JAPAN
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JBICI Research Paper No. 32

Impact of Irrigation Infrastructure Development on Dynamics of Incomes and Poverty: Econometric Evidence Using Panel Data from Sri Lanka

March 2007

JBIC Institute
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Joint Research with
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Foreword

In 2005, Japan Bank for International Cooperation (JBIC), the World Bank and the Asian Development Bank together published the report, "Connecting East Asia: A New Framework for Infrastructure." In that report, it was clearly stated that "there is little doubt that infrastructure development—by both the public and private sectors—has contributed to the region's enviable record on growth and poverty reduction."

Since the beginning of Japanese ODA in 1954, we have always emphasized the importance of infrastructure for development, even during periods when other development organizations were turning to social development. Now that the importance of infrastructure is re-acknowledged, the main developmental research question would be how to make infrastructure contribute most effectively and efficiently to economic development and poverty reduction, rather than whether or not infrastructure contributes to economic development and poverty reduction.

This research paper, along with three others, is our preliminary effort in using developmental microeconomics to empirically investigate the mechanisms in which infrastructure impacts poverty reduction. By investigating the detailed path to poverty reduction, we hope to find implication for more effective infrastructure development.

Finally, I would like to thank the International Water Management Institute (IWMI) for their dedicated effort in this research. All four research papers, No.19, 31, 32 and 33 were conducted in collaboration with them.

March 2007

Teruyuki Tanabe
Executive Director
JBIC Institute

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This report is the outcome of the collaborative research project initiated by the JBIC Institute, the Japan Bank for International Cooperation and undertaken by the International Water Management Institute (IWMI). Several people have contributed, directly or indirectly, to the production of this output. First of all, we are thankful to our survey respondents who furnished information during the five household level surveys and whose cooperation made this study possible. We greatly acknowledge the hard work and active cooperation of field data enumerators and fieldwork supervisors, especially Mr J.K. Somasiri. Special thanks to Mr. Izhar Hunzai for his contributions in the development of the proposal for the first phase of this project.

This study has been undertaken under the collaboration of following members (all affiliations are for the time of the completion of the report in March 2003):

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Executive Summary

This report is the outcome of a collaborative research project that was initiated by the Japan Bank for International Cooperation (JBIC) Institute and undertaken by the International Water Management Institute (IWMI). The project was conducted in two phases. Phase I commenced in April 2001 and ended in March 2002. The output of the first phase was published by the JBIC Institute in November 2002 (JBIC Research Paper 19). The report was based on analysis of data and information collected from the first three household level surveys that covered the agricultural seasons during 2000-01. The scope of the study was expanded by initiating Phase II of the project in April 2002 for conducting two additional household-level surveys covering agricultural seasons during 2001-02. This enabled the reporting of analysis data and information for all five surveys that covered the two-year period, and further strengthened the empirical findings reported in the earlier companion report.

The overall goal of the study is to develop an in-depth understanding of income dynamics in relation to access to irrigation water and to comprehensively evaluate the impact of irrigation infrastructure on poverty. This study investigates the dynamic poverty-reduction effect of irrigation infrastructure development by integrating field observations, economic theory, and econometric analysis. Developed, improved or rehabilitated irrigation systems in Sri Lanka and Pakistan that have been funded by the JBIC were selected as study areas. This report provides the output of the Sri Lankan component of the study.

The main activities of the study comprised (1) selecting suitable study areas and specific study sites, (2) developing a detailed sampling framework, (3) developing a panel database by undertaking household-level surveys during the years 2000–02 in order to include "before," "during," and "after" situations both for the wet and dry seasons of the year, and (4) undertaking econometric analyses of the impacts of irrigation infrastructure on poverty.

The study uses primary data collected through household surveys that were conducted five times during the years 2000-02 from a sample of 858 households, and using a detailed multi-topic questionnaire. The study was undertaken in Uda Walawe Left Bank Irrigation System (WLB) in the Uda Walawe area (Ruhuna Basin) in Sri Lanka. The study area exhibits considerable variability in cropping patterns. The main crops grown in the area include paddy, sugarcane, banana and other upland crops. The type of farming in the study area varies from irrigated to rainfed to Chena cultivation. Demographically, there is a combination of government allottees, encroachers, and

non-farm households in the area. Since the entire irrigation infrastructure in the WLB irrigation system has already been rehabilitated, upgraded or improved, the adjacent rainfed area and an irrigation system with the same source of water but without upgraded or improved infrastructure were selected as control sites for comparison purposes.

The study area was divided into six strata based on the following criteria: availability or non-availability of irrigation infrastructure, improved or unimproved irrigation infrastructure, and cropping pattern. A multistage sampling procedure was adopted for selecting the sample households in each stratum. The study employed a "with" and "without" approach by comparing sample areas with well developed/ improved irrigation, less developed/unimproved irrigation, and no irrigation.

The study focuses on three key aspects of the irrigation infrastructure-poverty nexus: (1) determine whether access to irrigation infrastructure increased household incomes and expenditures; (2) determine whether access to irrigation infrastructure affects variability in household incomes and expenditures; and (3) determine consumption smoothing effects of households' access to irrigation infrastructure. Three major hypotheses that were tested in the study are (1) the incidence, depth, and severity of poverty are lower in agricultural settings with irrigation infrastructure than in settings without infrastructure; (2) the variability in incomes and expenditures is lower in agricultural settings with irrigation infrastructure than in settings without infrastructure or, in other words, irrigation infrastructure helps to smoothen incomes and expenditures; and (3) if incomes in agricultural settings with irrigation infrastructure are higher than in settings without infrastructure, consumption expenditure may not track incomes during the year. On the other hand, if incomes in agricultural settings without irrigation infrastructure are lower than in settings with infrastructure, consumption expenditure may track incomes during the year. The key approaches used for rigorously testing these hypotheses in the study are as follows: (1) Inter-strata comparisons using quantitative values on various socio-economic (including household incomes and expenditures) indicators; (2) Inter-strata comparisons using both monetary and qualitative indicators of poverty; (3) Econometric analyses that estimate household income/consumption smoothing effects of irrigation infrastructure development on poverty; and (4) Econometric analyses that estimate key determinants of household incomes/expenditures/poverty, including estimating the impacts of irrigation infrastructure development (it should be clear at the outset that the study is based on inter-household analysis and does not examine intra-household poverty structures).

This study departs from conventional irrigation-poverty related studies in two important aspects. First, it treats poverty as a dynamic concept and decomposes observable poverty into chronic and transitory components. Second, it considers both temporal and spatial dimensions while quantifying the impact of irrigation infrastructure development and rehabilitation on dynamic poverty. In doing so, the study develops household-specific poverty profiles over the course of 24 months and traces the movements into and out of poverty during that period. Both income and non-income indicators of poverty are utilized to construct dynamic poverty profiles. This provides a useful insight into the relative magnitude of chronic and transient poverty. The irrigation-related poverty impacts are evaluated using an equity-efficiency-cost recovery and sustainability framework (Sampath, 1988; 1992) that in turn is integrated into a dynamic poverty framework (Sawada, 2000). In addition, dominance analysis is used to establish the superiority of one poverty profile over another. The quantitative findings are validated by using qualitative perceptions of users with regard to the benefits of irrigation infrastructure development and rehabilitation.

The results of this study provide strong quantitative evidence on the role of irrigation infrastructure development on poverty alleviation, particularly chronic poverty. The findings suggest that the incidence, depth, and severity of poverty—as measured by income/consumption-based FGT indicators—are the highest in areas without irrigation infrastructure and lowest in areas with access to established irrigation infrastructure and with adequate water supplies. The general indicators of household welfare, participatory poverty assessments, and self-rated assessments of the benefits of irrigation infrastructure by the user communities themselves, all reinforce income/consumption-based estimates of poverty; therefore, these indicators lead us to conclude that access to irrigation infrastructure has strong anti-poverty and welfare-enhancing effects for rural communities.

An analysis of socio-economic and demographic characteristics of the households across different settings indicates that family size is larger in irrigated areas than in rainfed areas. The number of workers per household is lower in rainfed areas, such that the dependency ratio is very high in the two rainfed settings as compared with any of the irrigated settings. The number of years of schooling and experience in farming are higher for the household head in irrigated areas than in rainfed settings. However, the incidence of female headship is significantly higher in irrigated settings. Although the land tenure arrangements are more or less similar and land markets are largely inactive in all settings, there is some evidence to suggest that land lease markets are relatively more active in irrigated settings as compared with rainfed settings, which leans toward the view that irrigation enables households to adopt a

risk-averse behavior and lease out plots that are situated in less favorable areas. Therefore, the policy of land resettlement under irrigated conditions has helped to reduce the incidence of landlessness and inequality in land distribution, although inequality in land ownership is relatively higher in areas without access to irrigation because the process of land allotment is currently underway and households are awaiting decisions on their land title submissions.

An analysis of the indicators of agricultural performance reveals that crop intensification, land productivity of major field crops, gross value of production per hectare, and degree of crop diversification are all higher in irrigated settings than in rainfed settings. Crop intensification in irrigated conditions enables households to cultivate crops during both the wet and dry seasons, and, therefore, has a strong land augmentation effect. Per hectare labor employment is higher in irrigated settings than in rainfed settings, such that access to irrigation infrastructure generates almost an extra month of employment during the wet season alone, when only labor use for crop production is accounted for. Further, household-level access to irrigation infrastructure reduces inter-season variability in labor employment, both hired and family, which implies that irrigation generates higher and stable employment throughout the year. Further, irrigation enables households to earn higher daily wages, and this difference in daily wages is sufficient to uplift one person out of poverty for every working member.

Not only do households in irrigated settings have better housing quality (as measured using the housing index), access to electricity, and other infrastructure, they also exhibit better health and lower incidence of malnutrition (as measured using the Body Mass Index (BMI) of household heads). Household heads whose BMI falls below 18.5 are classified as malnourished. Assessed on this criterion, the incidence of adult malnutrition is significantly higher in rainfed settings than in irrigated settings (33 and 27 percent, respectively). Sevanagala irrigated has one of the lowest incidences of adult malnutrition (24.5 percent), while the reverse is true for Sevanagala rainfed and Extension Area where malnutrition is rampant at a hefty 38 and 29 percent, respectively. However, both Extension Area and Sevanagala rainfed have the highest incidence of adult malnutrition. Although irrigated settings have lower indices for adult malnutrition than rainfed settings, in absolute terms, the incidence is very high and indicates chronic energy deficiency among household heads. The results indicate that households in irrigated settings tend to have more balanced diets.

A decomposition of the livelihood sources reveals that in absolute dollar terms, the overall total income and source-wise income—except non-rice crop income and agricultural-wage income—are higher in irrigated settings than in rainfed settings. Income from non-rice crops and agricultural wage work is higher in rainfed settings than in irrigated settings because these households are dependent on non-rice crops due to the non-availability of irrigation and low-paid agricultural wage work for their sustenance. Although land inequality is modest, mainly due to the land re-settlement policy, income inequality is not—the latter being substantially higher than the former. Household endowments of physical and human capital resources, and, therefore, the ability to secure high paid jobs, must explain the inequality in income distribution. However, whatever the sources, income distribution is more unequal than land distribution in our settings. Extension Area has the highest inequality in land and income distribution.

Income patterns reveal that (1) Extension Area has the lowest average income as compared with any of the settings with access to irrigation infrastructure; and (2) farm households have higher incomes than non-farm households. This implies that access to irrigation and involvement in farming activities enables households to earn higher incomes. An analysis of intertemporal income patterns in irrigated and rainfed settings indicates that despite considerable variability in incomes over the course of the agricultural year, incomes in irrigated areas are generally higher than in their contemporary rainfed settings, and this holds true for all 12 months.

Estimates of poverty using FGT poverty indices reveal that in irrigated (rainfed) settings over 78 (81) percent of the households have some experience of poverty over the course of 12 months; in other words, their income becomes lower than the poverty line at least once during 12 months. Approximately 25 percent of the households in irrigated settings are chronic poor, while the corresponding figure for rainfed settings is 45 percent. Further, Extension Area has one of the highest incidences of total poverty (88 percent), the lowest percentage of non-poor households, the highest incidence of chronic poverty (55 percent), and the highest average headcount index (57 percent). On the other hand, the incidence of poverty is more or less similar in Sevanagala, although merely 19 percent of the households are chronic poor in Sevanagala irrigated, while the corresponding figure for Sevanagala rainfed is 27 percent. More importantly, all four irrigated settings have relatively lower incidences of chronic poverty than either of the rainfed settings. Estimates of transient poverty indicate that almost one-third of the poverty in Extension Area is transient, while over half of the poverty headcount is transient in irrigated settings. In both Sevanagala irrigated and Ridiyagama, over 70 percent of the total poverty is transient, and this is an expected outcome given the lowest chronic poverty in these settings. The average

index or monthly poverty rate, in other words, the total poverty headcount indexed by the number of months—which is 12 for this empirical estimation—is highest in Extension Area, and one of the lowest in Sevanagala irrigated and Ridiyagama.

Farm households have a lower incidence of poverty, and almost half the incidence of chronic poverty as compared with non-farm households. For farm households, almost two-thirds of the total poverty is transient, while for non-farm households half of the total poverty is transient. The average monthly poverty rate is lower for farm households (38 percent) than for non-farm households (47 percent). The headcount estimates indicate that whether it is overall poverty or chronic poverty, irrigated settings out-perform Extension Area; moreover, a greater part of the poverty in irrigated settings is transient, while a greater part of the poverty in Extension Area is chronic. This reveals that the incidence, depth, and severity of total and chronic poverty are lower in either of the irrigated settings than in Extension Area, and for farm households than for non-farm households. Further, a major proportion of each poverty type in irrigated settings is transitory. Therefore, this implies that whether it is total poverty or chronic poverty, irrigation infrastructure development unfailingly contribute to poverty alleviation. Moreover, the impact of irrigation interventions is much more pronounced on chronic poverty, although transitory poverty continues to be a problem.

Since consumption is often argued to be a better measure of poverty than income, in order to fully comprehend the poverty-alleviating effects of irrigation infrastructure we also constructed consumption/expenditure-based poverty estimates for households across settings. The results are similar and in general support the aforesaid conclusions.

Using coefficient of variation and standard certainty equivalence as measures of negative welfare costs of income/consumption variability, household-level estimates indicate that income/consumption variability implies welfare costs for all segments of the population, poor or non-poor. The negative welfare cost of income/ consumption fluctuations is low for the non-poor and high for the poor. Among the poor, the negative welfare cost of intertemporal income/consumption variation is highest for the transitory poor and relatively low for the chronic poor. Further, for all socio-economic groups, negative welfare cost of income/consumption seasonality is higher for households in irrigated settings. While all rural households are vulnerable to income risk, the poorest among them are least able to protect themselves against income variability and shocks; therefore, they absorb the largest negative welfare cost. This implies that the poor, in particular the transitory poor, will be the largest beneficiaries of targeted income-stabilization or consumption smoothing programs.

This study compares seasonal consumption patterns of different groups of households that have different seasonal income patterns based on a set of household characteristics that determine the timing of income receipts. These factors include access to irrigation infrastructure (irrigated/rainfed and improved/unimproved), occupational status (farm/non-farm households), poverty types (non-poor, chronic, and transient poor households), and degree of crop diversification (households with high/low crop diversification). The results reveal that the average monthly expenditures of households depend on average monthly incomes, and this is true for all the abovementioned strata and socio-economic groups. There are month effects in expenditures in all strata and groups. The results of this study indicate that monthly variations in consumption expenditures — in other words, month effects in expenditures—are higher for households in irrigated areas than in rainfed areas, higher for farm households than non-farm households, higher for non-poor households than chronic or transient poor households, and higher for households with high crop diversification than for those with low crop diversification. Expenditures in August and September (dry season) are much higher for households in settings with access to irrigation infrastructure than in households in strata without irrigation infrastructure, and for farm households than for non-farm households. These results are clearer in the comparison of households in irrigated (all) areas with those in rainfed areas, where month effects in expenditures for households in irrigated areas are higher and significant for all months and patterns of monthly expenditures are different, particularly during August and September. The results from these comparisons imply that household groups that have different income patterns also have different expenditure patterns (although not in all months), thereby suggesting that in addition to average monthly incomes and pure month effects (tastes, preferences, and prices), the timing of income receipts does influence monthly expenditures (the case of imperfect smoothing). The households' access to irrigation infrastructure helps in improving average incomes and increasing monthly incomes during the dry season. Therefore, households with access to irrigation infrastructure are in a better position to smooth their expenditures than those without it. We conclude that variations in monthly expenditures depend on the level of average monthly incomes, month effects (prices, tastes, and preferences), and monthly income share/timing of income flows. Overall, the results of the study imply that irrigation infrastructure helps to reduce income fluctuations and enables households to smooth their consumption.

In addition, the estimates of the multivariate regression model reveal that access to irrigation infrastructure at the household level has significant impacts on the levels of household incomes/expenditures. However, the magnitude of impact depends upon the adequacy/inadequacy of water. While the results suggest that irrigated areas in general have higher expenditure levels than rainfed areas, the higher the number of

family workers, family size, extent of agricultural land owned, value of non-land agricultural assets, productivity of land, non-crop farm income, and non-farm income of the household, the higher is the level of expenditures. The implications are that irrigation infrastructure — an important and significant contributor to annual expenditures—can increase annual incomes/expenditures/welfare and can, therefore, provide considerable benefits to the household and contribute substantially towards poverty reduction through income and consumption smoothing effects.

In view of the synergy between quantitative and qualitative approaches, we integrate our quantitative assessment of the dynamics of irrigation and poverty with a qualitative assessment based on perceptions of the communities in question (farmers, respondents, and subjects). The survey results reveal that farmers perceive that development and rehabilitation of irrigation infrastructure has enabled them to save scarce water resources, save maintenance labor, expand irrigable area, and realize higher crop yields. Moreover, it has improved timeliness and adequacy in irrigation supplies in general. In particular, users candidly confirm that system rehabilitation has promoted equity in irrigation distribution to the tail-end farmers and increased the poor's access to irrigation supplies. In other words, it has been both equitable and pro-poor. However, some reduction in seepage to home gardens and consequent loss in productivity has been reported.

The results of the study suggest that while irrigation infrastructure development has significant impacts in reducing poverty, providing irrigation infrastructure is only one, albeit disproportionately powerful, element of modern rural development strategies. The benefits of irrigation infrastructure development and rehabilitation to the rural communities can be enhanced by other complimentary interventions and infrastructure provisions and strengthening initiatives—such as development of small irrigation tanks and technologies that use raw material and local labor—both during construction and subsequent operation and maintenance. This would empower the poor by improving access to land resources, streamlining the land titling process, making land titles legally transferable and enforceable by the legal system, thereby providing crop and enterprise diversification opportunities that are supplemented by income diversification opportunities, and generating new avenues for non-farm employments. In particular, our results provide strong quantitative support to the latter types of interventions because they demonstrate that access to irrigation creates enabling environments and incentives for the rural communities to diversify crop production and shift from low-value subsistence crops to high-value market-oriented production, thereby earning a higher implicit wage rate for the surplus family labor. Strong land and water augmentation effects confer additional benefits to the rural households; however, on-ground realization of these benefits is contingent on several

enabling environments and conditions—the following are certain observations with regard to such environments and conditions:

First, irrigation infrastructure is a necessary but not sufficient condition for strengthening anti-poverty impacts of rural interventions, particularly in settings where agriculture is a major source of livelihood. Nevertheless, water is important. Should there be prolonged droughts, poorly distributed rainfalls, or water shortages, these and similar unhealthy conditions will discount the utility of irrigation infrastructure.

Second, there are strong complementarities between irrigation infrastructure and other forms of rural infrastructure, and the returns to infrastructure would fall drastically if one type is increased in isolation from the other, or without regard to characteristics of the rural user communities. Complimentary infrastructure interventions and human capital formation strategies — particularly education programs for the farmers—micro-credit programs, and market-support systems are highly desirable for intensifying the benefits of irrigation and other rural infrastructure investments affected thus far.

Third, participation is important. Development and rehabilitation of irrigation and other rural infrastructure should incorporate elements of empowerment. This can be achieved by involving the communities in the operation and management of the systems that, in addition to giving them a voice and stake, will also inculcate a spirit of ownership. Irrigation infrastructure tends to deteriorate, particularly if not managed properly, and as the maintenance tends to be labor intensive, community involvement —and at a latter stage system transfer to the farmers—would be particularly desirable from an efficiency, equity, cost recovery, and sustainability perspective.

Fourth, interventions that complement crop and income diversification strategies—that have been adopted by the households in an effort to spread risk—and other related pro-poor interventions are required forthwith in order to enhance the returns to irrigation infrastructure investments and optimize their intended benefits to the rural communities.

Part 1

Chapter I Introduction

1.1 Background

A large majority of the population in the Asia-Pacific continues to face food insecurity, malnutrition, vulnerability, and injustice despite decades of efforts directed at alleviating these ills. Growing populations, increasing demand for food, scarcity and degradation of natural resources, and ensuing social unrest are causing concern among development planners. A cause for particular concern is the limited access to and quality of land and water resources, which militates against food security for the poor and perpetuates poverty.

International development assistance agencies and donors have recently reinvigorated their efforts to alleviate poverty in developing countries. *A world free of poverty* has become the key focus of their development lending. The Millennium Development Goals (MDGs) have been internationally recognized as a common set of objectives to be achieved by 2015. These include the following goals: Goal 1-eradicate extreme poverty and hunger (reduce by half the number of people living on less than $1 a day); Goal 2-achieve universal primary education for all; Goal 3-promote gender equality and empower women; Goal 4-reduce child mortality; Goal 5-improve maternal health; Goal 6-combat HIV/AIDS, malaria, etc; Goal 7-ensure environmental sustainability; and Goal 8-develop a global partnership for development. Alleviation of extreme poverty, hunger and food insecurity, empowerment of the poor through improved access to resources, and environmental protection were also emphasized as important goals in the Johannesburg Summit on Sustainable Development in August 2003. An interesting aspect of these problems is that most of them are directly or indirectly related to water in both its production as well as consumption uses.

In the efforts to reduce poverty, two issues remain central: (1) proper identification and targeting of the poor in order to enhance the effectiveness of anti-poverty initiatives and programs and (2) identification of interventions/investments that have the highest impact on poverty (i.e., pro-poor investments). Once the poor and the pro-poor interventions are accurately identified, a portion of the poverty problem may be solved. There has been significant debate in the past on the first issue, leading to developments in the concept of poverty. It is now widely recognized that poverty is multidimensional, extends from low levels of income and consumption to lack of education and poor health, and includes social dimensions such as powerlessness,

insecurity, vulnerability, isolation, social exclusion, and gender disparities. Similarly, the concepts of livelihoods, basic capabilities and entitlements, and well-being have broadened the understanding of the poverty problem. In recent years, the perception of poverty has changed from a static to a dynamic one. Two useful concepts of dynamic poverty are chronic or permanent poverty and transient poverty. Chronic poverty is caused by persistently low levels of income and therefore remains the same over time, while transient poverty is caused by intertemporal fluctuations in income and therefore changes over time. Recent studies suggest that the two poverty types are not the same, and a significant component of existing poverty is only transitory. Further, the processes that cause these also differ. This implies that any efforts to quantify and alleviate poverty using estimates from a single point in time would poorly define and target the poor. Static measurements of poverty may be a poor estimate of the poor because these measurements capture those who fall into the poverty trap because of temporary misfortunes, or omits those who escape poverty due to temporary good fortune. Errors of inclusion or errors of exclusion are well-documented concerns in conventional poverty studies. Therefore, poverty alleviation policies that are based on static poverty definitions can lead to poor targeting and large leakages to the non-poor. Hence, for applied policy making and fine-tuning the targeting efforts, the concept of dynamic poverty has become popular among development planners. However, the construction of reliable dynamic poverty profiles generally requires panel data sets that span several seasons/years. Not only are such data difficult to acquire from the developing world, but efforts to collect such information have only recently begun.

It is commonly accepted that the development of irrigation infrastructure promotes growth and helps to improve the welfare of rural communities, and therefore, it has the potential to alleviate poverty. Further, irrigation infrastructure development, *inter alia*, in general, helps small, and presumably poor, farmers, to manage risk and reduce the income variability caused by untimely and unevenly distributed rainfall. However, there is little knowledge with regard to (a) the potential of irrigation infrastructure development and rehabilitation in alleviating dynamic poverty and (b) the enabling conditions under which such interventions are pro-poor. This study aims to fill this important gap in irrigation-poverty literature in terms of clarifying the relationship between irrigation infrastructure development and dynamic poverty.

IWMI has identified the following basic premise for intensifying the dynamic poverty-irrigation discourse:

a. Irrigation can help reduce transient poverty by reducing sudden fluctuations in income. The opportunities offered by irrigation can enable poor farmers to mitigate

or avoid the adversities associated with water scarcity, floods or drought, or personal setbacks.

b. Previous investments in irrigation infrastructure have tended to be more growth and production-oriented rather than equity-oriented. This imbalance can be corrected by complimentary interventions in the mainstream programs and by reaching out to the poor through better analysis and quantification of opportunities and constraints.

c. All-inclusive and poverty-focused interventions are required to enable the poor to share equitably in the benefits of irrigation; particular focus on poverty is required in *all* interventions designed to mitigate the impacts of water scarcity and associated problems on the poor.

d. Irrigation infrastructure and other forms of infrastructure, such as physical, human, social, and environmental, have a complimentary relationship. A combination of irrigation and other infrastructure interventions can achieve more than a single intervention.

1.2 Goal and Objectives

This study aims to evaluate the effectiveness of irrigation infrastructure development and rehabilitation as a policy instrument for dynamic poverty alleviation in developing countries. The objective of this study is to assess the impact of infrastructure development by using the concepts of transient and chronic poverty, by taking into consideration case studies of irrigation projects in Sri Lanka and Pakistan.

The study aims to fill a major gap in literature that is related to the role of irrigation in dynamic poverty reduction. It formally investigates the dynamic poverty reduction effect of irrigation infrastructure development by integrating field observations, economic theory, econometric analysis, and voices of the poor. In addition, this study also takes into account the impact of other infrastructure development, such as credit utilization, access to medical facilities, availability of electricity, and access to paved roads and communication facilities. By using the quantitative and qualitative evaluation results, the study also derives policy implications for future infrastructure development.

Specific objectives of the study are:

1. To assess the impacts of irrigation infrastructure development on poverty alleviation by taking into consideration JBIC-financed irrigation projects as case studies and using multi-season panel data sets.

2. To develop and refine an analytical method for the quantification of the impact of irrigation infrastructure development on dynamic poverty alleviation.

3. To identify a set of performance indicators in order to measure the impact of irrigation infrastructure development on dynamic poverty alleviation, and to test their intertemporal stability in contrasting environments.

4. To establish a panel database for impact assessment and to understand the dynamics of poverty in the selected study areas.

1.3 Scope and Coverage

The scope and coverage of the study include the following:

1. Undertake assessments of the impacts of irrigation infrastructure development on poverty by taking into consideration selected JBIC funded projects–Uda Walawe area in Sri Lanka (Uda Walawe Left Bank Irrigation System).

2. Establish a detailed methodology that includes inputs, outputs, and data requirements for the study. Develop an analytical framework that includes the indicators of poverty in order to analyze intertemporal changes in income, consumption, and welfare.

3. Utilize the sampling framework developed in Phase I of the study for implementing a second round of surveys, by incorporating lessons learnt in Phase I. The framework is based on several criteria that include access to irrigation water, cropping patterns, and stage of development of irrigation infrastructure. The specific locations that were identified within the selected areas were those where irrigation infrastructure is well established/developed/improved, partially developed/improved, unimproved, and those with no infrastructure.

4. Conduct household-level surveys over the course of an agricultural year using a representative sample of 858 rural households in order to establish a panel database.

5. Evaluate the impact of irrigation infrastructure on dynamic poverty reduction using the "with and without" approach by comparing sample areas with improved, unimproved, and no infrastructure and without irrigation in order to develop the optimal combination of irrigation accessibility in each of the selected settings.

6. Compare the intertemporal movements of household income and consumption, e.g., variance and means, in the surveyed areas. Through this quantitative evaluation, assess the impact of the irrigation infrastructure on dynamic poverty in the selected locations, *ceteris peribus* (assuming that other conditions such as climate, soil, and access to the market are more or less similar across the selected areas and locations in order to control these external factors in the analysis).

7. Conduct an econometric analysis of household-level panel data in order to investigate the impacts of irrigation infrastructure development and rehabilitation on dynamic poverty reduction. The empirical framework will be based on a rigorous analysis of dynamic investment and consumption decisions of rural households.

In summary: The main activities during Phase II include the following: (1) generating panel database by undertaking household-level surveys during the year (2001–02) to include "before," "during," and "after" situations both for the wet and dry seasons of the year and (2) implementing previously established protocol for irrigation-poverty impact evaluation and undertake econometric analyses of the impacts of irrigation infrastructure on dynamics of incomes/expenditures and poverty.

1.4 Organization of the Report

This report is organized into three parts comprising 14 chapters. Part 1 (chapters 1 to 3) provides the background material for the study. Chapter 2 provides a brief review of literature on the impact of irrigation infrastructure development on poverty. Chapter 3 provides an overview of the key developments and trends in the Sri Lankan economy, its agricultural sector, its poverty situation, and overall trends in the country. Part 2 (chapters 4 to 6) provides details on the study methodology. The overall study design, approach, and sampling framework are discussed in chapter 4, while details on household-level survey instruments, administration, and data collection procedures are discussed in chapter 5. Chapter 6 elaborates on the approach and analytical framework of the study. Part 3 (chapters 7 to 14) reports the results of the study. Profiles of sample households including asset base and livelihood patterns are provided in chapter 7; economics of crop production are provided in chapter 8 and dynamics of household incomes and expenditures, in chapter 9. Chapter 10 provides detailed estimates of chronic and transient poverty. The econometric analysis of

income-consumption seasonality and quantitative estimates of the impact of infrastructure development on poverty are provided in chapter 11. Chapter 12 provides an analysis of and the relationship between enterprise diversification and poverty alleviation, whilst chapter 13 describes the newly developed Mini Tank Dual Canal System in the Walawe Left Bank Irrigation System, Sri Lanka. Finally, a summary of the findings of the study, conclusions, and policy implications are provided in the last chapter. Other information, including detailed descriptive statistics, graphs, and supplementary tables are provided in the appendices of the report.

Chapter II Role of Irrigation Infrastructure Development in Poverty Alleviation: Review of Recent Research

Irrigation has been practiced for long in Asian countries, including India, Pakistan, and Sri Lanka. Not only did colonial governments make large investments in the development of large-scale irrigation systems in these countries, but postcolonial governments have more or less sustained these policies and investment patterns; in addition, they have also complemented irrigation infrastructure investment with the provision of other rural infrastructure[1] such as education and healthcare facilities, farm-to-market roads, rural telephones, electricity, and services such as banks, post offices, and rural/regional commodity markets and procurement centers. The key policy rationale behind these infrastructure investments have varied from (a) fighting hunger and famine and achieving food security for the rural poor, as in pre-independence India; (b) population resettlement; (c) raising revenue; and (d) as an instrument to exercise political and administrative control. Since the majority of the poor tend to live in rural areas, rural infrastructure developments have been implicitly assumed to target the poor and improve their access to these services, thereby promoting equity in favor of the poor. This has also served as an argument for state-ownership and public control of rural infrastructure projects, including irrigation, in Asia and elsewhere. However, empirical evidence indicates that with the exception of Eastern Europe, rural areas in general and poor locations in particular have inadequate infrastructure (Clarke and Wallsten, 2002); this is mainly due to the widespread failure of state monopolies. Sampath (1988) argues that publicly funded irrigation interacts with inequitable land and wealth distribution in India and worsens inequality. Further, the efficacy of these investments in alleviating poverty and malnutrition and delivering quantifiable and on-ground benefits to the poor is being questioned. Given the increasing scarcity of water resources, decelerating agricultural productivities, increasing resource degradation, and call for transparency, equity, and sustainability, donor and agency attention appears to be drifting away from future investment commitments. In addition, the vocal public is demanding a more equitable and fair allocation of national budget, and community-based organizations are mounting pressure to redirect government investment priorities and allocate more

[1] Major forms of rural infrastructure interventions include roads and bridges, canals and watercourses, (tube) wells, irrigation dams, water diversion structures, flood protection embankments, school and colleges, rural health centers, veterinary hospitals, extension and crop advisory services, product procurement centers, agricultural equipment rental centers, postal service, banks, storage warehouses, electricity, telephone, piped water supplies, sewage, and, more recently, information and communication technologies. Historically, almost all these services/ instruments have been operated in the public domain either by government agencies or large monopolies, and the private provision of these services is a most recent, but limited, episode in developing countries.

funds to the less favored but poverty prone areas, which had previously been underrepresented in government financial allocations. The policy dynamics of these trends have put the spotlight on the prior role of irrigation and rural infrastructure investments in reducing poverty.

Historically, government-patronized and foreign-donor-assisted rural infrastructure development programs in South Asia for achieving food security have contributed over three decades of sustained regional growth in food and livestock production, particularly through expenditures on agricultural technologies (high-yielding varieties of seeds, fertilizers, and other inputs), agricultural services (extension, credit), and rural infrastructure (irrigation, roads and markets.) For example, between 1980 and 1995, the net irrigated area increased by 30 percent in India, while it more than doubled in Bangladesh (World Bank, 2001). Similarly, in Pakistan, the average wheat yield increased from 1.7 tons per ha in 1970 to 2.2 tons per ha in 1999 (Government of Pakistan, 2002). The availability of irrigation enabled some farmers to cultivate up to three rice crops (*boro*, *aman*, and *aus* rice) per year in Bangladesh, and two rice crops and another third crop in certain parts of India. The poor received some benefits from these three decades of growth. For example, increased supply led to a decline in the real prices of food. Higher agricultural intensification and crop diversification increased the demand for labor and contributed to rising agricultural wages, the two being major factors contributing to the decline in rural poverty (World Bank, 2001). Governments in Asian countries have largely been able to achieve national food security; moreover, the success of the green revolution and technological change in Asia is directly centered on past infrastructure investments, including irrigation. However, anecdotal evidence on the misuse of public funds, corruption concerns, and negative third-party impacts arising from large-scale irrigation in Asia also exists.

While there are arguments in favor of both sides of the debate on the irrigation-poverty nexus, proponents believe that irrigation is a powerful instrument for the alleviation of rural poverty; the opponents, on the other hand, argue that irrigated areas continue to remain homes to a large number of people, and the environmental problems associated with irrigation (such as land degradation, water logging, and salinity) hit the poor first and hard, consequently perpetuating rural poverty. We choose not to subscribe to either of these views but rather opt to glean this evidence from empirical literature on irrigation and poverty.

Literature on the impacts of irrigation on poverty alleviation can be classified into the following three broad categories: (1) systematic empirical research measuring impacts with rigorous methods using primary or secondary data and information, with a focus on specific locations; (2) general articles and papers based on common

perceptions and logic; and (3) appraisals, evaluations, and assessments of projects, which are mostly undertaken by funding agencies. Our review focuses on the first category i.e., published, peer-reviewed empirical research studies.

There are three main pathways through which irrigation infrastructure development and rehabilitation can interact to alleviate rural poverty:

1) ***Micro pathway*** through increasing returns to physical, human, and social capital of households including the poor
2) ***Meso pathway*** through integrating the poor into factor products and information markets (*market participation* pathway)
3) ***Macro pathway*** through improving national growth rates and generating second-generation positive externalities (*growth* pathway)

The micro-level impacts are realized at the farm, household, and local levels, and these affect the intermediate variables of poverty including cropping intensity, land and water productivity of crops, labor employment, household income, etc. A number of studies conducted in various settings and countries indicate that cropping intensity, crop productivity (principally rice, according to these studies) and per ha employments are higher in irrigated settings than in rainfed settings. The recent empirical studies and settings include Agarwal and Rai (2002)—Gomti basin in the Gangetic plains, UP, India; Asian Development Bank (2000)—Kirindi Oya Irrigation Project, Sri Lanka; Bouman and Tuong (2001)—Philippines; Estudillo, Quisumbing, and Otsuka (2001)—Philippines; Fan, Hazell, and Haque (2000)—India; FAO (2002)—Indonesia; Food and Agricultural Organization of the United Nations (2002)—Malaysia; Garcia, Garcia, Oo, and Hossain (2000)—Myanmar; Hossain, Gascon, and Marciano (2000)—Philippines; Huang, Rozell, Huang, and Wang (2002)—China; Hussain, Marikar and Tharikawala (2002)—55 villages in Sri Lanka; Indian Planning Commission (1998)—All India (before-after focus); Integrated Agricultural Development Project North Selangor, Drul Ehsan, Malaysia, (2002); International Rice Research Institute (2002)—Comilla (irrigated) vs. Rajshahi (rainfed) districts, Bangladesh; Isvilanonda, Ahmad, and Hossain (2000)—Thailand; Janaiah, Bose, and Agarwal (2000)—India; Jatileksono and Otsuka (1993)—Indonesia; Joshi and Jha (1981)—East and West Uttar Pradesh, Mohanty (1999)—Villages in Maharashtra, India; Parthasarthy (1996)—India; Rahman (1999)—Bangladesh; Samarasinghe and Samarasinghe (1984)—Thalpotha area in Dry Zone, Sri Lanka; Thapa, Otsuka, and Barker (1992); Villages in Nepal Terai; Ut, Hossain, and Janaiah (2000)—Vietnam; von Braun, Puetz, and Webb (1989)—The Gambia. A comparative overview of these studies reveals the following

1. Cropping intensity, one of the intermediate indicators of poverty, is higher in irrigated settings than in rainfed settings. Cropping intensity ranges between 111 and 242 percent in the irrigated setting and 100 and 168 percent in the rainfed setting. Therefore, the availability of irrigation facilities has enabled farmers to raise almost one extra crop a year, with consequent implications for household food security.

2. Irrigation has contributed toward increasing the land productivity of major crops, including rice and wheat, the main staple foods of the Asian rich and poor alike. For example, rice yields fall in the vicinity of 3.0-5.5 tons per ha in irrigated settings, while the upper bound corresponding figure in rainfed settings is approximately 4.0 tons per ha; this implies that farmers can harvest an extra ton of rice per ha due to access to sufficient irrigation. Similarly, wheat yields are higher in irrigated settings than in rainfed settings.

3. Labor employment per ha and wage rates are higher in irrigated settings than in non-irrigated settings. Further, the former serves as an employer of surplus labor of adjoining non-irrigated areas. Although some studies have hinted at labor displacement under the influence of mechanization, these studies measure only the direct employment effects, although the indirect employment effects of irrigation may be much larger and often sufficient to counterbalance these *adjustments*.

Similarly, there is a second set of empirical studies that indicate that household income is higher and poverty is lower in irrigated settings than in rainfed settings. These include the following: Asian Development Bank (2000)—Kirindi Oya Irrigation Project, Sri Lanka; Estudillo, Quisumbing, and Otsuka (2001)—Villages in Philippines; Fan and Hazell (2000)—Rural India; Fan, Hazell, and Haque (2000)—Rural India; Garcia, Garcia, Oo, and Hossain (2000)—Myanmar; Hossain, Gascon, and Marciano (2000)—Villages in Luzon and Panay, Philippines; Huang, Rozell, Huang, and Wang (2002)—Sixty villages in 6 provinces in China; Hussain, Marikar, and Tharikawala (2002)—Irrigated and rainfed settings in Walawe area, Sri Lanka; Isvilanonda, Ahmad, and Hossain (2000)—Villages in rural Thailand; Janaiah, Bose, and Agarwal (2000)—Chhattishgarh, India; Mohanty (1999)—Maharashtra, India; Rahman (1999)—Villages in Jamalpur and Jessore, Bangladesh; Rajuladevi (2000)—Landless females in Tamil Nadu, India; Renkow (1991)—Pakistan; Samarasinghe and Samarasinghe (1984)—Thalpotha area in Dry Zone, Sri Lanka; Shand (1987)—Kemubu project, Malaysia; Thakur, Bose, and Janaiah (2000)—Bihar, India; Thapa, Otsuka, and Barker (1992)—Villages in Nepalese Tarai; Ut, Hossain, and Janaiah (2000)—Vietnam; von Braun, Puetz, and Webb (1989)—The Gambia. Although these studies do not use common income categories and yardsticks to permit meaningful inter-comparisons,

irrespective of the units used, income in irrigated settings is higher than in rainfed settings, and a 50 percent point gap is not uncommon. Moreover, income inequality is lower in irrigated settings than in rainfed settings, at least for these studies. The lower bound being almost the same, the upper bound Gini values are 0.53 and 0.61 for irrigated and rainfed settings, respectively. Some studies indicate that inequality is increasing and the poor appear to be losing out; this dampens progress in poverty alleviation in irrigated areas. Inequalities in resource endowments and multiple market failures often worsen existing income inequality. These studies have consistently documented evidence of lower poverty rates in irrigated settings than in rainfed settings. For example, the poverty headcount ranges from 18-53 percent in irrigated settings and 21-66 percent in rainfed settings. Studies using the dynamic concept of poverty—such as those by Hussain et al. (2002)—show that the incidence of chronic poverty is 10 percent (5 percent) lower for irrigated areas in Sri Lanka (Pakistan) than in the adjoining rainfed areas. The depth of poverty, measured by the poverty gap index, where reported in these studies, is found to be much higher in rainfed than in irrigated settings. This shows that the poor in rainfed areas are located relatively deeper below the poverty line, which implies that the income of the poor in rainfed settings has to grow manifold and relatively faster in order for them to match the level of the poor in an irrigated setting or to escape poverty.

A number of abovementioned studies, and others including Balisacan (1992 and 1993)—The Philippines; Binswanger, Khandker, and Rosenzweig (1993)—India; Datt and Ravallion (1998)—India; dela Cruz-Dona (2000)—73 out of 75 provinces in the Philippines; Faki, Gumaa, and Ismail (1995)—Irrigated schemes, Sudan; Fan, Hazell, and Thorat (2000)—India; Fan, Hazell, and Thorat (2000)—India; Fan, Zhang, and Zhang (2002)—China; Hanrahan and McDowell (1997)—Bolivia; Hassan, Faki, and Byerlee (2000)—Gezira irrigation scheme, Sudan; Hassan, Fletcher, and Ahmed (1989)—Rahad irrigation scheme, Sudan; Hossain, Gascon, and Marciano (2000)—Philippines; Hossain, Sen, and Rahman (2000)—Bangladesh; Huang, Rozell, Huang, and Wang (2002); Jagaich (2000)—Punjab, India; Joshi, Bahl and Jha (1981)—East and West Uttar Pradesh, India; Karunakaran and Palanisami (1998)—Tamil Nadu, India; Lampung, Indonesia; Looney (1994)—the Indus Basin Pakistan; Mann (1989)—India; Minot (2000)—Vietnam; Nagarajan (1999)—Erode district, Tamil Nadu, India; Narayanamoorthy (2001)—Indian states; Narayanamoorthy and Deshpande (2002)—Indian states; Orr (2000)—Malawi; Parthasarthy (1996)—India; Rahman (1999)—Bangladesh; Ravallion and Datt (1996)—India; Singh and Binswanger (1992)—Three villages in semi-arid tropics, India; Srivastava (1998)—Assam, India; Thiruvengadachari (1996)—Bhadra Project, Karnataka, India; Shah and Singh (2002)—Gujrat, India; Ut, Hossain, and Janaiah (2000)—Vietnam; van de Walle (2000)—Vietnam; and van de Walle and Gunewardena

(2001)—Vietnam have used econometric models to establish the irrigation-poverty nexus. Although the irrigation infrastructure variable is defined differently (for example, as a ratio of irrigated area to cultivated/command area, access to irrigation, and modern variety-irrigation interaction term, etc.), almost all of these micro and econometric studies show that irrigation is a positive determinant of income, a negative determinant of poverty, and households that have access to irrigation (and complimentary inputs) are less likely to be poor. Therefore, irrigation turns out to be a negative determinant of poverty, although the marginal effects of growth and irrigation on poverty (and the strength of their relationship) vary considerably, being approximately one for the headcount index and rising to approximately two for the squared poverty gap in India.

In addition to the above, a set of selected synthesis articles and reviews focus on the irrigation-poverty nexus. These include the following: David and Otsuka (1994)—a synthesis of eight village-level studies from seven Asian countries including Bangladesh, China, India, Indonesia, Nepal, Philippines, and Thailand, using cross-sectional village and household-level data collected during 1985-88; DFID (2001)—review material from South Asia, and particularly from Bangladesh and Nepal; FAO (1999)—a conceptualization of benefits of irrigation to the poor with selected examples from global empirical literature, and a succinct menu of how to increase the benefits of irrigation to the poor; Freebrain (1995)—analysis of the results of 307 empirical studies undertaken during the period 1970-89 (post-green revolution) to investigate the effects of the green revolution; IDE (2002)—a summary of research documents available with IDE (India), including studies conducted in Aurangabad and Bijapur, Cooch Bihar, Deccan Plateau, Gujarat, Himachal Pradesh, North Bihar, Uttar Pradesh, Orissa in India, Nepal Terai, and Bangladesh; Jayaraman and Lanjouw (1999)—a review of 35 longitudinal village-level studies from Andhra Pradesh, Bihar, Gujarat, Karnataka, Kerala, Maharashtra, Orissa, Punjab, Rajasthan, Tamil Nadu, Uttar Pradesh, and West Bengal in India; Kishore (2002)—empirical studies on socioeconomic impacts of canal irrigation in India, and spanning the past 30 years; Lipton et al. (2002)—an extensive review of empirical studies on direct and indirect impacts of irrigation on outputs, employments, prices, health, environment, resource allocations, and its equity and poverty implications at the micro and macro levels; Silliman and Lenton (1985)—review of evidence from 45 micro-level irrigation studies, with 25 of these from India; Songco (2002)—a survey of evaluations in sub-sectors of rural roads and transport, water supply and sanitation, energy, and irrigation, augmented by a case study conducted in two provinces in the Central Highlands of Vietnam; and von Braun eds. (1995)—a synthesis of long-term (1988-94) multi-country studies, conducted largely by IFPRI, in Bangladesh—Food-for-Work program, China—Yigong-daizhen Program, India—Employment Guarantee Scheme of

Maharashtra, and Botswana, Ethiopia, Tanzania, Niger, and Zimbabwe in Africa, and Bolivia, Chile, Costa Rica, Honduras, Mexico, and other countries in Latin America. These reviews and synthesis papers re-affirm the role of irrigation in enhancing crop intensification and productivity, generating employment, promoting growth, and enhancing and sustaining rural livelihoods.

Although macro-level studies are few in number, these provide strong evidence that the availability of irrigation facilities promotes growth. How the benefits of growth are spread across sectors and shared by various socioeconomic groups depends on the linkages with the rest of the economy and the size of national multipliers. For example, Haggblade et al. (1991) cite an income multiplier of 1.71 for the Muda Valley Irrigation Development Project in Malaysia (Goldman, 1982), which implies that a dollar increase in agricultural income will generate an additional 71 cents in rural non-farm goods and services. Bhattarai, Narayanamorrthy, and Barker (2002) estimate that the aggregate irrigation multiplier operating in India is approximately 3.15, which implies that each benefit of US$100 generated by irrigated crop land will generate another US$215 in the local economy on account of an induced effect. While the irrigation multipliers may vary from country to country, it helps to emphasize that an increase in agricultural productivity delivers large benefits to the rural communities, including the poor, and a large share of these benefits accrues through indirect channels and in the long term. In a state-of-the-art study, Mundlak, Larson and Butzer (2002) analyzed the effect of infrastructure variables, inputs, and price incentives on agricultural growth in Indonesia (1971-98), the Philippines (1961-98), and Thailand (1971-95). The infrastructure variables included in the growth model are roads, which represent physical infrastructure, and indicators of education and health, which represent human capital endowments. The education variable is given by the percentage of agricultural workers with no schooling for Indonesia and Thailand and as the mean accumulated school years of the total labor force (schooling percentage) for the Philippines. The infant mortality rates capture the level of health. The input variables include irrigated land, rainfed land, fertilizers, capital, and labor. The incentive variables are prices and shadow prices. The dependent variable is the log of value added, and not of the production. The results indicate that physical infrastructure accounted for 11-15 percent of the output growth in Thailand and Indonesia. Schooling and infant mortality had a similar contribution, with some variability over time. The infrastructure variables together accounted for a large proportion of the total factor productivity growth in all three countries, which should have a negative effect on poverty. Further, the second generation or multiplier effects should generate higher employment and incomes for the poor and non-poor.

Interestingly, the above analysis indicates that irrigated land contributed between 10–16 percent of output growth. The irrigated land has an elasticity of 0.46 in Indonesia, which is very high. The contribution of rainfed land is substantial in the Philippines and Thailand in the first period, but less important in the second period. The marginal productivity of irrigated land increased slightly in Thailand but less so in the Philippines. The marginal productivity of irrigated land rose drastically in Indonesia. This indicates that, as modern varieties of crops are grown intensively in irrigated land, and with the advent of modern production technologies, scarce resources are mobilized to irrigated land and the productivity of rainfed land suffers. The marginal productivity of irrigated land adjusted for labor is 1.6 labor years for Thailand and the Philippines and 4.9 for Indonesia. However, the marginal productivity of irrigated land is higher than that of rainfed land for all the three countries, and so is its contribution to total factor productivity and growth rates. The ratio of shadow rent on irrigated land to rainfed land is a good indicator of the marginal productivity of irrigated land. By this parameterization, irrigated land is approximately 2.5 times as productive as rainfed land in Thailand and the Philippines. Further, the productivity of irrigated land as compared with rainfed land is considerably higher in Indonesia. Fertilizers (an indicator of technological change) accounted for 14–20 percent of the growth. The elasticity of fertilizer varied from 0.06 to 0.084 (note the difference with irrigated land). The contribution of labor to growth varied considerably. The authors contend that the alleviation of rural poverty is not progressing well because modern agricultural technologies reduce labor requirement, wage rates are intentionally kept low, and labor income is low. Therefore, the welfare of the landless is not improving. On the other hand, landowners are able to work for a greater number of days on their farms and earn a higher implicit wage rate, which in turn increases returns to their physical and human capital endowments. Therefore, the alleviation of rural poverty, in the opinion of the authors, depends largely on the creation of non-farm employment opportunities.

Datt and Ravallion (1998b) show that farm productivity and rural poverty in India have moved hand-in-hand. The timings of irrigation and other infrastructure developments are of consequence. States with a better initial stock of infrastructure and irrigation intensity achieved higher growth in agricultural productivity, which in turn helped to reduce rural poverty. Jalan and Ravallion (2001) show that in China, irrigation usage reduces the amount of liquid wealth, thereby reducing the unproductive use of funds. Using Indian state-level time series data for the period 1957-91 Datt and Ravallion (1998) demonstrate how states with higher initial investments in physical and human infrastructure have performed better in promoting growth and alleviating poverty than poorly endowed states. Scholars note that differences in the trend rates of poverty reduction (measured as the squared poverty

gap) are attributed to differing growth rates of yield per acre, an indicator for technological progress in agriculture, and differing initial conditions. In the post-independence era, initial endowments of physical infrastructure and human capital appear to have played a major role in explaining the intertemporal trends in poverty: higher initial irrigation intensity, higher initial literacy, and lower initial infant mortality rates *all* contributed to higher long-term rates of poverty reduction. For example, states with lower irrigation rates, such as Maharashtra, achieved lower reduction in poverty than those with high irrigation rates, such as Punjab and Haryana. Evidently, the differences in poverty outcomes are due to differences in initial conditions of physical and human capital resources or past spending priorities, rather than inequitable growth and distributional outcomes. The authors contend that states with low levels of initial rural development were not well suited to achieve large reductions in poverty through economic growth (Datt and Ravallion, 2002a, 2002b). Further, Datt and Ravallion (1998) find "no sign" of trade-offs between growth and pro-poor distribution outcomes; however, they note that the rural poor are adversely affected by inflation in the short run and fluctuations in crop yields. In fact, adverse price movements and poor macroeconomic management can do more harm to the poor than could be offset by pro-poor growth; the Asian financial crisis and *el nino* are fresh memories of such effects.

In case of rural Vietnam, van de Walle (2000) hints at the pro-poor character of irrigation investments, given the right economic environment. This indicates that increased investments in adult education would generate gains accruing primarily to the poor and would have a strong equalizing effect on returns to irrigation investments; in other words, returns to irrigation would be higher for the poor than the non-poor, given the right level of adult education. Therefore, an appropriately targeted adult education program in Vietnam would have a "substantial equalizing effect" through its impact on returns to irrigation investments. Conversely, in the presence of inequalities in educational endowments, returns to irrigation for the poor are likely to remain lower: knowledge-poor will remain income-poor.

Canning (1999) emphasizes the distinction between quantity and quality dimensions of infrastructure by presenting measures of both quantity and quality in his database of world infrastructure stocks for 152 countries[2]. The database contains six measures of quantity: km of road, paved road, and railway line, and number of main telephone

[2] A Database of Political Institutions encompassing 177 countries over 21 years, 1975–95, also exists. It details political parties, tenure and stability, party affiliations, fragmentation, and parties in legislature (Beck et al., 2001). Do we have similar macro-meso-micro details regarding irrigation infrastructure worldwide, regionally, and locally? Unfortunately, little is known about large, old, established agency-managed irrigation systems let alone small scale farmer managed irrigation systems.

lines and electricity-generating capacity. Measures of infrastructure quality are the percentage of roads in poor condition, percentage of unsuccessful local telephone calls, percentage availability of diesel locomotives (environmental quality variable), and percentage of electricity lost from the distribution system. Usually, these quantity and quality distinctions are lacking in the analyses, and therefore, people continue to act in an information vacuum. Canning's regression results for infrastructure stocks show "a stable long-run relationship" between infrastructure and economic growth worldwide. This finding implies that the development of physical infrastructure will raise permanent incomes in the long run, and therefore make large reductions in chronic poverty globally.

Canning's analyses indicate that wide disparities exist in the distribution and access to infrastructure among rich, middle-income, and poor countries. This view is supported by Clarke and Wallsten (2002), who brand the poor's access to infrastructure as "*Universal(ly Bad)*." Based on World Bank's Living Standards Measurement Study, surveys from 15 countries, including Pakistan, Komives et al. (2001) further strengthen this observation. They explore the relationship between the access to infrastructure and the income level of households. Their study reports the extent to which poor households do not have access to electricity, in-house water taps, sewer connections, and private telephones. The study shows that as monthly household incomes increase from US$100 to US$250 (note that this lower (upper) bound is approximately 1.2 (2.9) times the poverty line used in our study), the coverage rates of these infrastructure rise, but at different rates. With exceptions, the findings confirm that the very poor rarely have these infrastructure facilities, and where communities are connected, many poor decide to connect too. The study negates self-exclusion but hints that infrastructure gaps exist for poor households.

Some of the empirical studies reviewed above have hinted at negative externality effects of irrigation infrastructure developments that include population displacement, upstream developments and over-abstraction of water resources, species, habitat, and biodiversity impacts, misuse of public funds and corruption, inequitable distribution of benefits of irrigation investments among poor with little land and landless households, the labor-saving nature of green-revolution technology, and inequities in the distribution of irrigation water, etc. These issues indicate operational problems in irrigation management and call for a more appropriate response from the irrigation planners and managers, and *per se* do not discount the significance of irrigation developments in alleviating rural poverty. Further, it is the failure of coordination and multiple markets that affect the poor the most, and these external factors must be completely accounted for while evaluating the impact of irrigation on poverty.

It must be pointed out that the impact of irrigation on poverty depends on how poverty is defined and measured. In such studies, it is important to distinguish what component of total poverty is chronic and what component is transitory. Often, transient poverty constitutes a large component of total poverty. For example, Jalan and Ravillion (2000) find that 49.39 percent of the squared poverty gap in China is transient. In some provinces, for example Guangdong, transient poverty accounts for 84.21 percent of total poverty. Unfortunately, most studies do not follow the chronic-transient framework for poverty analyses. Recent empirical studies that follow the chronic-transient approach in investigating the irrigation-poverty nexus are the JBIC/IWMI (2002) joint study, its sister study in the Indus Basin in Pakistan, and contributions by Sawada and Shinkai (2002) in Sri Lanka and Kurosaki (2001) in North Western Province, Pakistan. These contributions to knowledge provide strong empirical evidence that irrigation infrastructure does have a positive impact on reducing both chronic and transient poverty.

In summary, irrigation infrastructure developments have helped to increase crop productivities, crop intensification, and income diversification; these developments have also generated higher levels of employment and stable income for the rural households and delivered an opportunity to achieve household-level food security for the poor, but with consequent negative impacts on poverty. However, irrigation infrastructure development, like all other development programs, may have had its spillovers and unintended negative impacts. These unintended impacts *per se* do not discount the effectiveness of irrigation developments in alleviating poverty, rather they indicate the operational or *software* issues in irrigation management and call for a more focused and informed response from both the planning community and political governments. Therefore, before branding irrigation as being poverty-insensitive or anti-poor, it is necessary to acknowledge the strong complementarities that exist between irrigation and other physical infrastructure and human capital, the quantity and quality dimensions of infrastructure stocks, and the nature of market imperfections and governance, and more importantly, to distinguish whether poverty is chronic or merely transitory. The above arguments lead us to believe that the benefits of irrigation investments to the poor will continue to be discounted, and the existing inequality would continue to be compounded and long-term pro-poor growth would be compromised unless complementary and targeted interventions in *both* physical and human capital infrastructure are affected forthwith.

Chapter III Poverty Trends in Sri Lanka: An Overview

This chapter provides an overview of the poverty trends in Sri Lanka. It commences with a brief and succinct overview of the Sri Lankan economy; thereafter, a comparison is conducted with other South Asian and comparator countries from other regions, dynamic poverty trends are analyzed, and key determinants of poverty are gleaned from country-specific empirical literature. This is followed by a brief overview of key anti-poverty programs that have been instituted by various political governments in Sri Lanka. The last section presents an overview of irrigated and rainfed farming in Sri Lanka, with an explicit focus on the role of irrigated land and population resettlement schemes. Further, this chapter highlights the manner in which international donors and development agencies operating in Sri Lanka are mainstreaming water development as a central constituent of their integrated rural development portfolio.

3.1 The Sri Lankan Economy at a Glance

Sri Lanka is a tropical island in the Indian Ocean that gained independence in 1948. It has complex irrigation systems, some of which date back to the 5th/6th century BC. Estimates indicate that Sri Lanka has a population of 19.6 million, which grew at 1.3 percent during 1990-2001, and a population density of 304 people per square km (all these are figures pertaining to 2001). Further, the country's gross national income is $16.3 billion, which grew at 1 percent per capita during 2000-01, and stood at $830 per capita in terms of World Bank's purchasing power parity. In terms of social indicators, Sri Lanka has a life expectancy of 73 years at birth, under-five mortality rate of 18, and an adult illiteracy rate of 8 percent (World Development Report, 2003).

Sri Lanka is divided into the wet (West, South-west, and Centre) and dry zones (North, East, and Southeast). Its population is concentrated mainly in the wet zone and the island remains predominantly rural. Central Bank of Sri Lanka (2000) estimates that the population distribution is 72 percent in the rural area, 21 percent in the urban areas, and 7 percent in the estate sector; further, approximately 36 percent of the labor force is engaged in agriculture, forestry, and fishing. Although the share of the agriculture sector to national GDP has declined persistently over time, it continues to contribute approximately one-fifth to the GDP. In addition to permanent plantations (rubber, tea, and coconut), both permanent and shifting cultivation of field crops is practiced. Paddy is by far the dominant crop, grown in both wet and dry seasons, while other crops such as sugarcane, bananas, chilies, onions, pulses, maize, potatoes, vegetables, and fruits are also grown.

Through the decades, Sri Lanka has made sustained investments in public health, education, and service delivery to rural and urban areas; as a result, it now boasts of social indicators that are more in line with those of a developed nation than its poor country counterparts with a per capita income of just over US$800. For example, compared with all South Asian countries (including Bangladesh, India, Nepal, and Pakistan) and selected East Asian and Pacific economies (including China, Indonesia, Philippines, Thailand, and Vietnam), Sri Lanka has the highest life expectancy at birth, the lowest under-five mortality rate and child malnutrition, and the highest net primary enrollments (Table 3.1). However, access to safe drinking water and infrastructure services, as measured by paved road length and the number of phone lines per 1000 population, is lower than these comparator countries. Further, Sri Lanka has strong green credentials, only second to Nepal, as its annual carbon dioxide emissions are much below the one-ton-per-capita threshold for most other countries.

Table 3.1: World Development Indicators for Sri Lanka and other Regional Countries

Region/ Country	Population in millions (2001)	Life expectancy at birth (2000) Years 2000	GNI per capita Atlas[a]$ (2001)	Under-5 mortality rate Per 1,000 (2000)	Child malnutrition % underweight (1993-2000)[b]	Net primary enrollment % (1998)	Adult illiteracy rate % 15 years and above (2000)	Prevalence of HIV, female % ages 15-24 (2000)	Access to safe water % (2000)	Fixed line and mobile telephones Per 1000 person (2000)	CO2 emissions Million tons (1998)
South Asia	**1380**	**62**	**450**	**96**	**49**	**-**	**45**	**0.48**	**87**	**31**	**1,194.4**
Selected countries											
Bangladesh	133.4	61	370	83	61	104	59	0.01	97	5	23.4
India	1033.4	63	460	88	47	-	43	0.61	88	36	1,061.0
Nepal	23.6	59	250	105	47	-	58	0.20	81	12	3.0
Pakistan	141.5	63	420	110	38	-	57	0.04	88	24	97.1
Sri Lanka	19.6	73	830	18	33	102	8	0.05	83	63	8.1
East Asia and Pacific	**1825.2**	**69**	**900**	**45**	**10**	**91**	**15**	**0.16**	**75**	**171**	**4,022.6**
Selected countries											
China	1271.9	70	890	39	10	91	16	0.02	75	178	3,108.0
Indonesia	213.6	66	680	51	34	*95*		0.03	76	49	233.6
Philippines	77.0	69	1,050	39	32	101	5	0.06	87	124	76.0
Thailand	61.2	69	1,970	33	18	77	5	2.32	80	143	192.4
Vietnam	79.5	69	410	34	37	97	7	0.09	56	42	43.9

Source: World Development Report, 2003; *2002 World Development Indicators* database, World Bank, 20 April 2002, http://www.worldbank.org/data/databytopic/sas_wdi.pdf.

a. Atlas method; see WDI *Statistical methods.*

b. Data are for the most recent year available. Figures in italics are for years other than specified.

Historically, successive governments in Sri Lanka have maintained[3] an emphasis on universal health and education and have attempted to capitalize on the high level of human capital that the country inherited at independence. Universal and free health and education services and a focus on gender equality and women's education have been permanent features of Sri Lanka's social policies over several decades. A large number of these programs have also benefited from fairly strong external donor support. These remarkable achievements have implied higher levels of well-being for all Sri Lankans and have contributed to a considerable reduction in income and non-income poverty. Table 3.2 presents quantitative estimates of poverty using both national and international poverty lines for selected countries in the Asia-Pacific region. It is evident that for all three poverty lines, for which estimates are available, both the percentage of population below the poverty line and the poverty gap is lowest for Sri Lanka than its comparator countries, although its income distribution, as indicated by the Gini coefficient, is not better than certain economies. Official estimates concede that from 1986-87 to 1996-97, the Gini coefficient increased that indicated a worsening of income distribution across the urban, rural, and estate sectors. In light of the latter observation, it is unclear if the poorest of the poor are also benefiting, and whether relative poverty is declining in Sri Lanka. Further, Sri Lanka's success in reducing income poverty is less "noteworthy" when compared with East Asian countries that started with comparable levels of development a few decades ago. For example, the per capita income of Sri Lanka was comparable to Thailand, Korea, and Malaysia in the 1960s. At the end of the 20th century, income in Sri Lanka was less than half that of Thailand, one-fourth that of Malaysia, and one-tenth that of Korea. Although poverty in Sri Lanka declined to approximately 25 percent in 1995-96, this is still about twice than that in Thailand, Malaysia, and Korea for both nationally comparable poverty lines and international poverty lines (World Bank, 2002).

As noted earlier, despite its historical achievements in human development and favorable economic growth, the country has been unable to eradicate poverty, and poverty continues to persist and perpetuate in various forms. As Sri Lanka has no official poverty line, empirical studies have utilized different indicators to identify the poor and quantify poverty over time. The mainstream approaches include (a) food-energy intake, (b) household income, and (c) household expenditure, and more

[3] In terms of numbers, government spending on social welfare (health, education, and welfare benefits) was maintained at relatively high levels during the 1970s with over 40 percent being spent on welfare. The expenditure on education and health accounted for approximately 20 percent and that for food subsidies accounted for 20 percent of government expenditure. In the late 1980s, certain austerity measures were affected and the expenditure on food stamps was reduced to approximately 6 percent and that on education and health to approximately 16 percent of the total current expenditure. As a share of total government expenditure, it has ranged from 23.1 to 27.8 percent (over 1994-1998), while as a share of GDP it has ranged from 7.3 to 8.5 percent. Overall, the welfare benefits have averaged at 9.7 percent of total government expenditure in the mid-1990s and reached 12.7 percent in 1996.

Table 3.2: Incidence of Poverty in Selected Asian Countries

Country	National Poverty Line* (Population below poverty, %)			$1 a day International Poverty Line**		$2 a day International Poverty Line		Gini Value
	Rural	Urban	National	Population blow (%)	Poverty gap (%)	Population blow (%)	Poverty gap (%)	
Bangladesh	39.8	14.3	35.6	29.1	5.9	77.8	31.8	33.6
India	36.7	30.5	35.0	44.2	12.0	86.2	41.4	37.8
Nepal	44.0	23.0	42.0	37.7	9.7	82.5	37.5	36.7
Pakistan	31.9	19.1	28.2	31.0	6.2	84.7	35.0	31.2
Sri Lanka	-	-	25.0	6.6	1.0	45.4	13.5	34.4
Philippines	50.7	21.5	36.8	-	-	-	-	46.2
Indonesia	-	-	27.1	12.9	1.9	65.5	21.5	31.7
China***	4.6	<2	4.6	18.8	4.4	52.6	20.9	40.3
Vietnam	44.9	9.0	37.4	-	-	-	-	36.1

Source: World Bank (2003).
* Bangladesh, 1995–96; Indonesia; Nepal, 1995-96; Source: World Bank (2003)
* Pakistan, 1998–99; Source: Government of Pakistan (2002)
** Bangladesh, 1996; India, 1997; Nepal, 1995; Pakistan 1996; Sri Lanka 1995: Source: World Bank (2003)
***China: National figures, 1998; international poverty line figures, 1999.
Philippines: 1997.
Vietnam: 1998, Source: Cho and Yagi, eds. (2001).
Source for Gini values: World Bank (2003).

recently a prototype of holistic approaches. Since the yardsticks used by empirical studies for poverty measurement are not the same, this poses potential difficulties for establishing clear trends in poverty reductions. Table 3.3 presents an overview of data sources, poverty lines, and poverty estimates from various empirical studies conducted between 1970 and 2003. It is evident that (a) there is wide variation in empirical poverty estimates, (b) poverty estimates differ even for studies using the same datasets and reference periods, and (c) data comparability problems obscure intertemporal poverty comparisons.

In order to establish clear trends in poverty reduction, it is inevitable that estimates are based on comparable data and use the same indicators of poverty, for example, those based on the cost-of-living approach and defining poverty lines in terms of minimum per capita expenditure for food energy intake as well as living expenses. Unfortunately, such empirical studies are rare. Table 3.4 provides poverty estimates for three points in time, using a reference and a higher poverty line as well as data from the Consumer Finances & Socio-economic Survey 1996-97 of the Central Bank of Sri Lanka. Although not strictly comparable to the earlier data, all sectors show a reduction in poverty. The lower half of Table 3.3, which uses a higher poverty line, indicates a similar trend as the lower reference poverty line for all sectors. The

magnitude of poverty is obviously higher because of the high poverty line. Urban poverty indicates a decline between 1986 and 1990 and a marginal rise in 1996. In the estate sector, poverty declined substantially between 1986 and 1991, but increased above the 1986 level in 1996. The increase in poverty in rural areas between 1991 and 1996 is attributed to the drought that prevailed during this period. The highest incidence of poverty was recorded in 1995-96 among households that derived their income from agriculture. Thus, slow per capita growth in agriculture (only 1 percent during 1990-96), major droughts, contraction in the paddy sector, and slow growth in the rubber and mining subsectors may have contributed to the high poverty levels in these sectors.

Overall, poverty in Sri Lanka has declined over time. Datt and Ravallion's (1992) analysis of three recent datasets confirms that the declining trend in poverty reduction has continued since the mid-1980s, although poverty reduction somewhat slowed down during the early 1990s. This trend holds regardless of the threshold at which the poverty line is set. The decomposition of changes in the Foster-Greer-Thorbecke (FGT) poverty measures reveals that between 1985-86 and 1990-91 the national poverty level fell because of consumption growth and favorable redistribution. Between 1990-91 and 1995-96, the lack of consumption growth explains the increase in poverty. During this period, the pattern of redistribution was more complex with favorable redistribution offsetting the lack of consumption growth in the urban sector. In the rural and estate sectors, both growth and redistribution effects were adverse, contributing to the rise in poverty.

Table 3.3: Empirical Estimates of Poverty in Sri Lanka from 1970 to 2003

Study	Reference period	Data source	Definition and reference poverty line	Percent poor-Sri Lanka	Percent poor-Urban	Percent poor-Rural	Percent poor-Estate
Visara (1979)	1969-70	DCS (1970)	Food energy intake 2750 calories per capita per day	52.0	58.3	52.3	38.5
Bhalla and Glewwe (1985)	Do	Do	Per capita food expenditure Rs. 70 per month at 1978-79 prices	11.2	5.0	12.8	11.1
Anand and Harris (1985)	1978-79	CBSL (1983)	Per capita food expenditure Rs. 60 per month at 1978-79 prices	12.3	14.3	12.8	3.6
Gunaratne (1985)	Do	Do	Per capita food expenditure Rs. 70 per month at 1978-79 prices	22.3	19.4	25.0	7.6
DCS (1987)	1985-86	DCS (1987)	Average monthly household income to meet minimum food energy intake (2200 kcal) and basic needs Urban=Rs. 1920 Rural=1610 Estate=Rs. 1451	39.4	27.6	45.7	5.7
Datt and Ravallion (WB, 1995)	Do	Do	As above Rs. 565.44 per capita per month	40.6	26.8	45.5	30.8
World Bank (1995)	1990-91	DCS (1994)	Food energy intake and basic needs Rs. 565.44 per capita per month	35.3	28.4	30.5	27.5
DER (2000)	1995-96	DCS (1995-6)	Expenditure Rs. 791.67 per capita per month	25.2	14.7	26.9	24.9
DER (2000)	Do	Do	Expenditure Rs. 950 per capita per month	39.2	24.9	41.3	45.3
Pradhan (2000)	1996-97	CBSL (1996-7)	Rs. 860 per capita per month	18.9	17.3	20.3	17.5
Hussain, Marikar and Thrikawala (2002)	2000-01	Monthly panel data (Uda Walawae only)	Income and expenditure Rs 952 per capita per month	-	-	16.0*	
World Bank (2003)	Do	WDI database	Dollar a day	6.6	-	-	-

Source: Partially adapted from Tudawe (2002)
*Chronic poverty, based on quarterly data.

Table 3.4: Intertemporal Poverty Estimates for Sri Lanka by Sector

Category	1985/1986			1990/1991			1995/1996		
	Incidence	Depth	Severity	Incidence	Depth	Severity	Incidence	Depth	Severity
	Reference Poverty Line : Rs 792 per person per month at 1995/1996 prices								
Urban	18.4	4.4	1.6	15.0	3.4	1.2	14.7	3.0	0.9
Rural	35.6	8.9	3.2	22.0	4.5	1.4	27.1	5.8	1.9
Estate	20.5	3.9	1.3	12.4	2.1	0.6	24.9	4.9	1.6
Sri Lanka	30.9	7.6	2.8	19.9	4.1	1.3	25.2	5.4	1.7
	Higher Poverty Line : Rs 950 per person per month at 1995/1996 prices								
Urban	28.1	7.5	2.9	24.5	6.1	2.2	24.9	5.8	2.0
Rural	50.2	14.6	5.9	36.0	8.6	3.0	41.3	10.5	3.8
Estate	20.5	3.9	1.3	12.4	2.1	0.6	24.9	10.1	3.3
Sri Lanka	44.5	12.6	5.0	33.0	7.8	2.7	39.2	9.9	3.5

Source: Department of Census and Statistics; World Bank Sri Lanka Poverty Assessment 1995

Other studies have also suggested significant variation in the poverty, poverty reduction outcomes, and distributional effects across regions in Sri Lanka. As shown in Table 3.5, the incidence of poverty is high in Uva, followed by the North Western region. The incidence of poverty is almost similar in the Subragamuva and North Central regions, estimated at slightly over 31 percent. The Western region has the lowest incidence of poverty, estimated at approximately 14 percent in 1995 (at a lower poverty line) followed by the Southern and Central regions. Further, poverty reduction outcomes vary considerably among provinces.

Table 3.5: Incidence of Poverty in Sri Lanka by Region

Province	Poverty Head Count					
	Poverty line= Rs. 791.67 per person per month			Poverty line= Rs. 950.00 per person per month		
	1985	*1990*	*1995*	*1985*	*1990*	*1995*
Western	19.49	15.23	13.61	30.04	25.92	23.35
Central	30.11	23.49	27.89	45.64	37.88	42.90
Southern	39.24	23.73	26.84	53.37	38.64	41.38
North Western	33.78	18.03	33.87	48.50	31.00	52.38
North Central	33.05	18.16	31.16	50.76	34.12	46.67
Uva	40.45	23.71	37.04	55.56	39.81	55.17
Sabaragamuwa	40.96	23.07	31.59	54.74	35.65	46.77

Source: Gunetilleke (2000).

Table 3.6 reports intertemporal poverty reduction rates by province. It is clear that in the period 1985-95, poverty declined rapidly in the Western and Southern provinces but less so in the case of poor provinces such as the North Western and Uva. Table 3.7 reports the Gini coefficient for intertemporal consumption inequality among provinces. Although the Gini coefficients are not strictly comparable due to differences in the definition of expenditures in the 1995-96 and 1999-2000 surveys, the numbers indicate that the Western and Central provinces have the highest inequality, and relatively poor provinces, such as the Uva and North Western, have relatively low inequality. In general, consumption inequality has been increasing over time, and this holds true for all provinces.

Table 3.6: Poverty Reduction Rates (%) by Province: 1985 to 1995

Province	1985-90	1990-95	1985-95
Western	22	11	30.7
Central	22	-19	7.3
Southern	40	-12	32.4
North Western	47	-88	-0.3
North Central	45	-71	5.7
Uva	41	-56	8.6
Sabaragamuwa	44	-37	22.9

Note: A negative rate implies a rise in poverty, and a positive rate implies a reduction in poverty.
Source: World Bank (2002) calculations based on Gunewardena (2000).

Table 3.7: Gini Coefficient of Consumption Inequality by Provinces: 1995-96 and 1999-2000

Province	Gini Coefficient: 1995-96	Gini Coefficient: 1999-2000
Western	0.339	0.358
Central	0.297	0.349
Southern	0.294	0.325
North Western	0.268	0.292
North Central	0.284	0.264
Uva	0.287	0.297
Sabaragamuwa	0.280	0.331

Sources: 1995/96: Gunewardena (2000), based on 1995/96 Household Income and Expenditure Survey; 1999/2000: World Bank, based on 1999/2000 Sri Lanka Integrated Survey.

The current declining trend in the incidence of poverty is probably the result of structural changes and opening up of the economy, which has sustained a reasonably high rate of economic growth over the last 15 years. However, there continues to be a significant proportion of the population that remains susceptible and vulnerable to economic changes and income fluctuations because they are clustered at the borderline of the poverty line. Poverty levels are particularly high among landless and casual laborers employed in agriculture, mining, construction, and the informal sector. Greater vulnerability and insecurity of the poor and those clustered above the poverty line may be due to poor targeting of poverty alleviation programs, considerable increases in temporary and casual employment, and insufficient attention to risk management in agriculture. Further, relatively slower progress in poverty alleviation than its comparator countries, as noted above, is attributable to the reluctance in adopting modern economic and social policies; this has impeded progress in the structural transformation of the economy. Although the last two decades have witnessed gradual but sustained liberalization of the economy, the economy in general continues to be more protected than countries in East Asia and the Pacific, which are regions that began liberalization long after Sri Lanka, but managed to move forward much faster. Protracted unrest and ethnic conflict in the north further added to Sri Lanka's economic woes and certainly have had negative spill-over effects on other provinces, consequently leading to a rise in poverty. Had the country been able to (a) rapidly withdraw private sector regulation, (b) promote private sector participation, (c) facilitate effective functioning of financial markets, (d) limit the state's role strictly to the infrastructure and social services sectors, and (e) inculcate broad-based and self-inclusive social policies, then poverty reduction and welfare outcomes could have been different for Sri Lanka at the onset of the new millennium.

Overall, the government's track record in reaching out to the poor and delivery of education and healthcare services has been commendable. Sri Lanka has long been committed to well-established social welfare programs providing free health and education services to all. In addition to health and education programs, over time, various political governments have instituted a number of food subsidy programs to reach out to the poor, which had been implemented at varying scale and time horizons. For example, the Government of Sri Lanka introduced a food subsidy program in the 1940s for the poor in the aftermath of World War II, which continued until 1977. In 1978, this program was restructured and redirected to the poorest population, which was later re-emulated by various programs such as the Food Stamp Program (FSP) of 1979, the Janasaviya Program (JP) of 1989, the Mid Day Meal Program (MDMP) (targeted towards children) of 1989, and more recently, the Samurdhi program of 1995. A complete discussion of these programs, and their effectiveness, in reaching out to the poor is omitted here for reasons of maintaining brevity, and can be found in a sister

study (JBIC/IWMI, 2002), or other appropriate sources. Overall, these programs have met with varying degrees of success in targeting the poor. The political bias of program administrators, poor targeting and high transaction costs, poor participation rates, and weak exit mechanisms continue to haunt the later programs.

A survey of empirical literature on poverty in Sri Lanka shows that the poor are a heterogeneous group with diverse socioeconomic characteristics. Further, some are poor only temporarily, that is transitory poor, while others are innately or chronically poor. Transitory poverty may arise due to sudden fluctuations in household income/consumption, which can be smoothed in the short run, while chronic poverty arises from long-term defects and persistently low levels of consumption/welfare; these issues can only be addressed in the longer term. Notwithstanding the joint JBIC/IWMI study (2002) and Nanayakkara (1994), there are no quantitative studies pertaining to chronic and transitory poverty in Sri Lanka; therefore, little is known with regard to the specific determinants of chronic and transient poverty. However, quantitative studies analyzing poverty in general, and not in terms of chronic and transient, have identified certain general determinants of poverty, and these (Datt and Gunewardena, 1997; Gunewardena, 2000; Tudawe, 2000; Allailima, 2001; World Bank, 2000, 2002; Ajwad, 2002) reveal the following aspects:

1. Location: Rural poverty is generally higher than urban poverty. Moreover, poverty is lower in the wet zone while rural poverty is concentrated in the dry zone.
2. Occupation type: Households dependant on primary occupations, such as agriculture, fishing, and mining, tend to be poorer than households deriving income from other or multiple sources. Unskilled laborers tend to be the poorest.
3. Employment status: Poverty is higher among the under-employed, seasonally employed, and unemployed households.
4. Civil status: Older people, street children, working children, the disabled, and widows tend to be poorer.
5. Household size: Households with a larger size and high dependency ratio are poorer.
6. Headship: There is a higher incidence of poverty among female-headed households.
7. Education: There is an inverse relationship between poverty and the level of education.
8. Market participation: Households with limited access to formal credit and little or no productive assets as well as poor access to infrastructure and markets tend to be the poorest.

3.2 Water against Poverty in Sri Lanka

Publicly funded health, education, and food subsidy programs are important, but these are merely one facet of the programs aimed at alleviating poverty in Sri Lanka. In addition, in order to reduce the concentration of the poor in Sri Lanka's wet zone and to provide sustainable livelihood opportunities for them, the government has pursued a policy of population resettlement. This policy entailed the development of an irrigation system to help resettle the population from the land-scarce wet zone to the sparsely populated dry zone. Population resettlement in Uda Walawe, the study setting for this report, is one example of this policy. In these irrigated resettlement schemes, each settler household has been provided with 1–2 ha of irrigated land and 0.5 ha of highland for homestead. In addition, non-farm households have also been settled in the area. The JBIC/IWMI joint study (2002) assesses the impact of irrigation infrastructure development and rehabilitation on chronic and transient poverty in selected settings in this area by using a panel dataset collected for the period October 2000 to September 2001. Household-level dynamic poverty profiles, constructed by using income/consumption-based indicators, rapid rural appraisal methods, and participatory poverty assessments, show that irrigation infrastructure development aided in reducing both chronic and transient poverty. Households located in settings with no irrigation infrastructure, and, therefore, lacking irrigation facilities are either chronic or churning poor; moreover, the incidence, depth, and severity of poverty is much higher in these settings. Inadequate access to basic infrastructure has often been cited as a cause of poverty as has been low returns to investments in health and education. Further, development literature leans toward the view that poor provinces and poor households have the largest shortfalls in infrastructure. The poor have less access to basic services, such as safe drinking water, sanitation, electricity, efficient energy and safe cooking fuel, road transport, and communications. Basic infrastructure such as these is particularly deficient in plantations, which is where the majority of the poor live. As irrigated land resettlement has been accompanied by the provision of basic infrastructure such as road, electricity, telephone, healthcare, education, etc., these have helped to improve the poor's access to infrastructure and integrate them into the local and regional markets with clear anti-poverty impacts, as noted by the JBIC/IWMI joint study.

Centuries-old irrigation works in Sri Lanka are indicative of the fact that water has remained a critical resource in Sri Lanka's hydro-civilization. Sustainable management of irrigation water and infrastructure has been, and continues to be, the key focus of rural development and poverty alleviation efforts. World Bank has outlined its strategy and action plan for rural development in South Asia. The key elements of this, as spelled out by World Bank (2001), are as follows:

1. Enhancing human and social development in rural areas by focusing on health, nutrition, and education.
2. Facilitating rural and non-farm growth and competitiveness through policy support for regulatory reforms and sectoral investments.
3. Fostering efficient, sustainable, and equitable use of water resources through a program of assistance to the water sector and rural water supply and sanitation.
4. Improving natural resources and environmental management through a program of assistance to the fisheries and forestry sector for watershed development and disaster management.

The World Bank's country action plan for Sri Lanka (World Bank, 2001) further elucidates that its strategic objective is to promote more equitable and broad-based growth within the context of the Government's vision of poverty alleviation. Further, the Bank's strategy for Sri Lanka seeks to provide direct support to two medium-term development priorities identified by the government by (1) improving the investment environment and reinvigorating the rural economy to create a modern and productive economy and (2) empowering and building the assets of the poor. This endeavor is expected to provide a considerable boost to more equitable and all-inclusive growth. At the same time, the Bank would intensify the dialogue on improving the policy framework in agriculture, particularly emphasizing the maintenance of consistent trade and tariff policy, increasing access to imported agricultural technology, promoting large-scale private sector investment, improving service delivery and cost recovery in irrigation, and developing contract farming. Such measures would improve the productivity of poor farmers and promote commercial-market-oriented agriculture. Further, these plans seek to improve the delivery of basic services to the underprivileged rural areas and implement various rural anti-poverty initiatives in light of the lessons learnt from the Mahaweli Restructuring Project, in which villagers demonstrated a high degree of social inclusion despite their political differences. Further, the World Bank's strategy will be implemented in collaboration with IMF and the Asian Development Bank (ADB), with strong coordination and partnership with Japan Bank for International Cooperation (JBIC).