Demand, Supply and Welfare Aspects of Pipe-borne Water in Sri Lanka

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Dedicated to my Parents and Sanjaya

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PREFACE

This book identifies under-pricing as the major problem faced by the pipe-borne water sector in Sri Lanka, as well as many developing countries. Recently, the water board of Sri Lanka restructured its pricing strategy for pipe-borne water with the objectives of reducing water consumption and expanding the network. However, the success of the current pricing structure in achieving these objectives is uncertain. Therefore, to overcome the problems of identifying efficient water pricing, this book examines the use of cost-reflective alternative pricing strategies for pipe-borne water distribution services. The book evaluates current and alternative pricing strategies for pipe-borne water against the criteria of efficiency and equity while maintaining the financial viability of the national water utility in Sri Lanka. In order to analyse the welfare impacts of alternative pricing regimes, the demand for pipe-borne water by different user groups and the cost of pipe-borne water provision must be considered.

Such an evaluation requires the examination of operations and costs of the water board, and demands for pipe-borne water by residential, industrial and commercial user categories. Therefore, this book identifies the importance of price and other factors in determining residential, industrial and commercial water demand and respective production technologies of the Water board and marginal costs of supply. The pricing policies are examined and the approximate welfare losses or gains arising when prices diverge from marginal costs are computed. This work is based on a panel data sample of all (14) water board districts for sixty months (January 2001 to December 2005).

In summary, the main objective of the book is to analyse the welfare changes associated with the movement from the current tariff structure to the marginal-cost pricing structure. Within the context of this main research objective, the book also has the following subsidiary objectives:

(i) Estimate the price responsiveness of residential water consumers.

(ii) Investigate the relationship between rate structure, household characteristics, weather variables and level of water use.

(iii) Evaluate the minimum level of residential water use insensitive to price changes.

(iv) Estimate the price responsiveness of industrial and commercial water consumers.

(v) Estimate the short-run marginal cost and long-run marginal cost of water supply services.

(vi) Investigate the economies of scale or diseconomies of scale for the Water board.

(vii) Estimate the efficiency gains realised with the alternative pricing schemes.

The water tariff is an important management tool; however, pricing of water services is controversial in the existing political and social context. Water pricing decisions affect several different objectives of policy makers, often in conflicting ways. Therefore, empirical work is necessary to know with reasonable confidence how different categories of water consumers respond to water price changes. Initiation of water tariff reforms requires government or policy makers and the water board operators to understand the financial costs of providing the water services and the demand for water by different customer groups. This information is then used to assess how changes in the water tariffs affect the welfare of the pipe-borne water customers.

There is a substantial literature on water demand and cost estimations for developed countries, but very little research has been carried out in the context of developing countries. There are only a very few studies on residential water demand for Sri Lanka (Gunathilake, et al., 2001; Hussain, et al., 2002; Nauges & van-den Berg, 2006) and only one published study on industrial and commercial water demand (Hussain, et al., 2002). However, no demand study for Sri Lanka has used panel data covering all the NWSDB districts. Moreover, no study has been undertaken to research the structure of costs for pipe-borne water for the water board in Sri Lanka. These estimations are pertinent to the evaluation of price reforms. A number of authors have been critical of the pricing practices of pipe-borne water supply, only a few have quantified the magnitude of the deviations between actual and optimal consumption levels or the welfare losses or gains associated with the deviations (Garcia & Reynaud, 2004; Renzetti, 1992b, 1999). Moreover, very few studies in the developing country context have analysed the welfare effects of pipe-borne water pricing.

This study is the first attempt at a comprehensive analysis of the welfare effects of pipe-borne water sector in the Sri Lankan context. The findings have significant policy implications because they provide information on impact of price and other factors on residential, industrial and commercial water demand management, importance of threshold of consumption by residential users, the extent of economies of scale in pipe-borne water production and the welfare implications of different water

pricing practices. Further, the findings will inform policy makers, the water authority and consumers in Sri Lanka and will have applications for other developing countries too.

Demand analyses (residential, industrial and commercial) are carried out to estimate the price elasticities for water and to observe the influences of socio-demographic and climatic variables on water use (Billings, 1982; Garcia-Valinas, 2005; Renzetti, 1992b). Both SRMC and LRMC are estimated using the cost functions for the NWSDB (Martinez-Espeneira, 2003a; Renzetti, 1999). Simulation models are then applied to estimate individual household welfare impacts and aggregate efficiency effects. Welfare gains and losses for proposed pricing alternatives are calculated (Garcia-Valinas, 2005; Renzetti, 1999).

The book is organized in the following manner: chapter 2 details the institutional background of the pipe-borne water sector of Sri Lanka and lays the contextual background for the analyses undertaken in the later chapters. This chapter provides a general overview of the water board: the organization, services and pricing strategies adopted over time (1994 to 2005). The institutional changes which have influenced the activities and the performances of the water board are discussed. Chapter 2 also provides water tariff structures for residential, industrial and commercial users of the water board. This chapter identifies the need for sector reforms to facilitate private sector participation and decentralization of services to improve the performances of the water board. Chapter 3 discusses the theoretical framework for efficient water pricing. This is followed by a discussion of the general theory of alternative pricing structures in the context of a water utility. This chapter provides the theoretical foundation for the rest of the book in terms of efficiency, equity and financial viability and identifies the inefficiencies associated with the present multi-block pricing structure.

Chapter 4 estimates the residential water demand based on aggregate data. This chapter provides a literature survey of past demand modelling. It specifies the data used and presents the methodology adopted in estimating the residential demand function. Analyses of this chapter are based on panel data composed of 14 water board districts over 60 months (from January 2000 to December 2005 for all water board districts). This chapter presents the results of Stone-Geary specification in addition to the traditional Cobb-Douglas demand model. Finally, the discussion of the results of the demand function along with some implications concludes the chapter. The results of this chapter suggest that the residential consumers of pipe-borne water are relatively price and income inelastic.

Chapter 5 estimates the industrial and commercial water demand separately using aggregate data. This chapter begins by surveying past empirical studies on industrial and commercial demand modelling. Similar to chapter 4, this chapter specifies the data set used and presents the methodology adopted in estimating demand functions. The analyses of this chapter build on a set of panel data similar to that of chapter 4. The chapter concludes by presenting the results and discussion along with some policy implications for industrial and commercial water demands. The results of this chapter suggest that the industrial consumers are more responsive to price changes than the commercial and residential users of water.

The estimation of the cost function for pipe-borne water is reported in chapter 6. First, SRMC and LRMC are estimated using a trans-log functional form and monthly panel data. This chapter highlights the importance of the estimation techniques and the application of theory. Cost functions are re-estimated imposing theoretical properties such as monotonicity and concavity. Apart from determining the marginal cost, the estimations also provide measures of economic parameters of production cost such as cost-output elasticities, cost shares and economies of scale. The estimated cost functions demonstrate economies of scale and the SRMC differ from LRMC by a substantial margin.

Chapter 7 examines a number of welfare measures: consumer surplus, deadweight loss and Hicksian welfare measures – compensating and equivalent variations. This chapter discusses the derivation of equivalent variation and compensating variation using a log-linear Marshallian demand curve. The results of the previous chapters (chapter 4, 5 and 6) are then combined with the information of pipe-borne water pricing to generate estimates of deviations and welfare losses or gains. The welfare gains or losses are analysed by the deviations of current consumption levels from those predicted under marginal-cost pricing and other proposed pricing. According to the results of this chapter two-part SRMC pricing has the highest welfare gain.

Chapter 8 concludes and highlights the importance of the findings for government policy. The contribution of the book is discussed in terms of estimation of marginal cost, residential, industrial and commercial demands and simulation models. In order to provide a comprehensive analysis of pipe-borne water provision in Sri Lanka, conclusions from the four empirical chapters are placed under broad headings. Finally, policy implications and directions of future research are identified.

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ABBREVIATIONS

2SLS	Two-Stage Least Square
3SLS	Three-Stage Least Square
AC	Average Cost
ADB	Asian Development Bank
ADF	Augmented Dicky Fuller
AIC	Average Incremental Cost
AP	Average Price
AR	Auto Regression
CES	Constant Elasticity of Substitution
CS	Consumer Surplus
CV	Compensating Variation
DBTS	Decreasing Block Tariff Structure
EV	Equivalent Variation
FAO	Food and Agriculture Organization
FGLS	Feasible Generalised Least Square
GLS	Generalised Least Square
IBTS	Increasing Block Tariff Structure
IV	Instrumental Variables
IWMI	International Water Management Institute
LR	Likelihood Ratio
LRAC	Long-run Average Cost
LRMC	Long-run Marginal Cost
MC	Marginal Cost
ML	Maximum Likelihood
MP	Marginal Price
MRS	Marginal Rate of Substitution
MRT	Marginal Rate of Transformation
NWRA	National Water Resources Authority
NWSDB	National Water Supply and Drainage Board
OLS	Ordinary Least Square
PCSE	Panel Corrected Standard Error
PP	Phillip-Perron
PWISC	Present Worth Incremental System Cost
RSC	Regional Support Centre
RSP	Rate Structure Premium

SLRS	Sri Lankan Rupees
SRAC	Short-run Average Cost
SRMC	Short-run Marginal Cost
SUR	Seemingly Unrelated Regression
WB	World Bank
WRB	Water Resources Board
WRC	Water Resources Council
WRS	Water Resources Secretariat
WRT	Water Resources Tribunal

CHAPTER ONE

INTRODUCTION

In Sri Lanka, the provision of water for drinking and irrigation on a sustainable basis is a national priority (Central Bank of Sri Lanka, 2005). Achieving sustainability requires economising on the usage and appropriate pricing to prevent wastage and over-exploitation. The annual consumption of pipe-borne water through individual services covering residential, commercial, industrial and institutional use has increased from 275 to 383 million cubic metres during the last decade (NWSDB, 2005). However, the pipe-borne water supply situation is deteriorating in terms of quality and quantity due to continuous population increase, lack of maintenance, improper pricing, poor spatial coverage and non-revenue water (Central Bank of Sri Lanka, 2005).[1]

Two major factors which threaten the long-term sustainability of water resources in Sri Lanka are improper pricing and deficiencies in regulation. Pipe-borne drinking water is subject to a price with a subsidy segment, but other forms of water supply (agricultural or irrigation water and water directly drawn from reservoirs, streams, wells and lakes) are not subject to any form of pricing. This has led to over-exploitation and inefficient utilisation of water resources in Sri Lanka. The water resources can be managed efficiently by using cost-reflective pricing. This book focuses on the pipe-borne water sector in Sri Lanka and evaluates alternative pricing structures for pipe-borne water in terms of economic efficiency, equity and financial viability. This requires research to understand consumer behaviour and the impacts of cost structures of the water utilities. Therefore, this book undertakes empirical analyses of demand, cost and welfare to address issues related to pipe-borne water management in Sri Lanka.

[1] Non-revenue or unaccounted water is the quantity of water not billed from the total production. This includes leaks from transmission, distribution mains and other structures in the systems, illegal connections, metering errors and consumption on way side and garden taps (Hussain, et al., 2002).

A major problem faced by the water sectors in many countries is that prices are almost universally below the level of full-cost pricing (Renzetti, 1992b). Under-pricing of pipe-borne water results in over-consumption of water, reduces new investments, diminishes the quality and quantity of water delivered, slows spatial coverage of water (especially for poor settlements), and jeopardizes financial viability of water supplying entities. Household expenditure on water usually comprises a very small proportion of the household budget and, therefore, the significance of price to decrease water consumption is over-looked. Average household monthly consumption of 20 cubic metres of water corresponds to a water bill of Sri Lankan Rupees (SLRS) 117.50 (according to the 2005 water tariffs) and is less than 1 per cent of average household income (NWSDB, 2005).[2] Twenty cubic metres of water per month for a household is about three times the lifeline standard set by the World Health Organization (WHO). The main reasons for inefficient pricing are; first, raw water is typically assigned no value, therefore, recorded expenditures are unlikely to equal the full economic costs of water supply (Renzetti, 1992b).[3] Second, because consumer demand is considered exogenous, there is no recognition of the role played by prices to signal resource scarcity. Third, governments use water as a political tool to strengthen their power base. In order to overcome the inefficiencies in the pipe-borne water sector, water prices need to be raised to cover the full costs. The recent World Water Commission strongly endorsed the need for full-cost pricing of water services in both developed and developing countries (WWC, 2000).

To achieve the Millennium Development Goals set by the United Nations, policy makers and relevant authorities are attempting to expand the pipe-borne water coverage in Sri Lanka. These goals require all citizens in a country to have access to safe drinking water and adequate sanitation facilities by 2015 (Central Bank of Sri Lanka, 2005). Access to safe drinking water is estimated by the percentage of the population using improved drinking water sources, such as household connection to pipe-borne water, public stand pipe, borehole, protected well, protected spring and rain water collection (World Health Organization, 2002). In 2005, 92 per cent of the Sri Lankan population had access to safe drinking water, of

[2] The exchange rate announced by the Central Bank of Sri Lanka as at 2005 is US$ 1=SLRS 102.

[3] Raw water is water taken from the environment, (water withdrawn from initial sources) and is subsequently treated or purified to produce potable water.

which only 39 per cent had access to pipe-borne water (Central Bank of Sri Lanka, 2005).[4]

The premier national organization for the provision of safe and adequate drinking water supply and sewerage facilities in Sri Lanka is the National Water Supply and Drainage Board (NWSDB). It provides water supply and sewerage facilities primarily for residential, industrial and commercial establishments in urban areas and has recently been extended the services to rural areas. The Government of Sri Lanka together with the NWSDB has formulated sector goals to extend the pipe-borne water supply to 100 per cent of the urban population and 75 per cent of the rural population by 2010 (NWSDB, 2002).

Recently, authorities have suggested many solutions to water scarcity problems including increasing storage capacity through the construction of new dams; recycling waste water; reduction of per capita water consumption to the internationally determined lifeline level; charging increased water tariffs to reduce wasteful water use; and allowing water trading between agricultural water and domestic water (Edwards, 2006).[5] In the Sri Lankan context, most of these solutions are difficult to achieve in the near future. Building a new dam requires an enormous amount of capital and, hence, may need more government and foreign agency funding than is presently available. Water trading between agricultural and domestic use is not possible due to the lack of property rights and institutional arrangements to support such reforms. Therefore, in order to achieve these goals, the only feasible options are to reduce water consumption to lifeline level and create a water tariff which encourages efficient water use (Imbulana, et al., 2006).

1.1 Purpose

This book identifies under-pricing as the major problem faced by the Sri Lankan pipe-borne water sector. Recently, the NWSDB restructured its pricing strategy for pipe-borne water with the objectives of reducing water consumption and expanding the network. However, the success of the current pricing structure in achieving these objectives is uncertain. Therefore, to overcome the problems, this study examines the use of cost-

[4] 95 per cent of urban and 75 per cent of rural population had access to safe drinking water and 75 per cent of urban and 14 per cent of rural population had access to pipe-borne water in 2005 (Imbulana, et al., 2006).

[5] The internationally cited standard for lifeline level is 4 – 5 cubic metres of water per month that is sufficient for essential needs of a household with 5 members (WHO, 1997).

reflective alternative pricing strategies for pipe-borne water distribution services. The book evaluates current and alternative pricing strategies for water against the criteria of efficiency and equity while maintaining the financial viability of the national water utility. In order to analyse the welfare impacts, understanding the demand for pipe-borne water by different user groups and the cost of pipe-borne water provision must be considered.

Such an evaluation requires the examination of operations of the NWSDB, and demands for pipe-borne water by residential, industrial and commercial user categories. The importance of price and other factors in determining residential, industrial and commercial water demand management are identified. The respective production technologies of the NWSDB are characterised and marginal costs of supply are estimated. The pricing policies are examined and the approximate welfare losses or gains arising when prices diverge from marginal costs are computed. This work is based on a panel data sample of all (fourteen) NWSDB districts for sixty months (January 2001 to December 2005) (Renzetti, 1999).

In summary, the main objective of the book is to analyse the welfare changes associated with the movement from the current tariff structure to marginal-cost pricing structure. Within the context of this main research objective, the study also has the following subsidiary objectives:

i. Estimate the price responsiveness of residential water consumers.
ii. Investigate the relationship between rate structure, household characteristics, weather variables and level of water use.
iii. Evaluate the minimum level of residential water use insensitive to price changes.
iv. Estimate the price responsiveness of industrial and commercial water consumers.
v. Estimate the short-run marginal cost (SRMC) and long-run marginal cost (LRMC) of water supply services.
vi. Investigate the economies of scale or diseconomies of scale for the NWSDB.
vii. Estimate the efficiency gains realised with the alternative pricing schemes.

1.2 Contribution

The water tariff is an important management tool; however, pricing of water services is controversial in the existing political and social context. Water pricing decisions affect several different objectives of policy makers,

often in conflicting ways. Therefore, empirical work is necessary to know with reasonable confidence how different categories of water consumers respond to water price changes. Initiation of water tariff reforms requires government or policy makers and the NWSDB operators to understand the financial costs of providing the water services and the demand for water by different customer groups. This information is then used to assess how changes in the water tariffs affect the welfare of the NWSDB customers.

There is a substantial literature on water demand and cost estimations for developed countries, but very little research has been carried out in the context of developing countries. There are only very few studies on residential water demand for Sri Lanka (Gunathilake, et al., 2001; Hussain, et al., 2002; Nauges & van-den Berg, 2006) and only one published study on industrial and commercial water demand (Hussain, et al., 2002). However, no demand study for Sri Lanka has used panel data covering all the NWSDB districts. Moreover, no study has been undertaken to research the structure of costs for pipe-borne water for the NWSDB. These estimations are pertinent to the evaluation of price reforms. A number of authors have been critical of the pricing practices of pipe-borne water supply, only a few have quantified the magnitude of the deviations between actual and optimal consumption levels or the welfare losses or gains associated with the deviations (Garcia & Reynaud, 2004; Renzetti, 1992b, 1999). Moreover, very few studies in the developing country context have analysed the welfare effects of pipe-borne water pricing.

This study is the first attempt at a comprehensive analysis of the welfare effects of the pipe-borne water sector in the Sri Lankan context. The findings have significant policy implications because they provide information on impact of price and other factors on residential, industrial and commercial water demand management, importance of threshold of consumption by residential users, the extent of economies of scale in pipe-borne water production and the welfare implications of different water pricing practices. Further, the findings will inform policy makers, the water authority and consumers in Sri Lanka and will have applications for other developing countries too.

Demand analyses (residential, industrial and commercial) are carried out to estimate the price elasticities for water and to observe the influences of socio-demographic and climatic variables on water use (Billings, 1982; Garcia-Valinas, 2005; Renzetti, 1992b). Both SRMC and LRMC are estimated using the cost functions for the NWSDB (Martinez-Espeneira, 2003a; Renzetti, 1999). Simulation models are then applied to estimate individual household welfare impacts and aggregate efficiency effects.

Welfare gains and losses for proposed pricing alternatives are calculated (Garcia-Valinas, 2005; Renzetti, 1999).

1.3 Structure of the Book

The book is organised in the following manner: chapter 2 details the institutional background of the pipe-borne water sector of Sri Lanka and lays the contextual background for the analyses undertaken in the later chapters. This chapter provides a general overview of the NWSDB: the organization, services and pricing strategies adopted over time (1994 to 2005). The institutional changes which have influenced the activities and the performances of the NWSDB are discussed. Chapter 2 also provides water tariff structures for residential, industrial and commercial users of the NWSDB. This chapter identifies the need for sector reforms to facilitate private sector participation and decentralization of services to improve the performances of the NWSDB. Chapter 3 discusses the theoretical framework for efficient water pricing. This is followed by a discussion of the general theory of alternative pricing structures in the context of a water utility. This chapter provides the theoretical foundation for the rest of the book in terms of efficiency, equity and financial viability and identifies the inefficiencies associated with the present multi-block pricing structure.

Chapter 4 estimates the residential water demand based on aggregate data. This chapter provides a literature survey of past demand modelling. It specifies the data used and presents the methodology adopted in estimating the residential demand function. Analyses of this chapter are based on panel data composed of 14 NWSDB districts over 60 months (from January 2000 to December 2005 for all NWSDB districts). This chapter presents the results of Stone-Geary specification in addition to the traditional Cobb-Douglas demand model. Finally, the discussion of the results of the demand function along with some implications concludes the chapter. The results of this chapter suggest that the residential consumers of pipe-borne water are relatively price and income inelastic.

Chapter 5 estimates the industrial and commercial water demand separately using aggregate data. This chapter begins by surveying past empirical studies on industrial and commercial demand modelling. Similar to chapter 4, this chapter specifies the data set used and presents the methodology adopted in estimating demand functions. The analyses of this chapter build on a set of panel data similar to that of chapter 4. The chapter concludes by presenting the results and discussion along with some policy implications for industrial and commercial water demands. The results of

this chapter suggest that the industrial consumers are more responsive to price changes than the commercial and residential users of water.

The estimation of the cost function for pipe-borne water is reported in chapter 6. First, SRMC and LRMC are estimated using a trans-log functional form and monthly panel data. This chapter highlights the importance of the estimation techniques and the application of theory. Cost functions are re-estimated imposing theoretical properties such as monotonicity and concavity. Apart from determining the marginal cost, the estimations also provide measures of economic parameters of production cost such as cost-output elasticities, cost shares and economies of scale. The estimated cost functions demonstrate economies of scale and the SRMC differ from LRMC by a substantial margin.

Chapter 7 examines a number of welfare measures: consumer surplus, deadweight loss and Hicksian welfare measures – compensating and equivalent variations. This chapter discusses the derivation of equivalent variation and compensating variation using a log-linear Marshallian demand curve. The results of the previous chapters (chapter 4, 5 and 6) are then combined with the information of pipe-borne water pricing to generate estimates of deviations and welfare losses or gains. The welfare gains or losses are analysed by the deviations of current consumption levels from those predicted under marginal-cost pricing and other proposed pricing. According to the results of this chapter two-part SRMC pricing has the highest welfare gain.

Chapter 8 concludes and highlights the importance of the findings for government policy. The contribution of the book is discussed in terms of estimation of marginal cost, residential, industrial and commercial demands and simulation models. In order to provide a comprehensive analysis of pipe-borne water provision in Sri Lanka, conclusions from the four empirical chapters are placed under broad headings. Finally, policy implications and directions of future research are identified.

CHAPTER TWO

BACKGROUND AND PERFORMANCES OF THE NWSDB

2.1 Introduction

Sound management of water resources and access to water and sanitation services are now regarded as key components of sustainable development, particularly as a precondition for the steady improvement in living standards in developing countries (United Nations Development Programme, 2006). However, the use, abuse and competition for increasingly scarce water resources have intensified over the past decades. Population growth, urbanization together with changes in lifestyle and economic development in developing countries has heightened the pressure on water resources that are already limited (UNESCO Division of Water Sciences, 2003; World Bank, 1992). These countries are particularly vulnerable to the problems linked to climate change, such as floods, droughts and tsunamis. These will affect prospects for economic and social development, political stability, as well as ecosystem integrity (UNESCO Division of Water Sciences, 2003). Therefore, careful economic and environmental management of water is required.

Water in most cities and towns in developed and developing countries are under-priced with damaging long-run consequences (ADB, 1993; J.J. Boland, 1997; J. J. Boland & Whittington, 1998). The price of pipe-borne water is low in relation to the cost that is incurred on its provision and this under-pricing has resulted in poor services and reduced incentives to expand the spatial coverage of services (J. J. Boland & Whittington, 1998). The problems associated with pricing of raw water and public infrastructure has resulted in under-pricing of water. The pipe-borne water sector is often characterised by high levels of subsidies on grounds of lack of affordability by the poor (Mathur & Thakur, 2003). Subsidies on pipe-borne water are ineffectual in improving welfare of poorer households since these households typically do not have private connections and,

therefore, are unable to benefit from the subsidy (J. J. Boland & Whittington, 1998).

Appropriate institutions are required to improve incentives for both water users and providers. This chapter presents the institutional background and performance in the context of the pipe-borne water sector in Sri Lanka with a greater emphasis on the NWSDB. However, comprehensive analysis of institutional evolution and context in the water sector in Sri Lanka is not the primary objective of this chapter. One of the main purposes of this book is to test the efficiency of various price reforms. Therefore, this chapter provides a contextual background for the analyses undertaken in later chapters about efficiency, equity and financial viability in the pipe-borne water pricing. For the purpose of this book, the pipe-borne water sector in Sri Lanka is considered to cover consumptive uses like residential, industrial and commercial from surface or sub-surface water sources. Other consumptive uses like irrigation and non-consumptive uses such as power generation, navigation and ecological water needs are not considered.

In most developing countries, women and young girls often spend hours collecting and carrying water, restricting their opportunities in productive activities due to poor pipe-borne water coverage (United Nations Development Programme, 2006). Water-borne diseases like gastrointestinal illnesses, vector-borne diseases and water-washed diseases are caused due to insufficient water for basic hygiene and unsafe water use (UNESCO Division of Water Sciences, 2003).[1] These water related diseases are among the most common causes of illness and death and these limit poverty reduction and economic growth in some of the developing countries such as India, Ethiopia and Indonesia (United Nations Development Programme, 2006). Further, these put pressure on a country's economy due to lost productive labour time, increased health costs by the government and individuals and long run impacts of nutritional deficiencies. An expansion of pipe-borne water coverage, well-regulated water supply and full sanitation would reduce the burden of water-borne diseases (UNESCO Division of Water Sciences, 2003). Access to safe drinking water and improved water management practices has a great potential to reduce the vector-borne disease and gastrointestinal illness burden (World Health Organization, 1997a). Further, it will reduce

[1] Gastrointestinal illness is defined as an episode of vomiting and/or diarrhoea (Nygard, et al., 2007) and water-washed disease is caused by water scarcity or unsafe, unreliable water which fail to provide adequate quantities of water for hygienic purposes (World Health Organization, 1997a).

the time to secure water and leave more time for people to engage in productive activities.

However, authorities often misallocate, misuse water and damage the environment as a result of institutional weaknesses, market failures, distorted policies and misguided investments. The problems in the water sector have resulted not purely from the natural limitations of water supply but rather from inefficiencies in water management. The problems in the water sector has revealed the limitation of institutions in dealing effectively with resource allocation and management (Saleth & Dinar, 2004). The major underlying constraints to increasing access to safe drinking water are lack of well-functioning water institutions, shortage of investment capital for extending the service and the negligible or partial recovery of operating costs of service provision. More recently, policy makers paid attention to impacts of institutional design on water institutions and the way these institutions can be designed to cope with changes and facilitate the achievement of economic and social objectives (Saleth & Dinar, 2005).

Water institutions set the rules and thus define the action sets for both individual and collective decision-making in the realm of water resource development, allocation and utilization (Saleth & Dinar, 1999). In this way, they establish the incentives, information and compulsions that guide behaviour and influence economic outcomes (Livingston, 1995). Institutions operate at different levels and contexts. There are formal and informal institutions, macro-level and micro-level institutions (Saleth & Dinar, 2004). Formal institutions have the foundation in the laws and structures of organised society while the informal institutions spontaneously develop to address specific issues (Gandhi, et al., 2007; Williamson, 2000). Macro level institutions are rules that structure interactions (both formal and informal rules) and micro level institutions are institutions of governance including markets, transactions or economic activities (Gandhi, et al., 2007; Williamson, 2000).

Most developing countries have informal water economies, marked by heavy dependence of water users on self-provision (through private wells, streams, rivers, lakes, and ponds) or community managed water sources. The common characteristic of informal systems is absent or limited use of prices to recover the costs of resource use. In contrast, self-provision gives way to more formalised service provision in developed countries. Volumetric supply and economic pricing are commonly used in these sectors for cost recovery and resource allocation; therefore, water emerges as an industry (Shah, 2005).