer-oriented projects with design options, settlement processes and economic feasibility dependent upon assumptions of cropping patterns, practices and productivity that had been clearly proved ad hoc and unrealistic in the past. The example of the intent to "change the present nomadic system of cattle management to a privately managed permanent holding system" illustrates this point (Nippon Koei and MASL 1995).

The feasibility study pointed to current weaknesses of the Sri Lankan agriculture sector—"inactive production of staple food with decrease in its self-sufficiency," low diversification and decline in farm income—and argued that one "cannot take an optimistic view of the agricultural sector in the country unless an effective programme would be implemented to overcome the above constraints. The project has various advantages over the agricultural development in the dry zone and urgent implementation is needed" (Nippon Koei and MASL 1995). The necessity of agricultural development was also stressed, based on the situation of unemployment in the country and on the "government's poverty alleviation drive." The Southern Area Development Strategy was also seen to reflect the government's special concern in the region.

In sum, the justifications given during four decades were based on modernist principles that echoed very general objectives of the government: raising national production and rural income, diversifying agriculture, alleviating poverty and increasing employment. All projects do this to a greater or lesser extent and, thus, have easily fallen in line with general government policies. As noted by Berkoff (2002), "irrigation is so obviously a *good thing*—who can be against it?"

## Cost-Benefit Analysis and Economic Rationale

Normative project planning assumes that intervention decisions are taken based on a ranking of their relative net benefits to society. Over the past 50 years, the societal benefits of large-scale public investments have been typically measured using cost-benefit analysis (CBA). Despite the longstanding controversy on the legitimacy of CBA's claim for objectivity (see below), it is still widely used as a means to assess both the desirability and degree of success of projects. Decision-makers seek projects where benefits exceed costs and the economic internal rate of return (EIRR) is adequate.[50] The EIRR measures the return on investment and a value of 10 percent is generally considered as a threshold for "feasibility" on an *a priori* basis and for "successfulness" on an *ex post* basis. The necessity of projects to reach such a target EIRR for funding consideration by

[50]The EIRR is the discount rate such that the discounted stream of benefits equals the discounted stream of costs; it measures return on investment.

bilateral and multilateral donors heavily impacts on the assumptions consultants make, not only about prices, yields or cropping patterns, but also about water requirements and canal design. It also impacts on what type of work or action is to be deemed necessary.

The 1960 report by the Photographic Survey Corporation (PSC and SGC 1960) had a grand vision of the future of the basin. It recognized that "it is difficult to evaluate the ultimate benefit of this proposed irrigation and colonization scheme to the national economy, but it would certainly be very great." The RVDB report of 1963 estimated costs at US$14.41 million and computed expected optimistic revenues to come from annual land rents (US$10.38/ha) and water fees (US$2.60/ha) during 50 years, as well as from the sale of electricity, to arrive at a cost-benefit ratio of 1.94. The Hunting report (1968) estimated the costs of the project at full development at US$47.6 million and assessed that "at maturity, the project, if successfully implemented, will provide 12,000 farmers with generous incomes" as well as "a substantial return to capital invested." The report, however, fell short of calculating a cost-benefit ratio or an EIRR. It also captured only a portion of actual physical infrastructural costs.

In the 1969 ADB project assessment report, a water charge of Rs 40/acre (US$16.6/ha) per year was assumed (up from Rs 5/acre in the earlier feasibility study). The BC ratio of the project, including past investments (dams as initial irrigation works) and benefits from agricultural production and water and land fees, was calculated at 1.1 (with a discount rate of 10% per year) and the EIRR reached 11.1 percent. The life of the project was taken as 40 years. The ADB also estimated the BC ratio and EIRR ignoring earlier investment costs, which yielded a rosier BC ratio of 1.7 and an EIRR of 16 percent that helped cast the project into a more favorable light. The report also noted that the project "will produce other direct and indirect social and economic benefits, which will be considerable but are difficult to quantify."[51]

Ten years later, with a "newly" delivered project already in a worrying state of degradation, rehabilitation appeared inevitable. Cost-benefit analyses were carried out for two assumptions—one incorporated a portion of past investment and the other ignored earlier costs. Both CBAs included the full range of estimated benefits from the project. Due to the adverse impact of delays (10 years instead of 3), the elimination of two tracts in the southernmost area, unrealized "ambitious production targets," and the increase in costs, the EIRR dropped to 7 and 8 percent, for the two assumptions, respectively. In addition, the EIRRs would have been much lower without the unexpected tripling of the price of rice since donor appraisal (Nijman 1991). "Numerous important non-quantifiable benefits" accruing to a now "flourishing region with considerable progress in various sectors" were also expected but no effort was undertaken to estimate them.

The immediate rehabilitation of the RB project area held the promise of lifting the EIRR to the fatidic 10-percent level (or even to 35% if past investment costs were not considered) if cropping intensity was to increase from 134 to 185 percent. In the feasibility report, the CB ratio was evaluated at 1.72 (with a 10% discount over 50 years) and the EIRR at 17.3 percent. These estimates appear to ignore sunk costs and, as a result, the project was necessarily "low cost and quick yielding." Nijman (1991) reported that several sound options, such as forming water-user groups, raising the dam of the Uda Walawe reservoir by one meter and rehabilitating small tanks, were discarded because of their negative impact on the EIRR.[52]

The ADB's project performance audit of the RB rehabilitation in 1999 noted with satisfaction

[51]Detailed information contained in an appendix to the report also stated that in both cases costs for main roads and 50 percent of the costs for townships and villages were excluded because they would be built anyway.

[52]They raised the costs without raising the benefits, which were already derived from the most optimistic hypothesis.

the expansion of banana cultivation and its US$9 million of yearly gross product "making the project the leading production area in the country," while rice yield (5 t/ha) also featured as one of the highest in the country. These results raised the EIRR of rehabilitation to 11.3 percent (assuming the first phase of the project was treated as sunk costs) and the project was therefore classified as "successful." On the other hand, while banana had successfully restored the EIRR of the project, it was noted that the sustainability of this EIRR was threatened by a possible decline in the price of banana resulting from increased production associated with expansion of the area under cultivation. For example, a reduction of 20 percent in banana prices would reduce the EIRR to 9.2 percent.

The review of the feasibility study of the extension of the LB area carried out in 1995 by Nippon Koei included several changes with regard to the 1993 pre-feasibility report. Sugarcane, expected to grow on 3,000 ha, was substituted with banana, onion and vegetables, which yielded much better returns. Water supply, which the ADB considered as insufficient to warrant the development of the last phase under the then management practices, was considered to be secured by both the Samanala reservoir and the diversion from the Timbolketiya river.[53] Although the 1995 revised feasibility study by Nippon Koei increased the estimated cost of the project from US$107 million (Rs 5.5 billion) in the 1993 report to US$141 million (Rs 7.2 billion), they estimated the EIRR at 17.8 percent.

EIRRs are routinely churned out to justify investment projects that are often decided on totally different grounds, although most economists readily admit that the categories of cost, benefit, project lifetime, etc. can be manipulated to obtain very contrasting results (Ingram 1971). While some acknowledge that the CBA is easily "corrupted," others consider the variability of the results as a product of incompetence or bias, not a weakness of the method (Williams 1972). Yet others present more philosophical objections to the idea that values and preferences could be commensurate and could be reduced to a single number.[54] The EIRR undoubtedly suits bureaucratic processes of decision making, which are unable to deal with complexity and need to base decisions on assumedly neutral and objective criteria. It provides scientific support and legitimization, and may serve as a powerful tool "to clothe politically desirable projects in the fig leaf of economic respectability" (Marshall 1965). Despite these alleged limitations and manipulations, CBA allows one to identify and weed out projects that are absurd from an economic point of view (Ingram 1997).

Porter's (1995) study of the history of CBA at the US Army Corps of Engineers (Corps) unearthed more subtle dimensions of the technique. Quantitative techniques provide a sense of "mechanical objectivity" that seems to override the passions and interests that inform political debate. But they are also driven by the rivalry between administrations (in Porter's work, between the US Department of Agriculture, the Bureau of Reclamation and the Corps), which provide incentives to seek a single standardized method of the CBA.[55] In regard to the Corps, Porter shows that "as the best harbors were developed, levees erected and dam sites used up, more and more of these so-called intangible benefits were made tangible, and quantified. In consequence, many projects that were turned down, some decisively, in the 1940s or 1950s were eventually approved and built." In other words, "the Corps was engaged in a perpetual

[53]While the MMP study of 1993 found that the Samanala reservoir would slightly decrease the frequency of deficit in the Walawe system, a feasibility study 2 years later arrives at the opposite conclusion.

[54]For further discussion of the strengths and weaknesses of CBA, a subject of extensive literature, see Porter 1994; Kopp et al. 1997, and Lohman 1997.

[55]This attempt was largely unsuccessful, as each administration continued to incorporate its own interests and viewpoints in the techniques it used.

effort to push back the frontiers of cost-benefit analysis so that there would always be a manageable supply of economically approved projects." As early as the 1940s, this led the Corps to consider five classes of "extended benefits radiating outward" categorized as merchandizing, direct processing, other stages of processing, wholesale trade and retail trade.

This stands in marked contrast to the crudeness of the CBAs carried out by successive consultants or by the ADB for UWIRP. Wishful hypotheses were made without much necessity being felt to justify them; the project lifetime was taken as 50 years despite rehabilitation starting 4 years after completion, and it had unrealistic cropping patterns aimed at boosting benefits, ad hoc estimates of future irrigation efficiency and infeasible cost-recovery scenarios. The EIRRs for the rehabilitation phase were based on costs only for the rehabilitation rather than the entire investment as a way to enhance the benefits of the proposed rehabilitation. In sum, while the bureaucratic necessity to raise the EIRR to 10 percent was influencing the way the CBA was carried out, the reports were quite liberal with parameters and did not show pressure to produce "harder" results. Significantly, derived benefits, in particular the generation of job opportunities, were mentioned in passing and there was no quantification. In other words, there was no sign of the "accounting inventiveness" of the Bureau of Reclamation (Porter 1995). A tentative explanation for this difference is given below.

## Cost Recovery

Cost recovery is an important component of the policy of development banks. It is seen not only as a means to ensure sustainability, by providing financial resources for maintenance, but also as a way to instill a sense of ownership, as well as responsibility with regard to water-management practices. It is also vaguely assumed that making farmers pay for water might be conducive to limiting water wastage. In practice, discussions on farmers paying for water are about recovering part of the costs incurred by the project for the government coffers.

The ECI report in 1960 did not elaborate much on financial issues but endorsed the principle of water charges as a key element of the project: "experience in irrigated areas in other parts of the world has shown that the control of water distribution and the elimination of waste in irrigation depend as much on the levying of a water charge or tax as on any other factor." In a probable reference to colonial times or to some western countries,[56] the report says that charging for water "not only brings in revenue, but in many countries has also proved to be an efficient means of bringing into being and maintaining a desired land-use pattern."

In the RVDB report of 1963, revenues from land rent, water fees, and the sale of electricity during 50 years were supposed to balance part of the investment costs. The concern for cost recovery was also present from the start in the 1968 Hunting report, which emphasized that "an important objective of the Walawe plan is that farmers should pay for certain services and facilities provided to them." Since fee recovery was admittedly difficult to ensure, repayment should be "insisted on from the earliest opportunity as a pre-condition to the grant of title."

The 1969 ADB appraisal report proposes to recover costs in the order of US$1,680 per 2-hectare farm (Rs 10,000 per 5-acre farm) over a period of 25 years, which could be considered as "a considerable improvement compared to the present practice under which farmers pay only a

[56]The report shows a clear tendency—posing no problem at that time—to confuse contexts and to export issues and problems more familiar to northern America to developing countries. For example: "there is no water act in Ceylon defining the rights and limits applying to water users. It is assumed that existing developments would be given a prior right to the use of water. These rights should be evaluated by the legal authorities, and an attempt should be made to determine how they may affect the economic evaluation of new projects, such as the one suggested for the lowland plain of the Walawe basin." The issue was brought back by the ADB 1999 report, almost 40 years later, without a much clearer idea on how it could be put into practice.

nominal rent of Rs 20 per acre per year." The government also "intends to collect a water charge of Rs 40 per irrigated acre a year from settlers in the project area. This water charge will be reviewed in the fifth year when farmers are expected to realize more fully the benefits from the project. At that time, consideration will be given not only to maintenance and operating costs, but also to recovery of the development costs" (ADB 1969).

These intentions, however, would never be realized. Facing numerous and severe difficulties in the settlement process, as well as in the implementation of the construction work, the RVDB was obviously not keen to open a new front on such a sensitive issue.

With the dismal evidence of the rapidity of degradation, the ADB understandingly placed emphasis on cost recovery in the negotiations for rehabilitation. The government explicitly endorsed the principle of O&M cost recovery in the National Agriculture, Food and Nutrition Strategy and, in July 1983, issued the Irrigation Ordinance (amendment), which required the levy of Rs 100 per acre (US$10.50 per hectare) annually on gravity irrigation systems, effective April 1984. "This rate represented about 50 percent of average O&M costs on a country-wide basis. The government intention is to review this rate periodically and increase it at 20 percent per annum so as to attain full O&M cost recovery by 1989" (ADB 1984). With initial collection efficiency in the project area at more than 50 percent, the new policy seemed to receive adequate support from the government and contented the Bank.

The ADB mission also obtained "suitable assurances" from the government that it would, in consultation with the ADB, introduce variable irrigation fees for rice and upland crops to encourage crop diversification, and report regularly on the progress of the fee collection and on improvements in the collection mechanism. Because "subsidies for operation and maintenance costs of the irrigation system constitute a heavy burden on the government budget... the government has decided to phase out irrigation subsidies gradually by recovering the O&M costs from the beneficiaries of the irrigation system" (ADB 1984).

It may be revealing that none of the subsequent reports by MMP or the 1995 Project Completion Report commented on what happened to fee collection.[57] The report emphasized not only the need to strengthen farmer organizations but also the "need to consider financial incentives to encourage farmers to make efficient use of water. One means of doing so is to build on the proposal to issue bulk deliveries of water to distributary canal organizations for onward sale to field canal groups. This would raise the farmers' awareness of the cost of water, as well as generating revenue for maintenance and for the salary of farmer representatives and any gate operators."

Nothing was said about how such policy might be implemented, why the earlier collection failed, and how the general rhetoric on the benefits of water pricing might apply to the particular context of Walawe where volumetric pricing was a far-fetched option. In addition, the report also envisioned that "over the next five years, farmer organizations [were] expected to take over the full costs of maintaining distributary and field canals."

The 1999 post-evaluation report lightly touched upon the issue, and built upon the idea of volumetric pricing, adding a reference to water rights:

> "While full economic pricing will not be feasible for the foreseeable future, the same objective could largely be achieved through the allocation of transferable water rights, with areas with surplus encouraged to sell their excess rights to deficit areas. Transferability of water on a voluntary and compensated [*sic*] basis

[57]Fee collection was started but discontinued after 4 years because of widespread defaulting and vocal opposition from farmers. See Samad et al, Forthcoming.

will be a major tool to promote more efficient allocation and use of water resources" (ADB 1999a).

While such mechanisms are known to be useful and powerful tools in certain contexts of scarcity, notably in times of crisis (e.g., the drought bank in California), they are also known to demand that a set of drastic conditions be in place for them to function (Molle 2004). Such suggestions in the Sri Lankan context are inappropriate for the time being and illustrate how outsiders' mind-sets and blueprints are sometimes projected into utterly different contexts.

## Water Requirements: Supply, Demand and Management

Because of its importance to project management and adequateness of supply to farmers, it is instructive to insert here a comment on the malleability of supposedly fixed project parameters, taking as an example the loss of water by percolation in irrigated fields. Water duty, or the amount of irrigation water planned for one unit of land, as considered in project design, is often believed to be an unambiguous parameter that can be easily derived from sound technical parameters on crop physiology and soil types, as textbooks indicate. In reality, crop water requirements are calculated based on data with a significant level of uncertainty and, above all, high spatial and temporal heterogeneity (e.g., soil characteristics and management practices).

The design values of water duties are of crucial importance since they dictate the capacity of the canals to be built and, thus, have a critical bearing on project costs and the resulting cost-benefit ratios. In what follows, we look at how assumptions on water requirements have changed over time and the resulting impacts on project design, management and economic profitability.

The study by IEC in 1954 considered a total water requirement of 8 feet (2.44 m) for two crops of rice, based on past experiences in similar areas, while the Irrigation Department estimate was 10.5 feet or 3.20 m (IEC 1954). The ECI report, in 1960, investigated the capacity of the future Uda Walawe dam and apparently discovered the 10 feet (3.05 m) yearly water requirement mentioned in the Tender Notice data. Such a high figure was incompatible with the projected irrigated area (110,000 acres or 44,515 ha) and the storage capacity offered by the site envisaged. A study ("The Samanala Wewa Project Report") was opportunely reported to propose a value of 4 feet (1.22 m) per year that was eventually selected by ECI "as a sound representation of the average overall conditions for the farm water needs."

The 1968 Hunting report puts its faith in modern management, which will allow requirements for rice to be half the water used "under the traditional system of virtually unlimited irrigation." The farm-level irrigation water requirement is taken as 4.2 feet (1.28 m) per year; "this is considerably less than the design requirement used for the alienated rice areas in the Uda Walawe area, but will be sufficient if correct principles of water use are fully understood by engineers and farmers alike" (HTS 1968a). Consequently, water is found "to be in surplus above requirements and an additional 12,000 acres of accessible highland is proposed to be brought under lift irrigation." Design is not adapted to reality but, rather, reality is expected to fall in line with "correct principles."

The Government Plan (GOC 1969) revised these values and assumed a crop water need of 5.5 feet (1.68 m), plus 40 percent conveyance loss, giving a total water duty for rice of 7.7 feet (2.35 m). The 1969 ADB Appraisal Report is not much concerned about water issues, an understandable attitude since the project is about the construction of the RB only. In 1979, the Project Completion Report finds out "that only about 70 per cent of the RB area envisioned for irrigation at the time of appraisal is actually served, and this area is consuming about three times the water proposed for the entire RB area." A poor design and operation, added to widespread physical degradation, deprived many tail-end areas of water.

Indeed, the reports by PRC (1982), Wolf (1983) and SOGREAH (1984) give more attention to water management. It is now recognized that percolation losses are very high in RBE soils and Wolf takes them at 4 mm per day. SOGREAH assumes average infiltration loss in rice fields to be 3 mm per day and states that “5 mm/day is probably the maximum unavoidable loss on sloping land,” seemingly ignoring that many plots dry up in one day. A dilemma occurs in that it is impossible to plan an increase in cropping area in the project without drastically reducing this number. SOGREAH, therefore, envisions four types of water-saving measures, which constitute optimistic if not wishful ad hoc hypotheses.

Faced with the duty to implement the rehabilitation works based on new design parameters, MMP’s (1986) inception report identifies effective rainfall and deep percolation as critical factors, and stresses the absence of field measurement of actual losses. The percolation rate is taken as 5 mm/day and tests are advised but later reports do not indicate whether these have been carried out or not. Two years later, calculations of operational procedures appear to have been made based on a general assumption of 5 mm per day infiltration losses (MMP 1988). Oddly enough, the cropping patterns considered are not the actual ones and include many more OFCs than is the case in reality. The report indicates that “it is not suggested that the [cropping] pattern… will in practice be adopted by the farmers” but it is meant to “provide a practicable method for planning an equitable distribution of water… the farmers will then adapt their irrigation and cropping to match the available water within the specific constraints of the soils and topography, their farming practices and the conditions of their individual farms” (MMP 1988). The rotations calculated and proposed are therefore not meant to correspond to actual cropping patterns but, by incorporating some constraint in supply, are expected to force adjustments by farmers. A different possible outcome, of course, is that farmers will employ illegal means and damage infrastructures to access water. Last, MMP’s (1992) handbook issued at the end of the project does not comment on the issue. The tables given to calculate water duties by canal, however, consider high values of deep percolation for tracts 2, 3 and 4, that is, the very upper part of the scheme (see map in Appendix B), while keeping a value of 5 mm/day for the rest of the area.[58]

The feasibility study on the Walawe extension project (JICA 1993) addresses the issue of percolation loss more seriously. At last, systematic infiltration tests were carried out and yielded rates of 5, 10 and 20 mm per day for LHG, RBE (moderate drainage) and RBE (well-drained) soils, respectively. This gave water duties that are between 2 and 8 times those considered by Hunting in 1968. By investigating the spatial variability of percolation losses, JICA opened the Pandora’s box and found out extremely high plot water requirements that have the potential to jeopardize any attempt to add the extension area to the existing scheme. Subsequent generous hypotheses on field application losses and water reuse were then formulated to counterbalance this finding and reduce diversion requirements.

What this brief retrospective tells us is that the assessment of water requirements is both a touchy technical issue and one that governs the most crucial design parameters of the project as well as the assessment of its economic performance. The most astonishing observation is the range of variation of water duties, from 4.2 to 15 feet (1.28-4.57 m) per year (let alone the 36 feet or 11 m for well drained RBE soils found by JICA). It is also apparent that for 50 years consultants have avoided carrying out systematic percolation tests, until those undertaken by JICA in 1993. On the contrary, it appears that assumptions on water use have been largely

[58]It can be hypothesized that MMP’s earlier policy to consider losses of 5 mm/day and idealized cropping patterns was eventually judged too hazardous for the upper block, where losses are highest. We don’t have the records needed to fully analyze how MMP eventually struck a balance between what was technically/financially possible and the implications of considering the real values of percolation losses.

taken as given, based on historical reports, inferred, or "retro-estimated," based on the potential defined by the dam capacity and the corresponding irrigable area under its command. For example, ECI used comparisons with the United States. Hunting backed its water duties by arguing that modern management would halve the water use of "traditional agriculture." SOGREAH envisioned the wholesale adoption of four ad hoc water conservation measures. ADB (1969) and MMP (1986) assumed cropping patterns that involved more area in OFCs than could be realistically anticipated, and JICA (1993) minimized the implication of its own findings on percolation by adopting generous hypotheses on the rate of water reuse.

This "inventiveness" is no surprise for those who have been involved in project design. However, just as in the case of CBA, consultants cannot be fully blamed for their "adaptive" behavior. They are requested by the funding agencies to arrive at results that are by and large predefined by general targets and specific constraints. They must abide by the policy guidelines, avoid antagonizing management agencies and other officials, and must cast the project of their contracting agency in a favorable light. Just as in the case of CBA, it appears that the range of hypotheses that one can make on the numerous parameters of the project is extremely large and malleable, and that their impact on the EIRR can be surprisingly large (Williams 1972).

There is little scrutiny of and objections to the choices made. "Who is to say the assumptions are wrong?" asks Berkoff (2002). A collateral effect of such logic, however, is of extreme importance. When structures are designed based on unrealistically optimistic water duties, it creates an environment of future water scarcity that ultimately become inscribed in the physical landscape and on those who depend upon it. Hydraulic units and subunits will not get the amount of water they need and users will be led to tamper with or destroy structures. The resulting decay, ascribed to farmers' indiscipline, tampering of structures and poor management, is partly a consequence of the earlier "tampering" of technical parameters.

## Actors' Interests and Strategies

This section attempts to wrap up the different observations made earlier and to highlight how the combined strategies of the various "stakeholders" may result in the sequence of events described earlier. These stakeholders include multilateral funding agencies, the central government, local politicians (district and provincial), the implementing agencies, the international or national consultants and the "affected populations" (see table 9). The actions of stakeholders are determined, in part, by their role in the project, their particular interests, accountability and potential sanctions.

One of the most striking features of proposed development projects—especially one that does not involve land reclamation or resettlement—is the convergence of interests around the project. Development banks need to lend money and their representatives are partly evaluated on the amount of funds they have lent. The central government, particularly the Ministry of Finance, is traditionally more cautious about spending money, but the relatively advantageous conditions of such loans plus the pressure felt by the government to deliver public goods and to legitimize its actions by taking up the "development mission" make the option attractive or, at least, minimize opposition. This fosters an attitude of "getting the capital funds while you can, worrying about the use of the resulting project later, if at all" (Howe and Dixon 1993). Local politicians, especially those linked to the party in charge, hope to benefit through patronage and obviously add their pressure to the demand for investments. Implementing agencies, in turn, are eager to sustain the flow of resources that strengthens their power and soothes recurrent financial difficulties, particularly with regard to O&M. National and international consulting firms seek project work opportunities, to respond to the objectives of their clients, and to benefit from

TABLE 9.
Main actors in the development process and their respective strategies.

| Actor | Role | Particular interests | Accountability | Possible sanction |
|---|---|---|---|---|
| Central government | Central planner: Set project objectives, plan regional development | Create regional development; strengthen political legitimacy and local party members; desire for prestige | Accountable to society/ multilateral funding agencies | Loss of power/loss of future funding |
| Local politicians | Lobbying: Support further development projects and local public investments | Strengthen political basis through patronage | In principle, to people; in reality, little accountability | Non-reelection |
| International/ local consultants | Technocrat: Identify plans to meet objectives, ensure technical/economic feasibility, carry out plans | Acceptance of project; further role in design or implementation; complying with funding agency objectives | Accountable to central government | Loss of future work |
| Local implementing agencies | Technocrat: Identify plans to meet objectives, ensure technical/economic feasibility, carry out plans | Sustain the government budget attributed to it; justify existence and staffing; strengthe bureaucratic power | Accountable to central government | Loss of power |
| Multilateral funding agencies | Planner/technocrat: Help identify development goals via sectoral planning, identify plans to meet objectives, provide funding and other technical assistance | Lending money; select project with EIRR above 10 percent and increasing cost recovery; development of a market-economy; sustainable development | Accountable to self (and partly to member countries) | Loss of credibility if project is a severe failure |
| Affected population | Largely passive: comply with planning objectives, little say in planning and implementation | To be selected as a settler, or forcing decision through encroachment; risk aversion | Loosely accountable to local implementing agency | Loss of subsidies; degradation of facilities; nonselection |

further contracts. The concerned populations, which are by no means homogeneous in either their *a priori* socioeconomic status or their potential to gain or lose as a result of the project, tend to welcome the project if they see direct benefit for their families.

Some minor groups, however, stand to lose, but they are hardly organized to a level that could significantly influence the course of things. In some cases, such as the *purana* villagers under the Chandrikawewa reservoir who were successful in keeping their larger plots of land, succeeded in preserving their interests. In other instances, this is not the case. As we have seen earlier, the population making a living off the shrimp in the brackish lagoon lost their livelihood when irrigation drainage reduced the salinity of brackish water and decimated indigenous shrimp populations. The expansion of irrigated areas or “state enclosures” such as national parks or afforestation areas have also reduced the space available to indigenous chena cultivators and cattle farmers. The “nomadic” cattle owners of the LB are also likely to lose most of their grazing lands as development in the area continues. Chena cultivators are likely to be absorbed as settlers and since chena is deemed illegal most of the time, they also have little scope for opposition.

Notwithstanding these third-party impacts, which are at best mentioned in passing in the different project reports, UWIRP is characterized by a convergence of interests. Basically, all actors in the process have a strong interest in making it happen. Sanction in case of failure also appears to be very low. The evidence that, irrespective of its outcome, the project will increase the debt burden of the country is not a serious deterrent, as politicians struggle for reelection. Politics tends to be pervaded with a short-term “after me the deluge” attitude. Consultants give priority to respond to the donors’ objectives and are ready, for example, to incorporate cost-recovery mechanisms that suit a particular bank’s general policies, ad hoc cropping patterns or irrigation efficiencies that make the project more profitable, irrespective of whether they think these are realistic or not. If the assumptions made are not realized, failures are often blamed on the shortcomings in implementation, inadequate maintenance, poor performance of water-user groups and non-adherence to proposed cropping patterns. Responsibility for unrealistic targets set at appraisal is avoided by deeming them as “ambitious” rather than unfeasible.

Despite significant improvements in infrastructure after rehabilitation, national planners and managers have failed to boost project performance. This poor performance was due to the rapid turnover of Resident Project Manager, low accountability towards users, deferred maintenance, incapacity to ensure adequate supply to the tail-end areas despite very high supply-demand ratios, lack of incentives to managers for improved performance, limited consultation with users and reluctance to co-manage the scheme. However, management in a context of dilapidated infrastructure, poor communication and transportation means, and occasional political meddling is not an easy task. Local politicians, indeed, have partly captured project benefits through patronistic practices in the designation and choice of settlers, and sometimes through their intervention power and capacity to influence spatial allocation of water according to their needs.

In the 1960s and 1970s, multilateral development banks like the World Bank and the ADB pressed countries to present “development plans replete with dirigiste policies and lists of projects to be financed” (Roberts 2004). They run little risk of being sanctioned by defaulting clients, since their peculiar status entails that they are assured of reimbursement. This fosters a supply-oriented logic of disbursement encouraged by incentives for country managers to maximize loans (George and Sabelli 1993). These institutions are thus tempted to indulge in wishful thinking and to idealize the context in which the project is being developed. The RVDB, for example, is conveniently considered to have undergone “considerable changes in its organizational structure” and is fit to “promote successful implementation of the multi-purpose Walawe scheme." The ADB also tends to content itself with the assurances given by the government, knowing that political changes or even their evident impracticability, often reduce such commitments to dead letters, as the example of cost recovery has clearly illustrated.[59]

The ADB has also demonstrated exaggerated faith in the power of the state to reorder social settings. The evidence of degradation of infrastructure prompted the injunction that "a decisive halt needs to be brought to the deliberate destruction of project facilities. MASL needs to prosecute culprits to stop such practices from further developing and solemnly warn farmers that their area will be shut off from water delivery if further destruction takes place or if they do not repair the damaged structure." The crucial role of the implementing agency seemed to come to the fore only in the ADB's 1999 ex post project assessment report, where it is recognized that "for the participatory approach to work, it is essential that MASL forcefully backs it and be fully committed to implement it over the long term. This requires attitudinal and behavioral changes from the top to the bottom of the institution." In 1999, all the recipes of the day are potentially ready to put things back on the right track: "key issues that the policy could address include the development of effective O&M systems, water-right transferability and pricing. Urgent priority must be given to strengthening FOs [the funding of which had been disregarded 10 years earlier] if further decline of Walawe's irrigation system is to be prevented" (ADB 1999b). The report concluded with a pessimistic undertone, "it is not too late to redeem the situation," revealing some frustration with the stubborn resistance of projects to conform to idealized images.

The reputation of development banks, however, may suffer from outright project failures. To avoid such situations, banks sometimes get caught up in avoidable successive phases of rehabilitation or modernization. This is clear in the present case study, where rehabilitation was aimed at "realizing the benefits" of the preceding project; that is, fixing up the failures of a project by dubbing previous failures or shortcomings as "constraints." Since the interest of the ADB for rehabilitation exceeded that of the central government, a telling shift in the relative shares of funding occurred, with the ADB funding 80 percent of the rehabilitation phase, against 26 percent of the construction phase. In addition, the Bank used the leverage of possible loans to the nearby Kirindi Oya Project to put pressure on the government to accept the rehabilitation (Nijman 1991). Getting the EIRR back to 10 percent was a manifest concern of the Bank, even if the arithmetic involved might have been contested.

The point, indeed, is that except for the internal review at the Bank itself, nobody seems to have scrutinized or questioned the hypotheses and calculations made, or felt the need to test the sensitivity of parameters or to include a broader definition of benefits and costs. While Porter attributed the development of the CBA in the USA to bureaucratic conflict in a context of overwhelming public distrust, the situation in the USA is clearly at odds with that of the Walawe basin. First, loans are largely coming from multilateral development banks and this type of funding is subject to much less internal competition or objection than the use of government coffers. Second, public scrutiny, participation or alternative viewpoints were almost negligible in the process, diminishing the pressure to justify investments, particularly to present alternative use of the funds, or to address third-party impacts. The absence of "accounting inventiveness" in the bank and consultant reports is striking and reflects the lack of accountability, and the lack of scrutiny by outsiders. A more sophisticated CBA would be possible but would come at a cost, and there is obviously no incentive to embark in such an exercise since most parties have converging interests and do not dispute the case. No costly models or surveys are required to make the case.

[59]"The government has given assurance that problems of land titling will be solved and that policies of free market, subsidy reduction on agricultural inputs, and price support will continue," etc.

This consensus, however, was broken in the 1990s, when ADB did not support further development of the irrigation area, based on the evidence that the lack of improvement in water management and irrigation efficiency did not allow expansion of the system.[60] The government and MASL successfully resorted to alternative sources of funding, by approaching the Japanese Bank for International Cooperation and other funding agencies. As they were not involved in the earlier frustrating phase of development, the Japanese institutions were receptive to the request and conducted pre-feasibility and feasibility studies, adjusting hypotheses to produce an attractive project outlook and EIRRs. This shows that competition between lending agencies can be adequately exploited to further development (Howe and Dixon 1993), even when particular circumstances have drastically dampened the enthusiasm of a particular lender.

In sum, if we follow Ingram (1971), who states that “the inclusion of a particular project in a package depends upon its effect on the balance of support and opposition to the package, not the relationship of the project to any aims or goals established for water management in general or for the particular collection of projects,” then the “Walawe Package” appears as the natural outcome of contributing and converging interests faced with little or no opposition, and subject to little scrutiny. This should not be taken as a criticism of poor or faulty planning, although some elements were clearly unrealistic. Rather, we suggest that government interventions are almost invariably based on overarching policies or political priorities that come with strong self-justificatory undertones and that largely override formal cost-benefit analysis. This has been widely observed in both developing and developed countries (del Moral et al. 2003). Irrespective of whether the priorities defined are sound or not, the convergence of interests leads to choreographed cycles of project appraisal, design, implementation and assessments that unfold under the banner of rational planning and computed outcomes.

## Lessons Learned and Conclusions

This comprehensive analysis of the Uda Walawe Irrigation and Resettlement project in Southern Sri Lanka has led us to look at its successive development phases through different lenses.

The main point coming out of the description of over 50 years of progressive development is the wide range of difficulties that have constantly undermined the efforts made. They range from design failure, shoddy construction and poor maintenance to constraints on agricultural diversification, administrative inertia and political upheavals. What is striking is the contrast between the (sometimes blunt) assuredness of the hypotheses made in feasibility reports and the reality on the ground, between the simplistic technological and social engineering drive of the consultants and the complexity of regional development.

As a result, expectedly, the different performance indicators or, more simply, the comparison between expected and observed results of the different phases, reveal significant discrepancies. These discrepancies confirm the more general results found by various other studies on project performance.

[60]The 1999 ADB report states: “If supplies prove to be inadequate, decisions will be required by MASL on necessary changes to the design or phasing of expansion area development. It is suggested that MASL considers suspension of development of the LB expansion area.”

The review of direct costs and benefits showed that crop benefits remained quite depressed until the groundswell of banana cultivation, which came to occupy around 40 percent of the command area. It also shows how the price of agricultural products eventually dictated the profitability of the project. While a full-fledged assessment of all direct and indirect benefits and negative externalities was not attempted, the estimation of the value of other water-related benefits such as inland fisheries, the National Park, and home-garden produce showed that many important components need to be considered for a more comprehensive impact assessment.

The justifications of project development during four decades were based on modernist principles that echoed very general objectives of the government—raising national production and rural income, diversifying agriculture, alleviating poverty and increasing employment. All projects do this to a greater or lesser extent and they were easily shown to be consistent with general government policies. When presented as unquestionable necessities, national priorities can override benefit-cost ratios that are not sufficient to justify the project; they can also obviate the need to investigate in more depth the diversity of possible positive and negative impacts.

Indeed, cost-benefit analyses, as appearing in consultants' reports, were found to be confined to the estimation of crop-related direct costs and benefits and showed little of the sophistication that has emerged in contexts where substantial scrutiny and competition for resources are the rule. Assumptions on percolation losses, water requirements, cropping patterns, or management efficiency were partly made under the constraint to obtain an EIRR of over 10 percent. The case of the estimation of percolation losses was illustrative of the "malleability" of project parameters but it also showed the dramatic consequences on water management and infrastructure degradation that unrealistic assumptions made on paper may have on the ground.

The crude nature of cost-benefit analysis is also commonplace and might lead to the usual prescription that such analysis should be carried out in a more thorough manner. However, if cost-benefit analysis does have a role in eliminating "dead duck" projects and contributing to better choices (Green 2003) it must be recognized that social choice is eventually governed by a much wider array of considerations than mere financial calculations.

Finally, the history of UWIRP was examined from the perspective of a set of actors with their respective interests, constraints and strategies. These actors include the central government, local politicians, international and local consultants, local implementing agencies, multilateral funding agencies and affected populations. The case of UWIRP is notable by the convergence of interests to make the project happen; there was little apparent resistance to UWIRP. Accountability and sanction for failure of the different actors were found to be low or nonexistent. As a result, the unfolding of the project was very much driven by the agenda of those in control of financial resources (the state and lending agencies), with a bearing on stated priorities, project options (e.g., decision to rehabilitate), and the responses found by consultants to fulfill their expectations.

The ongoing gap between the rationality of these actors and the events on the ground, between planning and the combined behaviors of local managers and users, cannot be understood solely on the basis of poor performance or non-adherence to rules and plans. The trajectory of a project like UWIRP may be significantly influenced by external and unpredictable factors (e.g., boom of banana) and the articulation and conflict between different rationalities at work, which are confronted in the common arena of project development.

In sum, this review of UWIRP in the lower Walawe Basin underscores the importance of realistic planning, stakeholder participation, and adaptive management. Rather than adaptively adjusting to unanticipated changes, planners, donors and managers continued to return time and again to the original plan and launch successive attempts at realizing the original plan. Planning and implementation proceeded through a typical top-down, blueprint approach that constituted a typical example of Hirschman's "hiding hand" principle, whereby "ignorance of ignorance, uncertainties, and of difficulties" is the prelude of a "long *voyage of discovery* in the most varied domains, from technology to politics" (Hirschman 1967). The obvious drawbacks of such top-down approaches should warrant and encourage the adoption of process approaches on a wider scale (see Bond 1998). Participation of concerned stakeholders in planning is a widely accepted principle that brings about more equity and efficiency (Howe and Dixon 1993) but it entails a revolution of mindsets and practices and is eventually predicated upon wider societal changes and democratization.

# Appendices

## APPENDIX A

### Work Completed in UWIRP by 1968

1. Uda Walawe reservoir

2. Irrigation system:

   (a) RB: Planned length 41.8 km (26 miles); to irrigate 10,522 ha (26,000 acres)
   - 37 km (23 miles) of main RB channel completed
   - Irrigation facilities built for Tracts 1-7 covering 1,518 ha (3,750 acres)

   (b) LB: Planned length 64.4 km (40 miles); to irrigate 19,425 ha (48,000 acres)
   - Work in progress: irrigation facilities for Tracts 2-7, covering 1,518 ha (3,750 acres) near completion
   - Five tanks (*Kiri Ibban*, *Mahagama*, *Gal*, *Vedigam* and *Habaralu*) completed to irrigate 728 ha (1,800 acres)

3. Land Development and Colonization

   (a) RB
   - 1,619 ha (4,000 acres) cleared in Tracts 12 and 13
   - Sugar area: 809 ha (2,000 acres) cleared
   - 2,023 ha (5,000 acres) cleared in Tracts 1-7 by colonists on subsidy and 1,800 settlers on land

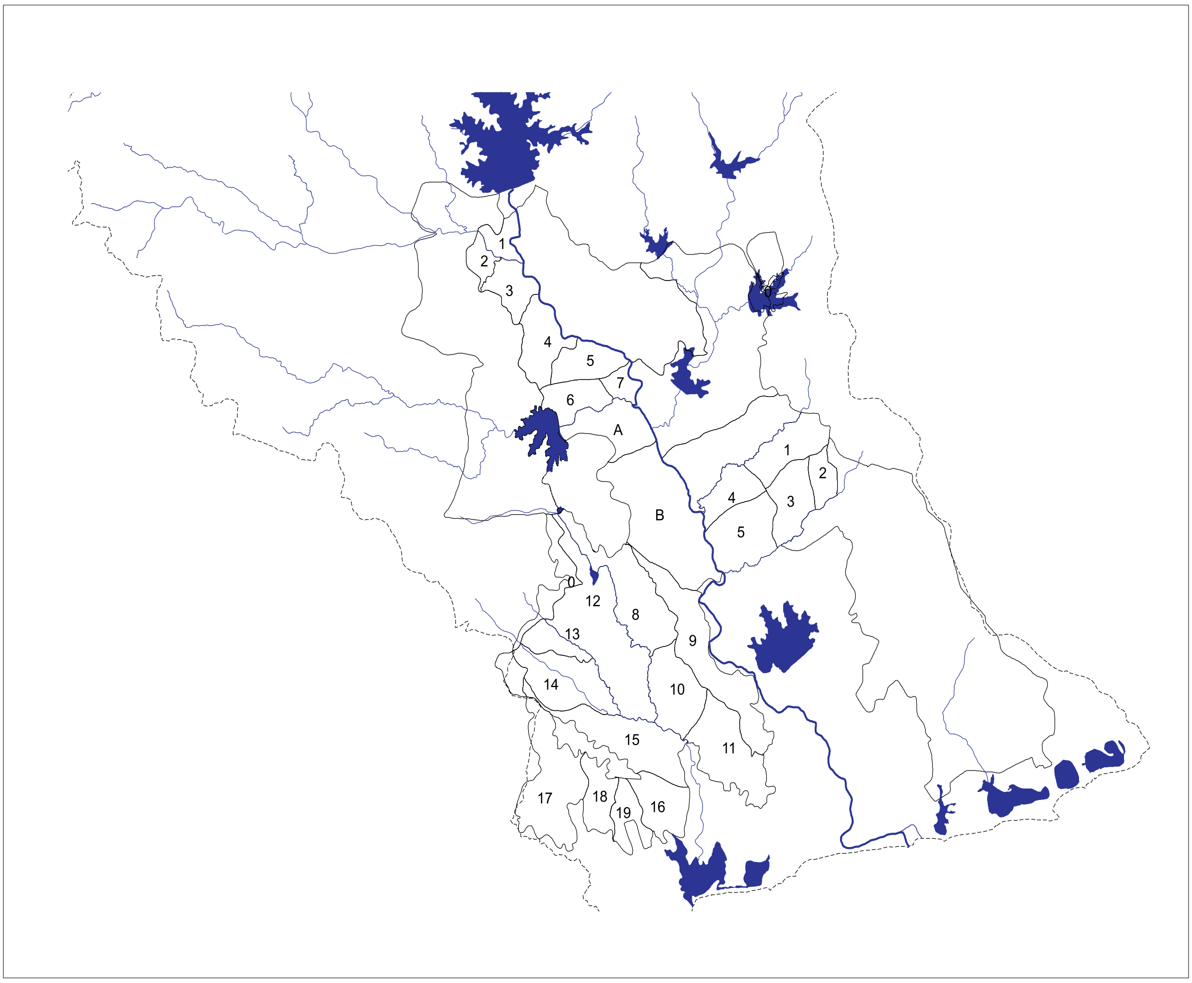
   (b) LB: 1,012 ha (2,500 acres) cleared by colonists on subsidy and 600 settlers on land

   (c) Youth schemes: 400 youth settled at *Kiri Ibban* tank on LB and on RB

   (d) Public utilities: Roads; Civic centers

APPENDIX B

## Tracts of the Uda Walawe Scheme



## APPENDIX C

# Planned Command Area for UWIRP

| *Command area* | | |
|---|---|---|
| | ha | acres |
| *To be developed* | | |
| RB | 8,711 | 21,525 |
| LB | 18,648 | 46,080 |
| *Total* | 27,359 | 67,605 |
| *Existing irrigable area included in the Government Plan* | | |
| Embilipitiya Hingura Ara and other village tanks | 1,151 | 2,844 |
| Uda Walawe reservoir | | |
| RB Tracts 1-7 | 1,520 | 3,755 |
| LB: Kiri Ibban Aru, Mahagama and Suriyawewa | 761 | 1,881 |
| Chandrikawewa (initially excluded but later added to Plan) | 2,133 | 5,270 |
| *Total* | 5,565 | 13,750 |
| TOTAL DEVELOPMENT INCLUDED IN PLAN | **32,924** | **81,355** |
| *Existing irrigable area excluded from the Government Plan* | | |
| Liyangastota anicut | | |
| LB | 2,513 | 6,210 |
| RB | 2,546 | 6,290 |
| *Total* | 5,059 | 12,500 |

*Source:* GOC 1969 and HTS 1968b.

## APPENDIX D

# Proposed Cropping Pattern

| Crop | Area[a] | | | | | |
|---|---|---|---|---|---|---|
| | RB | | LB | | Total | |
| | ha | acres | ha | acres | ha | acres |
| Rice | 2,883 | 7,125 | 5,573 | 13,770 | 8,456 | 20,895 |
| Sugar | 255 | 630 | 6,993 | 17,280 | 7,248 | 17,910 |
| Cotton and other OFCs | 5,573 | 13,770 | 6,082 | 15,030 | 11,655 | 28,800 |
| Total area to be settled | 8,711 | 21,525 | 18,648 | 46,080 | 27,359 | 67,605 |
| Total area already settled within project area | 3,946 | 9,750 | 1,619 | 4,000 | 5,564 | 13,750 |
| Total irrigable area planned and settled | 12,662 | 31,288 | 20,275 | 50,100 | 32,923 | 81,355 |

[a] Does not include 5,666 ha (14,000 acres) for homesteads, towns, etc., and existing settlements on 4,387 ha (10,840 acres) of unirrigable land.

*Source:* HTS 1968b.

# APPENDIX E

## Revised Plan of Land Use under the ADB Downstream Development Project

| | Rice | | Sugarcane | | Cotton and other OFCs | | Total | |
|---|---|---|---|---|---|---|---|---|
| | ha | acres | ha | acres | ha | acres | ha | acres |
| **RB** | | | | | | | | |
| *Land to be developed* | | | | | | | | |
| Tract 1 | | | 202 | 500 | | | 202 | 500 |
| Tracts 2-7 | 1,546 | 3,821 | | | 4,909 | 12,130 | 6,455 | 15,951 |
| Tracts 9-21 | 3,480 | 8,600 | | | | | 3,480 | 8,600 |
| Subtotal | 5,026 | 12,421 | 202 | 500 | 4,909 | 12,130 | 10,137 | 25,051 |
| *Existing development* | | | | | | | | |
| Chandrikawewa area | 2,133 | 5,270 | | | | | 2,133 | 5,270 |
| Embilipitiya and other village tanks | 1,151 | 2,844 | | | | | 1,151 | 2,844 |
| *Subtotal* | 3,284 | 8,114 | | | | | 3,284 | 8,114 |
| TOTAL FOR RB | 8,310 | 20,535 | 202 | 500 | 4,909 | 12,130 | 13,421 | 33,165 |
| **LB** | | | | | | | | |
| *Land to be developed* | | | | | | | | |
| Northern zone | 2,651 | 6,550 | 6,993 | 17,280 | | | 9,644 | 23,830 |
| Southern zone | 2,922 | 7,220 | | | 6,082 | 15,030 | 9,004 | 22,250 |
| *Subtotal* | 5,573 | 13,770 | 6,993 | 17,280 | 6,082 | 15,030 | 18,648 | 46,080 |
| *Existing development* | | | | | | | | |
| Kiri Ibban/other tanks | 761 | 1,881 | | | | | 761 | 1,881 |
| TOTAL FOR LB | 6,334 | 15,651 | 6,993 | 17,280 | 6,082 | 15,030 | 19,409 | 47,961 |
| Total new development | 10,599 | 26,191 | 7,195 | 17,780 | 10,991 | 27,160 | 28,786 | 71,131 |
| Total existing development | 4,045 | 9,995 | | | | | 4,045 | 9,995 |
| Total project area | 14,644 | 36,186 | 7,195 | 17,780 | 10,991 | 27,160 | 32,831 | 81,126 |

*Source:* ADB 1969, 22.

## APPENDIX F

### Historical Records of Visitors and Income in Uda Walawe National Park

| Year | No. of local visitors | No. of foreign visitors | Total no. of visitors | Annual Income | |
|---|---|---|---|---|---|
| | | | | Rs | US$ |
| 1991 | | | | 64,939 | 1,572 |
| 1992 | | | | 296,150 | 6,685 |
| 1993 | | | | 2,099,595 | 43,851 |
| 1994 | 18,849 | 6,554 | 25,403 | 4,209,124 | 85,274 |
| 1995 | 21,284 | 7,438 | 28,722 | 4,975,667 | 97,067 |
| 1996 | 33,602 | 6,180 | 39,782 | 7,974,000 | 144,169 |
| 1997 | 54,006 | 3,275 | 57,281 | 6,400,000 | 108,438 |
| 1998 | 48,101 | 15,733 | 63,834 | 18,800,000[a] | 288,034[a] |
| 1999 | 69,326 | 21,548 | 90,874 | 25,812,588[a] | 365,669[a] |
| 2000 | 71,144 | 17,641 | 88,785 | 22,477,489 | 287,878 |
| 2001 | 44,896 | 12,044 | 56,940 | 14,538,288[a] | 163,646[a] |

[a]Estimated values.

*Source:* Department of Wildlife.

# Literature Cited


Abeyaratne M., ed. n.d. *Ratnapura: As seen by government agen*ts. Colombo: Department of Government Printing.

ADB (Asian Development Bank). 1969. *Appraisal of Walawe Development Project in Ceylon.* Manila: ADB. Unpublished report prepared for the exclusive use of the ADB. 116 pp.

ADB. 1979. *Project completion report of the Walawe Development Project, (Loan Nos. 16- CEY(SF) and 17-CEY) in Sri Lanka.* Manila: ADB. Unpublished (restricted) document. iii + 129pp.

ADB. 1982. *Project performance audit report of the Uda Walawe Development Project*. Manila: ADB.

ADB. 1984. *Appraisal of the Walawe Irrigation Improvement Project in Sri Lanka*. ADB Project Report. Manila: ADB.

ADB. 1995. *Walawe Irrigation Improvement Project. Project completion report 1984-1996*. Manila: ADB. Draft.

ADB. 1999a. *Project performance audit report on the Walawe Irrigation Improvement Project (Loan 695-SRI[SF]).* Manila: ADB. Unpublished report. 18 pp.

ADB. 1999b. *Walawe Irrigation Improvement Project.* Manila: ADB. Unpublished report, Loan No.695-SRI(SF). 13 pp. + annexes.

Alwis, Lyn De. n. d. *The birth of a national park: Redeeming Uda Walawe.* www.lankalibrary.com/wlife/udawalawe.htm

Amarasinghe, U. S. 2003. New approaches to inland capture fisheries statistics in Sri Lanka. In *New approaches for the improvement of inland capture fishery statistics in the Mekong Basin*. Proceedings of the ad-hoc expert consultation, Udon Thani, Thailand 2-5 September 2003. RAP Publication 2003/01, FAO Regional Office for Asia and the Pacific, Bangkok, Thailand, pp. 116-121.

Amarasinghe, U. S.; De Silva, S. S. 1999. The Sri Lankan reservoir fishery: A case for introduction of a co-management strategy. Fisheries Management and Ecology. *Asian Fisheries Science* 6: 1-13.

Amunugama, Sarath. 1965. Chandrikawewa: A recent attempt at colonization on a peasant framework. *The Ceylon Journal of Historical and Social Studies* 8(1&2): 130-162.

Bastiampillai, B. 1967. The revival of irrigation enterprise in Ceylon, 1870 to 1890. *Ceylon Journal of Historical and Social Studies* 10: 1–26.

Bell, C.; Hazel, P.; Slade, R. 1982. *Project evaluation in regional perspective: A study of an irrigation project in northwest Malaysia.* Baltimore, MD, USA: Johns Hopkins University Press, for the World Bank. x + 326 pp.

Berkoff, Jeremy. 2002. *Economic valuation: Why is it often unsatisfactory? And does it matter? With reference to the irrigation sector.* Paper presented at the International Consulting Economists' Association (ICEA) meeting, 19 June 2002. http://www.icea.co.uk/archive/JBerkoffPaper190602.doc

Bhattarai, Madhusudan; Barker, Randolph; Narayanamoorthy, A. 2003. Who benefits from irrigation investments in India? Implication of irrigation multiplier estimates for cost recovery, and irrigation financing. Paper presented at the ICID Asian Regional Workshop, Taiwan, 10-12 November 2003. International Commission on Irrigation and Drainage.

Birner, Regina. 1996. The role of livestock in economic development: Theory and empirical evidence. The case of Sri Lanka. Ph.D. thesis. Gottingen, Germany: University of Göttingen.

Boelee, E.; van der Hoek, W. 2002*. Impact of irrigation on drinking water availability in Sri Lanka*. ICID-CIID 18th Congress on Irrigation and Drainage, 21-28 July, Montreal, Canada. Paper No. Q51/R5.7 (http://www.cancid.org/tech_papers.htm#IWMI). International Commission on Irrigation and Drainage.

Bond, R. 1998. *Lessons for the large-scale application of process approaches in Sri Lanka*. International Institute for Environment and Development. Gatekeeper Series No. 75. http://www.iied.org/docs/gatekeep/GK75.pdf

Collins, C. H. 1932. The Archeology of the Sabaragamuwa Binthenne. *Journal of Ceylon Branch of the Royal Asiatic Society* 32 (85): 158-183.

De Silva, S. S. 1988. *Reservoirs of Sri Lanka and their fisheries*. FAO Fisheries Technical paper. Rome: Food and Agriculture Organization of the United Nations (FAO).

del Moral, L.; Hill, G.; Paneque, P.; Pedregal, B.; Spash C.; Kevin, K. 2003. Evaluation practices in water project decision-making processes. Comparative analysis of five European cases: Alqueva dam (Portugal), Evinos reservoir (Greece), Ythan nitrate vulnerable zone (UK), the grensmaas (the Netherlands) and Ebro river transfer (Spain). Draft. www.us.es/ciberico/archivos_word/phnponendelmoral.doc

Deraniyagala, S. U. n.d. Early man and the rise of civilisation in Sri Lanka: The archaeological evidence. Mimeo.

DWLC-FAO (Department of Wildlife Conservation-Food and Agriculture Organisation of the United Nations). 1997. *Management plan: Uda Walawe National Park*. DWLC-FAO. 3 vols.

ECI (Engineering Consultants, Inc). 1960. *Preliminary report. Uda Walawe Project: Development of the Walawe Ganga Basin*. Denver, Colorado: ECI. 41 pp.

Farmer, B. H. 1976. *Pioneer peasant colonization in Ceylon: A study in Asian agrarian problems*. Connecticut, USA: Greenwood Press Publishers. xv + 387 pp.

Fernando, A. D. N. n.d. *Discovering the lost cities of Ruhuna*. WWW Virtual Library Sri Lanka (accessed 26-01-2005). www.lankalibrary.com.

George, S.; Sabelli, F. 1993. *Faith and credit. The World Bank's secular empire*. Boulder, Colorado: Westview Press.

Ghanawimala, Rev. Kiriella. 1942. "*Sabaragamuwe parani liyavili" (Ancient documents of Sabaragamuwa)*. Colombo: Jinadasa Press.

Ghanawimala, Rev. Kiriella. 1967. *Sabaragamu darshanaya (The philosophy of Sabaragamuwa).* Ratnapura, Sri Lanka: Shasthrodaya Printers.

Gleick, P. H. 1996. Basic water requirements for human activities: Meeting basic needs. *Water International* 21 (1996) 83-92.

GOC (Government of Ceylon). 1989. *Administration report, Hambantota district*. Colombo: Ceylon Government Press.

GOC (Government of Ceylon). 1969. *Uda Walawe Project: Plan of development and cost estimates.* Unpublished report. 40 pp.

Green, C. 2003. *Handbook of water economics: Principles and practice*. Hoboken, NJ: Wiley.

Hassan, R. M. 2003. Economy-wide benefits from water-intensive industries in South Africa: Quasi-input-output analysis of the contribution of irrigation agriculture and cultivated plantations in the Crocodile river catchment. *Development Southern Africa* 20(2): 171-195.

Hazell, P.; Ramasamy, C.; Rajagopalan, V. 1991. An analysis of the indirect effects of agricultural growth on the regional economy. In *Green revolution reconsidered: The impact of high yielding rice varieties in South India,* eds. P. Hazell and C. Ramasamy. Baltimore, Maryland: Johns Hopkins University Press. Ch. 8, pp. 153-180.

Hill, H.; Tollefson, L. 1996. Institutional questions and social challenge. In *Sustainability of irrigated agriculture*, eds. L. S. Pereira, R. A. Fedds, J. R. Gilley and B. Lesaffre. Dordrecht/London: Kulwer Academic Publisher.

Hirschman, A. 1967. *Development projects observed*. Washington, D.C.: The Brookings Institution.

Howe, J. A.; Dixon, J. A. 1993. Inefficiencies in water project design and operation in the third world: An economic perspective. *Water Resources Research* 29(7):1889-1894. (Also published in *Water resources and economic development*, ed. R. M. Saleth. 2002. Cheltenham, UK: Edward Elgar Publishing. Pp. 339-344.)

HTS (Hunting Technical Services). 1968a. *The Uda Walawe report, Vol II*, *The Outline Development Plan.* August 1968. Hunting Technical Services Ltd.

HTS (Hunting Technical Services). 1968b. *The Uda Walawe report: Volume I, Summary.* Report for: Great Britain. Ministry of Overseas Development; Government of Ceylon. River Valleys Development Board. Hunting Technical Services Ltd. Unpublished report. 64 pp.

Hussain, I.; Marikar, F.; Thrikawela, S.; Shinkai, N.; Sawada, Y.; Aoki, M. 2002. *Impact assessment of irrigation infrastructure development on poverty alleviation: A case study from Sri Lanka.* Tokyo: Japan Bank for International Cooperation (JBIC); Colombo: International Water Management Institute (IWMI). JBIC Institute Research Paper No. 19. vi + 216 pp.

Hussain, I.; Hanjra, M.; Thrikawela, S.; Wijeratne, D. 2003. *Impact of irrigation infrastructure development on dynamics of income and poverty: Econometric evidence using panel data from Sri Lanka*. Tokyo: Japan Bank for International Cooperation (JBIC); Colombo: International Water Management Institute (IWMI). vi + 269 pp.

Hussain, I.; Thrikawela, S.; Regassa, N.; Wijeratne, D.; Shinkai, N. 2004. *Impact of irrigation on chronic and transient poverty alleviation: The case of Walawe system in Ruhuna basin, Sri Lanka*. Draft IWMI Research Report. Colombo: International Water Management Institute.

ID (Irrigation Department). 2002. *Potential water resources for development of Ruhunupura: Pre-feasibility study*. Draft report, 3 vols. Colombo: Irrigation Department (Planning Branch).

IEC (International Engineering Company, Inc.). 1954. *Economic report on the Walawe Ganga Project. Report to the Government of Ceylon*. San Francisco: IEC.

IIMI (International Irrigation Management Institute). 1990a. *Final report of the Technical Assistance Study (TA 846 SRI), Irrigation Management and Crop Diversification (Sri Lanka)*. Colombo: IIMI.

IIMI. 1990b. *Irrigation management and crop diversification (Sri Lanka). Volume 1- Synthesis of findings and recommendations Kirindi Oya and Uda Walawe Projects. Volume 2 - Kirindi Oya Project. Volume 3 - Uda Walawe Project.* Colombo: IIMI.

Ingram, Helen. 1971. Patterns of politics in water resources development. *Natural Resources Journal* 11:102-118.

Ingram, Helen. 1997. Water and equity: A direction for research. *Common Property Resource Digest*, No.43, September 1997.

Jayatissa, L. P.; Guero, M. C.; Hettiarachchi, S.; Koedam, N. 2002. Changes in vegetation cover and socio-economic transitions in a coastal lagoon (Kalametiya, Sri Lanka), as observed by teledetection and ground truthing, can be attributed to an upstream irrigation scheme. *Environment, Development and Sustainability* 4: 167–183.

JICA (Japan International Cooperation Agency). 1993. *Feasibility study on Walawe Irrigation Upgrading and Extension Project*. Prepared for the Democratic Socialist Republic of Sri Lanka, Ministry of Lands, Irrigation and Mahaweli Development. 3 vols.

Kopp, R. J.; Krupnick, A. J.; Toman, M. 1997. *Cost-benefit analysis and regulatory reform: An assessment of the science and the art.* Washington, D.C.: Resources for the Future.

Kothare, V. D. 1961. Tentative development plan for the Walawe Ganga Basin. Preliminary report. 2 vols.

Lagman, Anneli; Aylward, Bruce. 2000. *Survey of multilateral bank practice on financial and economic analysis of large dams*. World Commission on Dams, Contributing Paper for Thematic Review III.1. http://www.dams.org/kbase/thematic/tr31.htm.

Lohmann, Larry. 1997. Cost-benefit analysis: Whose interest, whose rationality? Presentation to the Yale University Program in Agrarian Studies, 1997. New Haven, Connecticut, USA: Yale University.

Marshall, H. 1965. Politics and efficiency in water development. *Water Research* 294.

Meijer, K. 2000. Impacts of concrete lining of irrigation canals, Uda Walawe, Sri Lanka. M. Sc. thesis, University of Twente, The Netherlands. 65 pp. + annexes.

Mendis, D. L. O. 1967. Planning by network for construction of Uda Walawe headworks. *Transactions of the Institution of Engineers*, *Ceylon*, pp. 23-94.

MMP (M. Macdonald and Partners). 1986. *Walawe irrigation improvement project: Inception report.* Cambridge, UK: Sir M. Macdonald & Partners Ltd. 97pp.

MMP (M. Macdonald and Partners). 1988. *Cropping pattern for planning the operation of the right bank. Water Management Technical Note No 4*. Cambridge, UK: Sir M. Macdonald & Partners Ltd.

MMP (M. Macdonald and Partners). 1992. *Walawe Irrigation Improvement Project: Project Office Handbook*. Cambridge, UK: Sir M. Macdonald & Partners Ltd.

Molle, François. 2004. Defining water rights: By prescription or negotiation? *Water Policy* 6(3): 207-227.

Molle, François; Jayakody, Priyantha; de Silva, Shyamalie. 2003. *Anicut systems in Sri Lanka: The case of the Upper Walawe river basin*. Working Paper No.61. Colombo: International Water Management Institute.

Narada, Rev. Vekiliye. 1992. History of Ratnapura. In *Sabaragamu Udana 2*, ed. Bandula Liyanage. Ratnapura, Sri Lanka: Sabaragamuwa Provincial Council.

Nijman, C. 1991. *Irrigation management processes and conditions: A case study of Sri Lanka's Walawe Irrigation Improvement Project.* Colombo: International Irrigation Management Institute. 277 pp.

Nippon Koei; MASL (Mahaweli Authority of Sri Lanka). 1995. *Review report on feasibility study for Walawe Left Bank Irrigation Upgrading and Extension Project: Volume I. Main report.* Tokyo: Nippon Koei Co., Ltd. Unpublished report.

Obeyesekere, Gananath. 1984. *The cult of the Goddess Pattini.* Chicago and London: The University of Chicago Press.

Perera, L. R. 2003. *Assessment of multiple use of water resources: Inland fisheries in the Walawe basin*. Colombo: International Water Management Institute. Unpublished draft.

PSC (Photographic Survey Corporation); SGC (Surveyor General of Ceylon). 1960. *A report on a reconnaissance survey of the resources of the Walawe Ganga Basin, Ceylon.* Colombo: Government Press. xiv + 359 pp.

Porter, Theodore. 1994. Objectivity as standardization: The rhetoric of impersonality in measurement, statistics, and cost-benefit analysis. *Annals of Scholarship* 9(1992): 19-59.

Porter, Theodore. 1995. *Trust in numbers: The pursuit of objectivity in science and public life*. Princeton: Princeton University Press.

Powell, R. A.; Jenson, R. C.; Gibson, A. L. 1985. *The economic impact of irrigated agriculture in NSW*. NSW, Australia: New South Wales Irrigators' Council.

PRC (Engineering Consultants). 1982. *Termination report: Water management, Uda Walawe irrigation project*.

Renault, D.; Hemakumara, M.; Molden, D. 2000. Importance of water consumption by perennial vegetation in irrigated areas of the humid tropics: Evidence from Sri Lanka. *Agricultural Water Management* 46(3): 215-230.

Renwick, Mary E. 2001. *Valuing water in irrigated agriculture and reservoirs fisheries: A multiple-use irrigation system in Sri Lanka.* Research Report 51. Colombo: International Water Management Institute.

Roberts, J. 2004. Thirty-five years later in development assistance: Have we moved on, or just performed a minuet? *Development Policy Review* 22(5): 483-495.

Samad, M.; Molle, F.; de Silva, S. Forthcoming. Toing and froing: The politics of water pricing in Sri Lanka. In *Irrigation water pricing policy in context: Exploring the gap between theory and practice*, eds. François Molle, Jeremy Berkoff and Randy Barker. IWMI/CABI: Comprehensive Assessment of Water Management in Agriculture.

Senaratna Sellamuttu, S.; Clemett, A. 2003. Avoiding conflict between fishers and farmers: A study of potential social conflict over scarce water resources in Kalametiya. Proceedings of the Fourth National Symposium on Poverty Research in Sri Lanka, organised by the Centre for Poverty Analysis (CEPA), the Programme to Improve Capacities for Poverty Research (IMCAP) and the Sri Lanka Association for the Advancement of Science (SLAAS).

SOGREAH Consulting Engineers. 1984. *Walawe Irrigation Rehabilitation & Improvement Project: Draft final report.* Reports for ADB and Sri Lanka. Mahaweli Authority of Sri Lanka. Vols. 2-4; 279, 232 and 12 pages.

Somatilake, H. S. 2002. Water for energy. In *World Water Assessment Programme. Sri Lanka case study. Ruhuna basins.* Proceedings of a workshop held at Koggala Beach Hotel, Sri Lanka, 7-9 April 2002, eds. K. A. U. S. Imbulana, P. Droogers and I. W. Makin. Colombo, Sri Lanka: International Water Management Institute. Pp.129-141.

Steele, T. 1867. *Report on the Hambantota district*. *Administration reports, 1867*. Colombo: Ceylon Government Press.

Visvalingam, A. C. 1986. Lessons for the Mahaweli from the Walawe Experience. Mimeo.

WCD (World Commission on Dams). 2000. *Dams and development: A new framework for decision-making.* London: Earthscan.

Wickremaratne, M. L. H. 1995. The rationale of the accelerated Mahaweli Programme. In *The blurring of a vision—The Mahaweli: Its social, economic and political implications*, eds. H. P. Muller and S. T. Hettige. Ratmalana, Sri Lanka: Sarvodaya. Pp. 24-70.

Williams, A. 1972. Cost Benefit Analysis: Bastard science? And/or insidious poison in the body politick? *Journal of Public Economics* 1, 2, 199-226.

Wolf, J. W. 1983. *Walawe irrigation system*.

World Bank. 1996. *World Bank's experience with large dams: A preliminary review of impacts*. Washington, D.C.: Operations Evaluation Department, World Bank.

## Abbreviations and Acronyms

| | |
|---|---|
| ADB | Asian Development Bank |
| CBA | Cost-benefit analysis |
| CEB | Ceylon Electricity Board |
| CECB | Central Engineering Consultancy Bureau |
| ECI | Engineering Consultants, Inc. |
| EIRR | Economic internal rate of return |
| FO | farmer organization |
| GDP | Gross Domestic Product |
| GWh | gigawatt-hour |
| ha | hectare |
| IEC | International Engineering Company, Inc. |
| JICA | Japan International Cooperation Agency |
| kWh | kilowatt-hour |
| LB | left bank of the Walawe river |
| LBMC | Left Bank Main Canal |
| LHG | low-humic gley soils |
| MASL | Mahaweli Authority of Sri Lanka |
| MC | main canal |
| MEA | Mahaweli Economic Agency |
| MMP | Sir M. MacDonald and Partners |
| OFC | other field crops (field crops other than rice) |
| O&M | operation and maintenance |
| RB | right bank of the Walawe river |
| RBE | reddish brown earth |
| RBMC | Right Bank Main Canal |
| Rs | Sri Lankan rupee |
| RVDB | River Valleys Development Board |
| t | metric ton |
| UWIRP | Uda Walawe Irrigation and Resettlement Project |
| WCD | World Commission on Dams |
| WIIP | Walawe Irrigation and Improvement Project |

## Units and Currencies

| | | |
|---|---|---|
| 1.0 hectare (ha) | = | 2.471 acres |
| 1.0 acre | = | 0.405 hectare |
| 1.0 metric ton (t) | = | 1,000 kg |

*Value of US$1.00 in Sri Lankan Rupees (Rs)*

| | |
|---|---|
| 1963 | US$1.00 = Rs 4.76 |
| 1967 | US$1.00 = Rs 4.86 |
| 1968, 1969 and 1970 | US$1.00 = Rs 5.95 |
| 1971 | US$1.00 = Rs 5.94 |
| 1972 | US$1.00 = Rs 5.97 |
| 1983 | US$1.00 = Rs 25.53 |
| 1993 | US$1.00 = Rs 48.35 |
| 1995 | US$1.00 = Rs 51.25 |
| 1999 | US$1.00 = Rs 70.59 |
| 2000 | US$1.00 = Rs 78.08 |
| 2002 | US$1.00 = Rs 95.40 |
| 2003 | US$1.00 = Rs 96.91 |
| 2004 (January) | US$1.00 = Rs 97.50 |

## Glossary

| | |
|---|---|
| anicut | diversion weir |
| *ara* | non-permanent river or tributary |
| *ganga* | river (large) |
| *maha* | cultivation season from October to March |
| *oya* | river or tributary |
| *purana* | indigenous |
| *wewa* | reservoir |
| *yala* | cultivation season from April to September |

## *Research Reports*

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