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(KaR 8332)

Water demand management in areas of groundwater over-exploitation

WATER DEMAND MANAGEMENT STRATEGY FORMULATION

FINAL REPORT
FEBRUARY 2006

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in association with
VRV Consultants (P) Ltd, Chennai, India
Jouzy & Partners, Amman, Jordan

Contents

MAIN REPORT

PREFACE

This document has been prepared as the final output for Project No R8332, Water Demand Management in Areas of Groundwater Over-exploitation. The project has been undertaken and funded as part of the UK Department of International Development (DFID)'s Knowledge and Research Programme. The initial concept for the research was developed by Black & Veatch Consulting Ltd in 2003 in line with the DFID agenda on poverty alleviation and within the context of the UN Millennium Development Goals.

Water demand management has become an important element in integrated policies of water resources development and the purpose of the research has been to:

- develop water demand management strategies in areas where aquifers[1] are being over-exploited, ensuring the long-term livelihoods of the vulnerable and poor are safeguarded; and to
- discuss and disseminate the findings with potential end users of the research (Donor agencies, Government and agencies involved in water management).

Although the broad outlines of the strategies discussed in this report are widely applicable, the studies have been undertaken in developing countries with emphasis being given to pro-poor policies and poverty reduction. The research addresses the DFID Research Areas related to Millennium Development Goal No. 7, "Ensuring Environmental Sustainability". It addresses elements of the corresponding DFID research areas of natural resource management; reducing pollution and environmental damage; access to safe water supply; and improving the quality of life for slum dwellers.

During the studies a number of issues arose which have influenced the development of this document:

- It became clear that a water demand management strategy must be viewed as one component of a wider water resources strategy and although, in this document, the authors have concentrated on water demand management options, they have taken a broader view when discussing the development of a water strategy;
- Water demand management measures can be used to influence the distribution of water and, where equity and pro-poor policies are being introduced in areas of water shortage, there may be "losers" as well as "winners". The political context becomes a central issue in their introduction;
- Water demand management measures will only be successful if they are acceptable to the policy makers and the consumers. In many developing countries, there is a hunger for and political will to change. In introducing demand management measures, however, a number of vested interests may have to be overcome. The existing drivers for change have to be understood and, if the measures are to be promoted successfully, they must

[1] The studies have been widened where possible to make the findings applicable both to areas where aquifers are being over-exploited and to areas where surface water resources are restricted.

have a sound basis where they confront established assumptions on water priorities.

A number of studies have been undertaken in developing the material for this document, which describes an approach to Strategy Formulation for Water Demand Management. These included a Knowledge Review and Case Studies in Chennai, India and in Al Jafr, Jordan during 2004 followed by workshops and meetings with stakeholders in Chennai and Jordan in November 2004.

A Case Study Report was submitted to DFID in January 2005. Additional studies were undertaken in Pondicherry, India and Andhra Pradesh in 2005 to test the approach proposed in this Strategy Document and a final workshop with stakeholders was held in New Delhi in November 2005.

Black & Veatch Ltd has led the research, providing inputs on water resources, hydrogeology, economics, community participation, poverty and gender issues. The principal research collaborators have been: VRV Consultants (P) Ltd. and the Centre for Poverty Alleviation (CUPA) in India; and Jouzy & Partners and JOHUD, Queen Zein Al Sharaf Institute (ZENID) in Jordan

This document "Water demand management – Strategy formulation", the final report arising from the research project, comprises a Main Report plus three Annexes. The Main Report describes the background and overall approach to formulating a water demand management strategy. Annex A discusses poverty and vulnerability; Annex B describes the case studies undertaken in India and Jordan; and Annex C describes water demand management measures and water supply options.

Acknowledgements

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In India: The Ministry of Finance, The Department of Public Works and The Department of Municipal Administration and Water Supply in Tamil Nadu; Chennai Metropolitan Water Supply and Sewerage Board (CMWSSB); The Institute of Water Studies, Chennai; World Bank; Asian Development Bank; Madras School of Economics; DFID, New Delhi; the Deputy British High Commission, Chennai; and several NGOs in Tamil Nadu.

In Jordan: The Ministry of Planning, The Ministry of Water and Irrigation, The Ministry of Agriculture, UNDP, USAID, EU, GTZ, and The University of Jordan

The principal members of the research team were:

Black & Veatch: David Stacey, Research Coordinator; Dr. Elizabeth Mann, Community Development Specialist; John Petrie, Hydrogeologist; Tran Kim Tanh, Economist. VRV Consultants, Chennai, India: Dr V.R.Visweswaran, Water Resources Specialist; Kandaswamy Barathan, Economist. Centre for Poverty Alleviation (CUPA) in India: Louis Menezes, Ms R Bhuvana, Social Studies Consultants. Jouzy & Partners, Hashemite Kingdom of Jordan: Mr. Elie Halaby, Dr. Omar Shadid, Hydrogeologist. JOHUD, Queen Zein Al Sharaf Institute (ZENID) in Jordan: Dr Imam Nimri, Fatima Abu Kaff, Consultant Sociologists. Universtity of Jordan: Professor Elyas Salameh, Consultant Hydrogeologist.

SUMMARY

S1. Introduction

The purpose of this report is to disseminate the findings of a project funded by the UK Government's Department for International Development (DFID) under its Knowledge and Research Programme, Project R8332 - Water Demand Management in Areas of Groundwater Over-exploitation. The purpose of the research project was to develop water demand management strategies in areas where aquifers are being over-exploited, ensuring the long-term livelihoods of the vulnerable and poor are safeguarded.

Many countries have reached a position where the quantity or quality of fresh water renewable resources will not meet the demand for the resource and is imposing a limit on economic development. Others are rapidly approaching a similar critical situation. These countries face a common problem - the implementation of existing policies and strategies are inadequate to ensure that water use needs are met. They fail to provide for sustainable development and often the poor are the most severely affected by the lack of resources.

"Water demand management" has become an important element in integrated policies of water resources development. Multilateral and bilateral funding agencies involved in the water sector (e.g. World Bank, Asian Development Bank, USAID, GTZ) recognise the need for a better understanding. Water demand management has been variously described:

The FAO/World Bank/UNDP (1995) defined it as the *"use of price, quantitative restrictions and other devices to limit the demand for water".* The UK Water Industry Research/Environmental Sciences Association (1996) described it as *"…the implementation of policies or measures which serve to control or influence the amount of water used".*

These definitions enshrine the broad elements of the water demand management concept and in particular the employment of a variety of "measures" to influence and control the demand for and consumption of water.

Controlling and influencing the amount of water used by consumers in regions where there is a scarcity of water resources raises issues for communities, water providers and regulators for which there is rarely a simple solution. Where equity and pro-poor policies are being introduced in areas of water shortage, demand management measures can be used to influence the distribution of water. There may be "losers" as well as "winners".

Political and social issues are, therefore, central to the implementation of measures which influence the demand for water. Decision-makers need to understand the often complex and overlapping views of different water users. This requires planners to work within a methodological framework that safeguards the interests of the vulnerable and meets with public acceptance of any final strategies adopted.

World Bank/UNDP/FAO Land and Water Bulletin No 3, "Water sector policy review and strategy formulation – A general framework" (1995) is a useful foundation document to which detailed strategies for water demand management can be linked. Strategy formulation for water demand management has been developed taking this document into account.

The introduction of water demand management measures, however, should be seen not only in relation to water supply and quality options but also in a wider context which includes consideration of a country or region's macro-economic policy, its strategic water security and, for instance, its dependence on "virtual water"[2].

S2. Water demand management measures

The authors of this report have drawn on earlier work and on Case Studies undertaken by them during 2004 in India and Jordan to develop a framework within which potential water demand management measures can be placed.

A list of generic water demand management measures have been identified. These have been categorised as:

- Developmental and technical measures;
- Allocative, financial and market based measures; and
- Other socio-economic measures

The measures are further divided as those affecting the domestic and municipal provision of water and those affecting irrigated agriculture. The three categories of measures can only be implemented with supporting or enabling measures.

S3. Poverty and vulnerability

The Sustainable Livelihoods Approach provides a useful basis for defining poverty and vulnerability in relation to water demand and use in terms of asset base. It allows a definition of the poor and vulnerable in this regard as:

- those households whose basic needs of food, shelter, health, livelihood and sense of empowerment, outstrip the resources available to meet those needs and consequently are more likely to experience harmful or negative impacts as a consequence of water shortage.

Poverty, in itself, is a highly complex issue. The relationship between water and poverty is characterised by the nature of the links between water availability, water demand, and the ability of individual households to use their different assets most effectively. Water users with greater economic, social or political weight access water and influence demand management strategies more effectively than those without. It is important, therefore, for the water needs of the vulnerable to be adequately represented in strategic planning for water demand management

Many water demand management options raise greater social and political issues than technical ones, particularly where the re-allocation of water between consumers is concerned. Governments throughout the world are often reluctant to force people to curtail abstraction of water or use, foreseeing either social or economic impacts on large sections of the population, or on small sections of the population with high levels of social and political influence. Water related legislation and regulation, to be effective, have to gain the tacit agreement or understanding of those to whom it applies. Understanding and determining the social and political influences on the provision and management of the demand for water is an essential ingredient of strategy development.

[2] Virtual water – the amount of water consumed in the production of imported foodstuffs and goods

S4. Strategy development

Formulation of a water resources management strategy requires a number of steps to be taken. These normally include a policy review, development of agreed goals and policies and the examination of a matrix of problems and critical issues. This is followed by strategy development within which a water demand management strategy should be embedded. Protecting the rights of poor and vulnerable water users should be accepted as an integral part of any water demand management strategy formulation.

Developing a strategy which is acceptable to all may prove difficult. There may be targets within different Government Ministries which, in themselves, may have a justifiable rationale but which are dependent on the availability of water and lead to a competition for water. A water resources strategy must, somehow, reconcile these competing interests where they arise and bring stakeholders together to consider the issues raised by water demand management.

S5. Impact of water demand management

The aim of introducing a water demand management measure is, normally, to reduce the water consumption, either to restore sustainability of a resource or to make water available for other consumers. Some measures may generate large savings in water (e.g. through restricting the planting of high water using crops), others smaller, although perhaps no less important savings (e.g. through introducing water saving devices in households to reduce the consumption).

There is a cost to introducing a water demand management measure. The unit cost may be high where new infrastructure or equipment is required (e.g. treating and recycling industrial water) or small where the measure relies principally on a public information campaign (e.g. use of grey water).

Comparisons of the value and impact of alternative measures and the likelihood of their success are important considerations when developing a water demand management strategy.

In practice, both quantitative and qualitative evaluation of different aspects of a water demand management measure will be required.

The following indicators can be used to assess a measure

- Potential amount of water saved per year
- Unit cost of water saved (taking into account subsidy and tax issues)
- Groups and number of persons affected
- Their impact, particularly on the poor and vulnerable

The first three indicators can usually be established after assessing the relevant data. The impact of the measure on the groups or persons affected, however, can be more difficult to assess.

Six indicators of the impact of a measure are suggested through which the measure can normally be shown to be positive, negative or to produce little or no change on the group concerned. The impact indicators relate to: (i) Access to water; (ii) Quality of water; (iii) Effect on livelihood; (iv) Affordability; (v) Sense of empowerment; and (vi) Health.

There will normally be a number of groups, with poor and vulnerable sections within each group, to be considered. Assessing these indicators will normally require the views of the parties affected and an understanding of their current status

In addition, there are a number of other issues to be considered when introducing a water demand management measure. These can broadly be described under the headings of "Pre-conditions to implementation" and the "Likelihood of success".

"Pre-conditions" may include items such as: the will of the implementing agency or agencies; the availability of funding; or the availability of appropriate technology.

The assessment of the "Likelihood of success" is an important consideration when comparing measures. Qualitative and subjective assessments may be required but these will generally address two key indicators: (i) the viability of the water demand management measure; and (ii) the ease of its implementation.

S6. Strategy formulation

The choice of participants in the review and strategy development normally needs careful consideration and will depend on the boundaries and scope of the review and strategy development being undertaken. In large and complex areas, the policy review and strategy development is likely to be undertaken by National, Regional or Local Government with their advisers. Even in these studies, consultation with community leaders, NGOs and other stakeholders will be required at policy review and strategy development stages. In smaller and more homogeneous areas (e.g. remote villages or small farming communities), the reviews and strategy may be developed by a community itself with guidance from NGOs, local government and advisers.

The final strategy and action plan should include the plans and programmes for implementation of water demand management measures and for periodic future monitoring and review of the proposed development programme and of the impact of the measures on the communities to be served.

S.7 The report

The report comprises a main report which elaborates on the issues described above. It is supported by three Annexes which discuss (a) "Poverty and Vulnerability", (b) the "Case Studies" undertaken as the supporting research, and (c) the methodology for developing a "Water demand management" and supporting data sheets describing options.

1.0 INTRODUCTION

1.1 Background and purpose of the report

The purpose of this report is to present the findings of a project funded by the UK Government's Department for International Development (DFID) under its Knowledge and Research Programme. The research was undertaken by Black & Veatch Consulting Ltd, UK in association with VRV Consultants, India and Jouzy & Partners, Jordan in 2004 and 2005.

The Research Project (R8332) – "Water demand management in areas of groundwater over-exploitation", has been undertaken as part of the UK Government Department for International Development (DFID)'s Knowledge and Research Programme[3]. The initial concept was developed by Black & Veatch Consulting Ltd, in 2003, in line with the DFID agenda on poverty alleviation and within the context of the UN Millennium Development Goals.
The purpose of the research was to:

- Identify the most appropriate water demand management strategies for controlling groundwater abstraction in areas where aquifers are being over-exploited, ensuring the long-term livelihoods of the vulnerable and poor are safeguarded; and

- discuss and disseminate the findings with potential end users of the research (Donor agencies, Government and agencies involved in water management)

The research has taken into account DFID objectives set out in Government White Papers on Eliminating World Poverty (1997)[4] and (2000)[5] and the sustainable livelihoods approach promoted by DFID. It has recognised the need for pro-poor policies and that water resources development strategies should be included within a country or region's poverty alleviation strategy.

Groundwater is the principal source of both irrigation and domestic water supplies in many arid and semi-arid regions of the world. However, many of these regions are consuming more water than is available from renewable resources. In some areas, over-abstraction of groundwater from aquifers has led to drawdown of the water table, saline intrusion and deteriorating water quality. Water demand must be managed if aquifers are not to be over-exploited.

A variety of measures can be introduced to achieve sustainability. These may have long-term benefits but their introduction may have negative impacts on the livelihoods of some sections of the community.

The poor and vulnerable, who may include, for example, farming families, domestic consumers and the elderly, can be adversely affected by the introduction of water demand management measures with poverty increasing as a result. Some, who

[3] Water demand management in areas of groundwater over-exploitation, DFID Engineering Knowledge and Research Programme, Competitative Component – Bid Round 2003/04

[4] Eliminating World Poverty: A Challenge for the 21st Century, UK Government White Paper (1997)

[5] Eliminating World Poverty: Making Globalisation Work for the Poor, UK Government White Paper (2000)

are unable to afford the technical solutions for water conservation, may be negatively affected by water quotas and crop restrictions and may be unable to meet the cost of water tariffs. Others, however, may benefit from re-allocation of the available water.

For many years the International Community has recognised “the basic right of all human beings to have access to clean water at an affordable price” (International Conference on Water and the Environment, Dublin, 1992).

Strategies are required to ensure that, when water is short, the poor and vulnerable are protected and that an enabling environment is provided in which they can escape from poverty and flourish in a climate in which their aspirations can be met.

Where supply is limited, water demand management measures can be introduced to contribute to pro-poor policies and to improve the equity of water distribution. In this study, the approach to strategy development takes as “a given” that measures should support pro-poor policies and equity considerations. However, measures of this kind raise socio-political issues. The drivers for change must be recognised and employed and the barriers to change removed, if the measures are to become effective.

During the studies it soon became clear that appropriate water demand management measures could not be identified or implemented without an understanding of the overall water resources situation (e.g. the water balance, the supply options, and the quality of the water resources) in any study region. Water demand management measures must be developed within an integrated water resources strategy.

The outcome of the research on strategy formulation for water demand management is presented in this report, therefore, in the context of the development of an overall water resources strategy.

The studies began in October 2003. Case studies[6] were undertaken in Tamil Nadu, India and in Shoubak and Al Jafr, Ma’an Governorate, Jordan in 2004. The results were discussed at workshops and meetings in India and Jordan in November 2004. Further supporting studies were undertaken in Pondicherry and Andhra Pradesh, India during 2005 with a final workshop in New Delhi in November 2005.

This report contains recommendations on the formulation and implementation of water demand management strategies, taking into account a range of options and the impact that the measures could have on poor and vulnerable sections of the community. There are generally “winners” and “losers” arising from the introduction

[6] Water demand management in areas of groundwater over-exploitation: DFID KaR8332; Report on Case Studies; Main Report and Annexes A - G, January 2005, Black & Veatch et el

of a water demand management strategy. This is particularly true when pro-poor policies and equity issues underpin the strategy.

The process, whereby a particular measure or mix of management options, can be evaluated and selected is discussed. This includes recognition of recent shifts in planning processes and the inclusion of a more open approach to determining and incorporating different water user and stakeholder perspectives.

A draft of this Strategy Document was discussed at the Workshop[7] held at the UNICEF offices in New Delhi in November 2005 with Donor, Government and other agencies involved in water management. Comments and suggestions made at that Workshop have been incorporated in this report. The Website for the research project is www.groundwater-poverty-KaR.co.uk.

1.2 International perspective

Many countries or regions have reached a position where the quality or quantity of renewable fresh water resources is imposing limits on the present use of the resource and on economic development. Others are rapidly approaching a similar critical situation. These countries and regions face a common problem - existing policies and strategies are inadequate to ensure that water demands are met. Some fail to meet the basic water needs of the poorer sections of the community when other sections of the community have more than enough. They are nearly all failing to provide for sustainable development. The International Agenda, developed over the last fifteen years, includes some useful criteria and principles relating to water resources development.

"Water demand management" is becoming an important element in integrated policies of water resources development. Multilateral and bilateral funding agencies involved in the water sector (e.g. World Bank, USAID, GTZ, Asian Development Bank) recognise the need for a better understanding of water demand management. The International Development Research Centre (IDRC), Canada regards water demand management in Africa and the Middle East as one of its priority research areas[8]. The International Water Demand Management Conference in Jordan, 2004[9] demonstrated the importance with which it is regarded in the Middle East and the intense effort that is being made to understand the complexities of water resource management.

Controlling and influencing the amount of water used by consumers in regions where there is a scarcity of water resources raises issues for communities, water providers and regulators for which there is rarely a simple solution. Political and social issues are central to the implementation of measures which influence the demand for water. Decision-makers need to understand the often complex and overlapping views of different water users on "rights" and "risks". This requires planners to work within a methodological framework which recognises the interests

[7] Strategy Formulation: Report on Workshop – 17 November 2005, UNICEF, New Delhi (Ref 5)

[8] Rached et al (Ed), Water management in Africa and the Middle East – challenges and opportunities, IDRC, 1996 (Ref 6)

[9] International Water Demand Management Conference, Jordan: sponsored by the Ministry of Water & Irrigation, Jordan and USAID, June 2004 (Ref 7)

of the poor and vulnerable and the importance of providing equity in water availability and which will also meet with public acceptance.

During the 1990s, attempts were made to define a number of over-arching international development principles that should be considered when developing water policy. It is now widely agreed that an integrated approach should be adopted when developing policy. The approach should ensure that not only technical but also institutional and legal reform, stakeholder participation, devolution, public and private sector management and environmental issues are included in policy review.

Statements issued in 1992 at the International Conference on Water and the Environment (ICWE) in Dublin and the United Nations Conference on Environment and Development (UNCED), The Earth Summit held in Rio de Janeiro, Brazil in 1992 as well as publications such as the joint bulletin of the FAO/World Bank/UNDP (1995)[10] are relevant.

Dublin Conference, 1992

This Conference called for new approaches to the assessment, development and management of freshwater resources and, in a Conference statement, asserted that "*….it is vital to recognise first the basic right of all human beings to have access to clean water and sanitation at an affordable price*."

The statement suggested four principles should be applied to water resources management:

- Water must be managed in a holistic way taking interactions among users and environmental impacts into account;
- Water must be valued as an economic good, managed as a resource necessary to meet basic human rights;
- Institutional arrangements should be reformed so stakeholders are fully involved in all aspects of policy formulation and implementation. (i.e. management should be devolved to the lowest appropriate group, with enhanced roles for non-governmental organisations, community groups and the private sector);
- Women (as well as men) must play a central role in the provision, management and safeguarding of water.

The Earth Summit, 1992

The Conference confirmed the widespread consensus that the management of water resources needs to be reformed.

It concluded that, "*The holistic management of freshwater as a finite and vulnerable resource and the integration of sectoral plans and programs within the framework of national economic and social policy are of paramount importance for actions in the 1990s and beyond. ……. Integrated water resources management is based on the perception of water as an integral part of the ecosystem, a natural resource and a social and economic good.*"

[10] World Bank/UNDP/FAO: Water sector policy review and strategy formulation – a general framework, FAO Land and Water Bulletin No 3, 118pp, FAO, Rome 1995 (Ref 8)

UNDP, World Bank and FAO

Since the Conferences in 1992, the UNDP, the World Bank and FAO have published a number of papers, bulletins and guidelines defining and discussing water sector objectives, and stating the need for national policy reviews. They have provided general guidance for the development of these within the broad framework of the Dublin and Earth Summit statements.

World Water Forums

World Water Forums (Marrakech, 1997; The Hague, 2000; and Kyoto, 2003) have proved important landmarks in the discussion of the issues of equity, efficiency, public health, the environment, institutions, public-private partnership, stakeholder participation, economics and sustainability.

World Summit on Sustainable Development, Johannesburg (2002) and Millennium Development Goals

The World Summit on Sustainable Development held in Johannesburg in 2002 focussed on poverty and sustainability issues and recognised the UN Millennium Development Goals. One of the eight goals is to ensure environmental sustainability with the pledge to reduce by half the proportion of people without sustainable access to safe drinking water.

1.3 Water Sector Strategies

World Bank/UNDP/FAO Land and Water Bulletin No 3, “Water sector policy review and strategy formulation – A general framework” (1995) is a useful foundation document to which detailed strategies for water demand management can be linked. The introduction of enabling conditions such as institutional and legal reforms may be a major aspect of strategy formulation. Economic tools, incentives and technological innovation are also important features in strategy formulation.

A water demand management strategy should be developed in the context of a related water sector strategy. Water demand management approaches should be evaluated in conjunction with those of supply and related water quality conditions. The needs of the poor and vulnerable should not be overlooked during policy review and planning phases and. In developing a strategy, the assessment of its impact on the poor and vulnerable should be a central concern.

In September 1994, The Sub-committee on Water Resources of the UN Administrative Committee for Coordination requested UNDP, FAO and the World Bank to prepare a joint guide on water resources policy review and reform and on strategy formulation. The outcome was the World Bank/UNDP/FAO Land and Water Bulletin No 3, “Water sector policy review and strategy formulation – A general framework” (1995), (Ref 8).

The document describes and discusses the strategic planning processes, focusing on policy review and strategy formulation for water resources management. It is a useful basis to consider when developing an approach to the formulation of water demand management strategies. The approach presented in the Bulletin is outlined in Box 1.1.

Box 1.1 Policy Review and Strategy Formulation

A policy review is intended to re-assess objectives of existing policy, the status of the water sector, and to provide new goals and policies on which a detailed strategy can be based. Highlights of policy reform may include aspects such as water rights; privatization; the promotion of price and market mechanisms; and reforms in planning and management.

The process of strategy formulation, however, is concerned with finding a way of putting policy into practice. In its simplest form, it should be a continuous process involving feedback of the results of strategy implementation and of the resulting programmes and projects. In reality, the planning process is far more complex. It may be complicated by shorter-term horizons, entrenched administrative processes, changing circumstances and with other aspects of public policy and economic development.

Policy review and strategy formulation may have to take into account longer-term effects such as increasing population, rates of urbanization and the increased demand for basic services, potable water, sanitation and secure food supplies. Component parts of a policy review may include determining the importance of water in specific national and regional contexts, conducting a comprehensive water resources assessment.

Broad options may then be evaluated to set the scene for detailed strategy formulation. These should identify critical elements such as institutional requirements and the stakeholders involved. Public consultation and participation in strategy development are important if the outcome is to be acceptable.

The principal elements and key issues addressed in strategy formulation should allow an integrated approach to be taken to assessment, development and management of water resources. Institutional and legal reforms may be a major part of strategy formulation. These may include, for example, the allocation and recognition of water rights, changes in organizational and ownership arrangements, and decentralization and devolution of responsibility in public sector management. Economic tools, incentives and technological innovation, environmental and health considerations may also be important features of strategy.

Broad options may then be evaluated to set the scene for detailed strategy formulation. These should identify critical elements such as institutional requirements and the stakeholders involved. Public consultation and participation in strategy development are important if the outcome is to be acceptable.

The principal elements and key issues addressed in strategy formulation should allow an integrated approach to be taken to assessment, development and management of water resources.

As population densities increase, there is a continuing reduction in per capita availability of renewable water resources. Since Land and Water Bulletin No 3 was published, managing the demand for water has assumed greater importance. Furthermore, there is increasing emphasis being placed on equity considerations, on the importance of poverty reduction and on ensuring that sufficient water is available for the vulnerable. The need to incorporate sound, effective strategic planning of water resources, which has cross-sectoral agreement, has become increasingly urgent.

Water demand management and evaluation of the impact that these measures may have on the poor and vulnerable, which has previously been given lesser emphasis, should now be an integral part of a water resources strategy study.

Some important pre-conditions to developing a successful strategy include:

- adopting an adaptive management approach which includes new mechanisms to be developed to manage poverty related issues. Initial administrative mechanisms may have to be updated as the experience of the agencies involved grows;
- involving stakeholders so that they can contribute to policy review and strategy development;
- the negotiation of specific agreements between implementing agencies with overlapping or inter-dependent responsibilities. For instance, agreements may be required between agencies responsible for water supply and urban slum development, or with health agencies.

2.0 WATER DEMAND MANAGEMENT

2.1 Definition

Water demand management has been variously described.

The FAO/World Bank/UNDP (1995) defined it as the *"use of price, quantitative restrictions and other devices to limit the demand for water".* The UK Water Industry Research/Environmental Sciences Association (1996) described it as *"…the implementation of policies or measures which serve to control or influence the amount of water used".*

These definitions enshrine the broad elements of the water demand management concept and in particular the employment of a variety of "measures" to influence and control the demand for and consumption of water.

2.2 Potential measures

2.2.1 Previous studies

A number of attempts have been made to categorise water demand management measures, principally those by James Winpenny[11], Professor Tony Allan[12] and David B. Brooks[13]. They recognise that controlling and influencing the amount of water consumed, must be seen in the context of the technical and economic viability of available water supplies and its quality, as well as regional and national water strategies, the dependence of a region on "virtual water"[14,15,16] and other socio-economic factors. However, water demand management raises complex issues for consumers, communities, water providers and regulators in regions where there is a scarcity of water resources.

James Winpenny categorised demand management measures as follows:

- Direct interventions (e.g. investment, spending programmes and targeted interventions to encourage the use of water-efficient and water saving measures);
- Incentives (policies, market and non-market based measures which influence the behaviour of users directly by providing them with the incentives for using the resource more carefully); and
- Enabling conditions (changes to institutional, legal and the economic framework)

Professor Tony Allan discusses the potential impacts of demand management through changes in:

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[11] Winpenny, James; Managing water as an economic resource, 1994 (Ref 9)

[12] Allan, J.A., Productive efficiency and allocative efficiency: why better management may not solve the problem; in Agricultural Water Management 40 (1999), Elsevier, Amsterdam (Ref 10)

[13] Brooks, D.B., Water demand management; conceptual framework and policy implementation, International Development Research Centre (IDRC), Canada, 1997 (Ref 11)

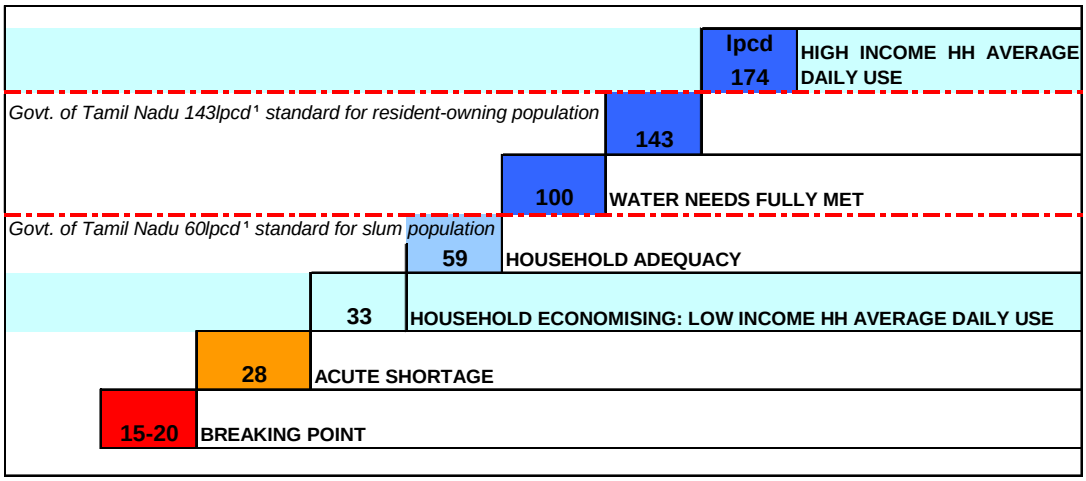
[14] Allan, J.A., Virtual water: a strategic resource. Global solutions in regional deficits, Groundwater 36(4) 1998 (Ref 12)

[15] v Hofegen, P., Virtual water, World Water Council, e-Conference, 4th World Water Forum, 2004 (Ref 13)

[16] Virtual water – the amount of water consumed in the production of imported foodstuffs and goods

- productive efficiency (technical efficiency of the water or irrigation system);
- allocative efficiency (economic efficiency or the consideration of which activity brings the best return to water); and
- trade in "virtual water" (relating to national/regional relationships within the global hydrological system).

He recognises that re-allocation of water has political implications. Improved "productive efficiency" is normally seen as the most welcome by politicians as increased investment in infrastructure and training provides a solution and serves the interests of manufacturers. The option of water re-allocation is seen to be less attractive because of the social and political implications and here is the nub of the equity and water poverty issue. Where water is short there will normally be "winners" and "losers" in any re-allocation of resources (Figure 2.1).



Note: lpcd = litres per capita per day

Source: Case Study Report, January 2005, DFID KaR Project R8332, Black & Veatch

Figure 2.1 Water consumption In Chennai, India (2004);

In addition, the introduction of water demand management measures should be seen not only in relation to water quality and water supply options[17] but also in a wider context, which includes consideration of a country or region's macro-economic policy, its strategic water security and its dependence on "virtual water".

Trade in "virtual water", requires an understanding of the global factors affecting future water; supplies and the overall economic strengths which could secure further supplies of "virtual water" for a region or country. In the context of this document, "virtual water" is regarded as a supply option. It is not, therefore, included when considering demand management measures, other than in the context of the broader water resources strategy that is required before a water demand management strategy can be finalised.

[17] For potential water supply and water quality improvement options see Annex C

2.2.2 Broad categories of water demand management measures

The authors of this report have drawn on the earlier work, described briefly above, and on Case Studies undertaken by them in India and Jordan, during 2004 and 2005 (Summarised in Annex B), to develop a framework within which potential water demand management measures can be placed. The table below lists a number of broad categories and the types of demand management measures within in each category.

These measures are divided as those affecting the domestic and municipal provision of water (D) and those affecting irrigated agriculture (A). The three categories of measures can only be implemented with supporting or enabling measures. The associated supporting or enabling measures (S) are shown as a separate category at the bottom of the table.

Box 2.1 Categories of water demand management measures

	WDM Measure	
	Domestic/municipal water	**Agricultural water**
Developmental and technical measures	**DT** Physical changes to the infrastructure which reduce losses in the supply system, improved water use by consumers and re-cycling of water in industrial systems.	**AT** Physical changes to the irrigation infrastructure or introduction of more water efficient systems (drip or sprinkler systems) and improved water management which reduce water consumption.
Allocative, financial and market based measures	**DA** Re-allocation through inter-sectoral and intra-sectoral water quotas and allocations and through water tariffs	**AA** Re-allocation through inter-sectoral and intra-sectoral water quotas and allocations, land use and cropping pattern changes, water tariffs and water markets
Other socio-economic measures	**DS** Community level management of water and measures relating to population	**AS** Establishment of water users' associations to improve water management and measures relating to population
Supporting or enabling measures	**SD** Measures required in support of the implementation of those above (e.g. legislation, regulation, public awareness campaigns, mobilisation and institutional changes)	**SA** Measures required in support of the implementation of those above (e.g. legislation, regulation, improved extension services and institutional changes)

[Note: The following codes are used above for generic measures: DT – Domestic Technical; AT – Agricultural Technical; DA – Domestic Allocation; AA - Agricultural Allocation; DS – Domestic Socio-economic; AS – Agricultural Socio-economic; SD - Supporting Domestic; SA – Supporting Agriculture].

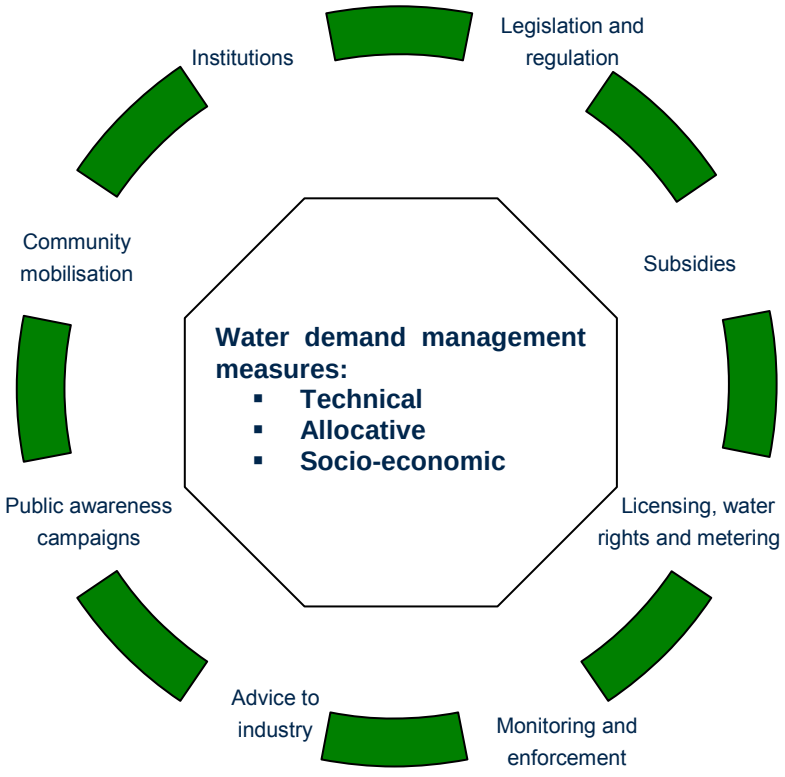
In addition, a distinction is made between those measures where:

(i) Water supply options are beginning to become limited or unreliable, or technically or economically impractical). In these instances:
   - developmental and technical measures (DT & AT) or
   - allocative, financial and market based measures (DA & AA);

   may be considered. These measures would be encouraged or implemented through regional or central government institutions, after consultation with stakeholders, making use of the appropriate policy instruments (shown as supporting or enabling measures); and where:

(ii) The supply of water is already limited or unreliable. In these instances, in addition to the above, other socio-economic measures may be adopted. These measures may arise spontaneously or may be encouraged at community level. For instance, a community may take action to manage the water demand of the community to ensure: (a) at least the limited quantity of water reaches the community; (b) an equitable (or other) allocation of the limited water available is made; (c) access is available to other diverse sources of water; or people may move to less water scarce areas (e.g. farmers or farm labour may migrate or move to other employment).

Consideration must also be given to supporting (or enabling) measures. The diagram below shows the principal supporting measures that may have to be considered when implementing demand management measures. Supporting measures may be applied at different levels (e.g. through public administration or community intervention). They are discussed further in section 4.7.



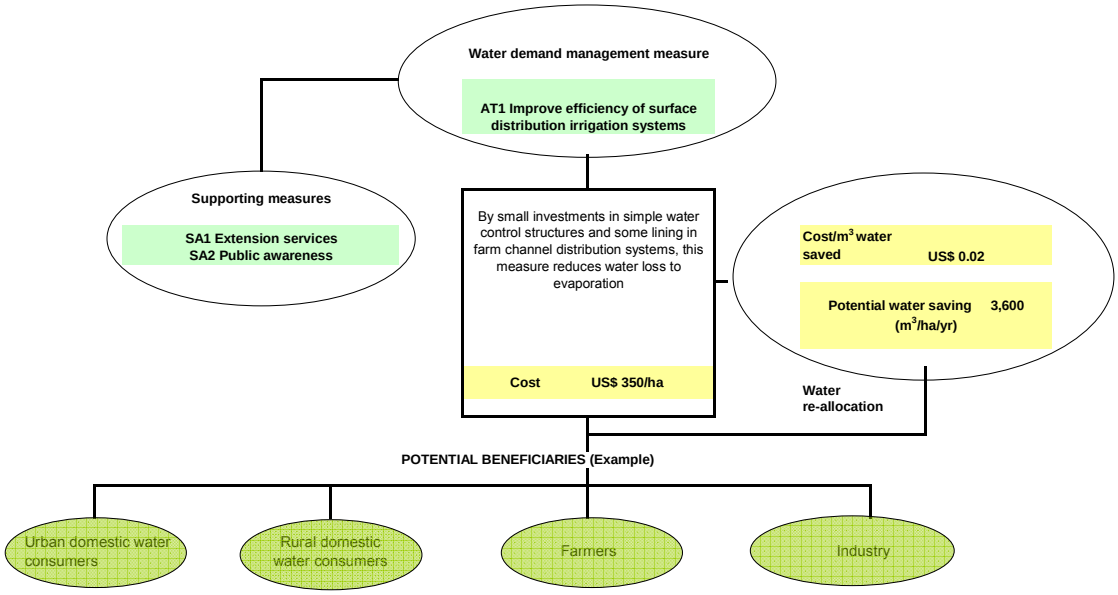
2.3 Potential impacts

The introduction of a water demand management measure will have a cost to government or the consumer (e.g. through the provision of new infrastructure or equipment or through its administration). If the measure is effective, it will induce water savings and make water available for other consumers. It may reduce the over-use of an aquifer, thereby increasing its sustainability. The measure may have an impact on individuals and communities by providing a re-allocation or redistribution of water. The impact can be complex and may be socially and politically contentious.

The diagram below gives an example of a demand management measure which reduces water consumption so that it can be re-allocated to others.

In many surface irrigation schemes the overall irrigation efficiency[18] is low due to: (i) poorly maintained earth irrigation water supply canals; (ii) low operating efficiency; and (iii) low field application efficiency due to poor on-farm development. Through the measure illustrated below, the losses to evaporation and the water lost to seepage which can not be re-used may be reduced by: (i) improving or lining the irrigation canal system, (ii) improving operation of the system; and (iii) improving field irrigation to reduce on-farm losses. Water would be saved by reducing evaporative water losses on the farm[19].

The water "saved" could then be used either to extend the area under irrigation or be made available for domestic use, perhaps by transfer to beneficiaries in urban areas.



[18] Defined here as: consumptive use as a percentage of water supplied from the source (See Glossary of terms).

[19] Where the water is currently pumped from the ground by the farmer, the investment cost in water saving infrastructure may be partially offset by reduced pumping costs.

The impact of water demand management measures in general and their potential effects on the poor and vulnerable are discussed in Section 4.9 and Annexes A to C.

3.0 THE POOR AND VULNERABLE

The Sustainable Livelihoods Approach provides a useful basis for defining poverty and vulnerability in relation to water demand and its use in terms of an asset base.

Water scarcity may arise for a number of reasons. A number of responses may be required at different institutional and community levels to overcome the impacts of this. Resolving conflicting water demand interests in areas of water scarcity presents a challenge if it is to address equity and poverty issues. Water users often ignore the fact that other people's water needs are not met, provided their own are satisfied.

Poverty is a highly complex issue. The relationship between water and poverty is characterised by the nature of the links between water availability, water demand, and the ability of individual households to use their assets effectively. The vulnerable are often the least visible and least articulate members of society. Planners need information about the extent of vulnerability in relation to water. Participatory methodologies can be used to identify the poorest in the community and the most vulnerable to water scarcity. Six key indicators of water use have been found to be sufficient to determine the level of vulnerability with regard to water.

3.1 Water, poverty and vulnerability

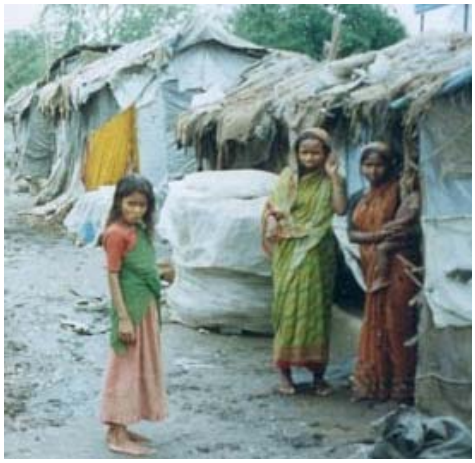
3.1.1. The sustainable livelihoods approach

One of the aims of this document is to demonstrate how different water demand management measures affect the livelihoods of the vulnerable and poor and how strategies may be developed which eliminate or reduce any negative impacts.

The Sustainable Livelihoods Approach (SLA) to poverty and vulnerability has its roots in the work of Conway & Chambers (1991)[20], subsequently developed through the work of NGOs such as Oxfam and Care International, and prioritised by DFID since 1997[21].

The SLA provides a useful basis for defining poverty and vulnerability in relation to water demand and its use in terms of an asset base. It allows a definition of the poor and vulnerable in these regards as:

- those households whose basic needs of food, shelter, health, livelihood and sense of empowerment, outstrip the resources available to meet those needs and consequently are more likely to experience harmful or negative impacts as a consequence of water shortage.



[20] Chambers, Robert & Conway, Gordon, Sustainable Rural Livelihoods: Practical Concepts for the 21st Century, Institute of Development Studies Paper No 296, University of Sussex, 1991 (Ref 14)

[21] White Paper on International Development, UK Government 1997 (Ref 15)

Over the past ten years or so, the SLA has experienced several interpretations and broadened its intellectual and practical applications over a number of sectors. In general, it is based on addressing the following:

- the priorities of the poor;
- the needs and concerns of the poor through a responsive and participatory approach;
- the adoption of an holistic view towards poverty reduction;
- the need for partnerships across sectoral divisions;
- the sustainability of proposed approaches;
- the need for flexibility of approach to enable adjustments to be made to changing circumstances.

A "livelihoods approach" towards poverty and water use is also interpreted as a "people-centred approach" rather than a technical approach, R. Calow & A. Nicol[22]. Numerous case studies have been sponsored by DFID, to support and refine this approach based on experience and best practice. The SLA has proved helpful in several ways, for example by:

- improving the integration of people-centred project planning and implementation;
- enhancing an understanding of the complex dimensions of poverty;
- encouraging flexibility during the course of project implementation, based on realities on the ground;
- supporting new development initiatives;
- encouraging inter-disciplinary working.

At the same time, the SLA has encountered obstacles which are no less significant in determining whether or not the concept has a viable application in the broader development context. Key limitations identified by development practitioners and listed by Allen & Sattaur [23] include:

- the SLA fails to make sufficiently explicit the links between poverty, power relations, gender, environment and human rights;
- over-intellectualisation of SLA, and lack of practical and simple tools and methodologies to support implementation under existing project and budget cycles;
- holistic working in a sectoral environment is difficult at best and distinctly discouraged in some circumstances;
- monitoring and evaluation: it is difficult to attribute livelihood outcomes to specific project interventions;
- oversimplification of complex realities;
- expectations raised beyond the competence of communities/institutions/projects to meet them.

Many water demand management options raise greater social and political issues than technical ones, particularly where the re-allocation of water between consumers is concerned. Governments throughout the world are often reluctant to

[22] Calow, Roger & Nicol, Alan, Sustainable Livelihods, Poverty Elimination and Water (Ref 16)

[23] Allen, Catherine & Sattaur, Omar, *Sustainable Livelihood Approaches: Engaging with SL or just best development practice?*, Paper presented at Bradford Workshop, 29-30 May 2002 (Ref 17).

force people to curtail abstraction of water or use, foreseeing either social or economic impacts on large sections of the population, or on small sections of the population with high levels of social and political influence. Water related legislation or regulation, to be effective, has to gain the tacit agreement or understanding of those to whom it applies.

While the SLA approach encourages and enables people's needs to be integrated into planning and management of water resources, it is challenged by the current realities of water management and delivery responsibilities. This is particularly pertinent in relation to sectoral reform – poverty alleviation is not customarily seen as the responsibility of service providers such as water supply agencies. In programmes of sectoral reform, the responsibility for a poverty alleviation component is often sub-contracted to an NGO with no sectoral decision making authority. This effectively marginalises the issue while simultaneously relieving the prime implementing agency from any responsibility to integrate poverty alleviation into its own strategic planning.

3.1.2 Water-Poverty links

Water scarcity may arise for a number of reasons. A number of responses may be required at different institutional and community levels to overcome this. Integrating and resolving conflicting water demand interests in areas of water scarcity presents a challenge if it is to address the needs of the poor and equity issues. Management of the supply usually involves a number of agencies which cross administrative boundaries. It is not unusual for different types of water users to ignore the fact that other people's water needs are not met, provided their own are satisfied.

One feature of water demand management is that different priorities may be placed by different water managers and users on different aspects of demand management. This can lead to a polarisation of attitudes and, in some cases, to difficulties in agreeing on an integrated approach to determining rights, roles and responsibilities. Those least able to argue their case or bring their needs to the attention of decision-makers, are often least well served. Characteristics of water-poverty links have been well described by Arthur McIntosh in an Asian Development Bank publication[24] .

Poverty, in itself, is also a highly complex issue. The relationship between water and poverty is characterised by the nature of the links between water availability, water demand, and the ability of individual households to use their different assets most effectively. The vulnerable are often the least visible and least vocal members of society. Water users with greater economic, social or political weight access water and influence demand management strategies more effectively than those without. It is important, therefore, for the water needs of the vulnerable to be adequately represented in strategic planning for water demand management.

[24] Arthur C. McIntosh, *Asian Water Supplies: Reaching the Urban Poor*, Asian Development Bank and International Water Association, ADB 2003 (Ref 18).

3.1.3 Vulnerability assessment

The first step to be taken, in integrating poverty alleviation into the planning process, is to gather data on vulnerability and poverty to assist in assessment. These data should play an equal part with technical and economic data in providing the basis for policy development and in contributing to analysis of the most appropriate water demand management measures.

There is no simple link relating water to poverty. Some poor communities in some locations experience severe inequities in relation to water access; others do not. Some may experience water shortages, but vulnerability impacts may be reduced by a supportive community or through social networks.

Decision-makers need appropriate information about the scope and extent of vulnerability in relation to water, and appropriate ways of obtaining that information. The first task is to identify who are the poor and who are vulnerable with regard to water shortage, and the second, to establish in what ways they are vulnerable to water stress.

Participatory methodologies, applied at representative sites, can be used in fieldwork to identify those considered poorest and most socially vulnerable. Details of these methodologies are described in Annex A.

From Case Study fieldwork in India and Jordan[25], some common indicators of poverty in relation to water became apparent. Ten key indicators of water use were identified. Six of these (shown in bold in the table below) were found to be sufficient to determine the level of vulnerability with regard to water.

A link was then made between those identified as poor and vulnerable to water shortage and the selected water use indicators. The link took the form of a simple rating and ranking exercise, described in Annex A. This exercise was undertaken with different socio-economic groups and with men and women separately. The results illustrated differences in water-related priorities, not just between different community sectors, but between the poor living in different localities, and between men and women of the same socio-economic group.

Different water users have different priorities and refer to different indicators to determine levels of satisfaction and understanding. The focus and priorities of stakeholders may differ.

[25] Water Demand Management in areas of groundwater over-exploitation – Report on Case Studies, Black & Veatch, DFID, January 2005 (Ref 4).

Ref. No.	Indicator
1	**Access to water**
2	**Quality of water**
3	**Effect on livelihood**
4	**Affordability**
5	Asset base
6	Reliability of supply
7	Awareness
8	**Sense of empowerment**
9	**Health**
10	Conflicts

Development of a methodology to assess vulnerability against these indicators highlighted several issues:

- dimensions of poverty are highly complex;
- there may be significant rural/urban differences in poverty, which planning processes need to recognise and take into account;
- vulnerability, in relation to water resources, sometimes relates to socio-economic differences within a community but sometimes affects entire communities, regardless of socio-economic differences;
- the higher the socio-economic status of water users, the higher the expectations for water supply;
- resource management, demand management and supply management cannot be separated. Actions relating to one affect management of the others. Integration of management systems is needed if a successful approach to the provision of basic water needs is to be developed;
- water/poverty links include: political issues; social issues; economic issues; gender issues; and technical issues
- the more complex the assessment methodology, the less likely it is to be adopted.

The links and relationships between poverty and competing water demand interests and how institutions deal (or fail to deal) with these interests are complex. It is important, therefore, to be able to identify poor and vulnerable groups with confidence and to relate their priorities, vis-à-vis water demands and availability, to those of other socio-economic groups. This is discussed in Annex A and in Section 4.3 below.

4.0. STRATEGY FORMULATION

Formulation of an effective strategy requires a number of steps to be taken. These are normally preceded by a policy review, development of agreed goals and policies and the examination of a matrix of problems and critical issues. Development of the strategy will test the practicality of the goals and policies. A water demand management strategy should be embedded within an overall water resources management strategy. The water demand management strategy should take account of the future livelihoods of the poor and vulnerable. Understanding the levels of political acceptability and the drivers for change as well as the means of overcoming any opposition to change will be important, if the strategy is to be implemented effectively.

4.1 General

Formulation of a water resources strategy is a complex process and should normally follow a review of regional water resources policy[26] and the setting of agreed sectoral goals. The policy review may include an examination of, for instance: (i) the importance of water in national social and economic life; (ii) quantification and ranking of the pressures on water resource development; (iii) the identification of options for mitigation; and (iv) the preparation of a matrix of problems and critical issues;[27]

Identification of the need for water demand management measures and related policies should be seen as a fundamental element of policy review. This is often given insufficient emphasis, in view of perceived social and political repercussions of their implementation. The development of, what may be relatively expensive, supply options (e.g. conveyance of water from distant sources; desalination of sea or brackish water) often take precedence. In developing a sustainable water resources strategy, within a regional macro-economic context, three features will normally need evaluating: (i) water resource and supply options, (ii) the maintenance or improvement of water quality, and (iii) the management of demand.

Ideally, water demand management strategies should be embedded within an overall water resources management strategy and form an integral part of it.

4.1.1 Policy review

Policy review can be divided into three main but interdependent areas:

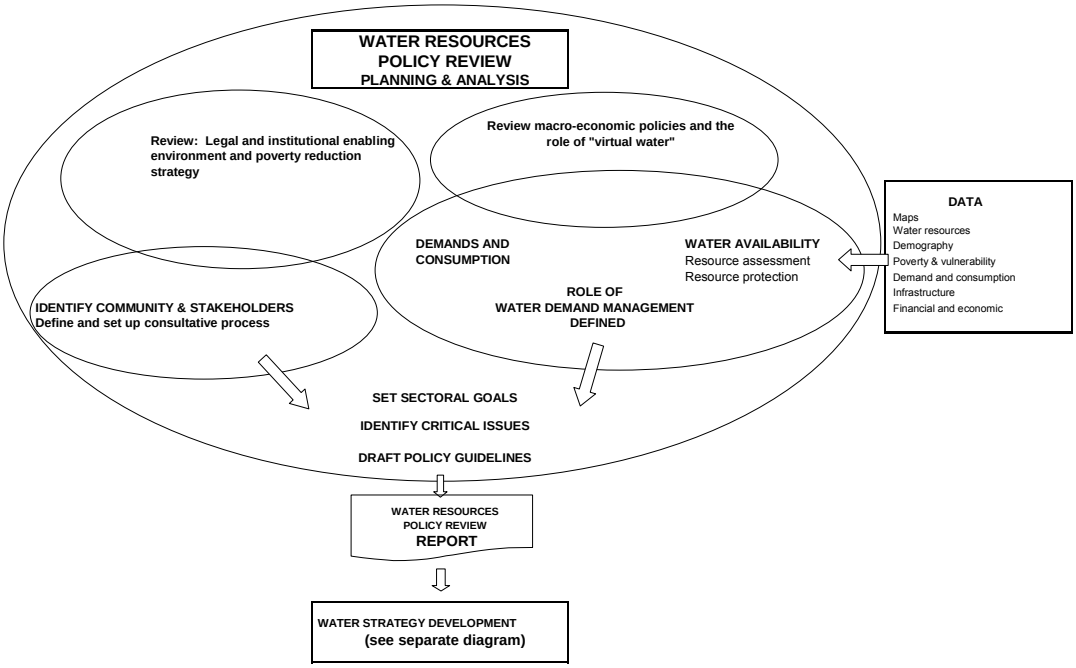
- Planning and analysis in which the objectives are to collect data on the water sector and develop national or regional policy guidelines.
- Consideration of legal and institutional issues where the objective is to create the right enabling environment for any future strategy. This should include the legal and regulatory framework in which rights and obligations in respect to water are made clear. They may include the definition of the abstraction, provision and use of resources and may address demand management issues. Institutional and management roles and responsibilities which are to be incorporated within the future strategy should be defined.

[26] The working definition used in this document is that strategy is a step in translating policy into action

[27] World Bank/UNDP/FAO: Water sector policy review and strategy formulation – a general framework, FAO Land and Water Bulletin No 3, 118pp, FAO, Rome 1995, p.35 (Ref 8).

- Economic aspects in which macro-economic and sectoral economic policies, which will support the water strategy, are evaluated. There is the opportunity here to examine and, where appropriate, define specific incentives for the careful use of water and review poverty reduction strategies.

During the policy review, the role of water demand management should be defined and, in reviewing and evaluating the importance of water in social and economic life, the livelihoods of the vulnerable and poor and their access to sustainable water supplies should be examined.



During the policy review, a number of problems and critical issues are likely to be identified in areas where renewable water resources (including groundwater) are already being over-exploited. These will include physical issues, social issues and those relating to the allocation or re-allocation of available resources. At this stage, the ranking and economic analysis of options for developing water resources or influencing the use of water will become central to the analysis. The social acceptability issues and political efficacy of options (i.e. the drivers and obstacles to change) will also have to be examined and evaluated, before an appropriate strategy can be developed.

4.1.2 Strategy formulation

General

Policy review should then lead to the development of an overall water resources management strategy within which the water demand management strategy should be clearly defined.

The water resources management strategy should address such aspects of water development as the requisite institutional and human resources framework and the medium to long-term issues of building or enhancing water management capacity.

Where water supply and demand management aspects are concerned, the views of the poorest and most vulnerable are often neglected. Where supplies and opportunities for augmenting these are limited, competition often arises between different water using sectors and between groups within any sector. The poor are normally least well able to protect their interests and it is only within an agreed and appropriate strategy that their demands can be safeguarded.

There are sometimes, but not always, winners and losers in introducing water demand management. It is important that all groups of stakeholders are consulted in establishing a strategy. This will encourage their commitment and ownership of an agreed approach. Issues that may have to be addressed include the differential levels of access to water by different socio-economic groups. It may be necessary to develop a strategy which will bring about a shift in water allocation and which is acceptable to all consumers. The approach may fail to win support if it is perceived to lack the input from key constituencies such as local communities, NGOs and private sector agencies.

Strategic planning is essentially a continuous process. During this process, development objectives and policies are reviewed, critical issues are addressed and after consideration of the relevant issues, options for implementing policy become clearer. The selection of a particular strategy will normally lead to the implementation of programmes and projects, whose outcomes should be assessed so that, based on feedback, appropriate modifications can be made to the strategy.

The formulation of national or regional strategies for integrated water management can be complex. Although experience worldwide is useful when generating options for action, the solutions to any country or region's problems must be tailored to its specific needs.

Strategy development

Strategy development will be based partly on data that have been collected as part of policy review. However, a considerable amount of further data will be required. Integration and analysis of a large amount of data on the available water resources and the demands and use of these resources will have to be undertaken, within the context of social, political and economic policy. These may, for instance, provide the basis for defining priorities in water allocation and the quantum to be supplied to a range of consumers. The analyses will have to take a long term view of development, allowing forecasts to be made of future resources and demands; horizons of probably twenty or twenty-five years may have to be considered. Such forecasts will not be possible without inputs from sociologists, demographers and economists and without understanding current political influences and gaining the advice and input of those who wield this power.

Before demand management measures can be assessed, water supply and resource augmentation options will have to be considered and a number of potential future scenarios evaluated. These may include, for instance, options for treating poor quality water, waste water treatment and re-use and water harvesting.

Demand forecasting for a period up to twenty-five years hence can be problematic. A number of different projections may to be considered which can be updated at

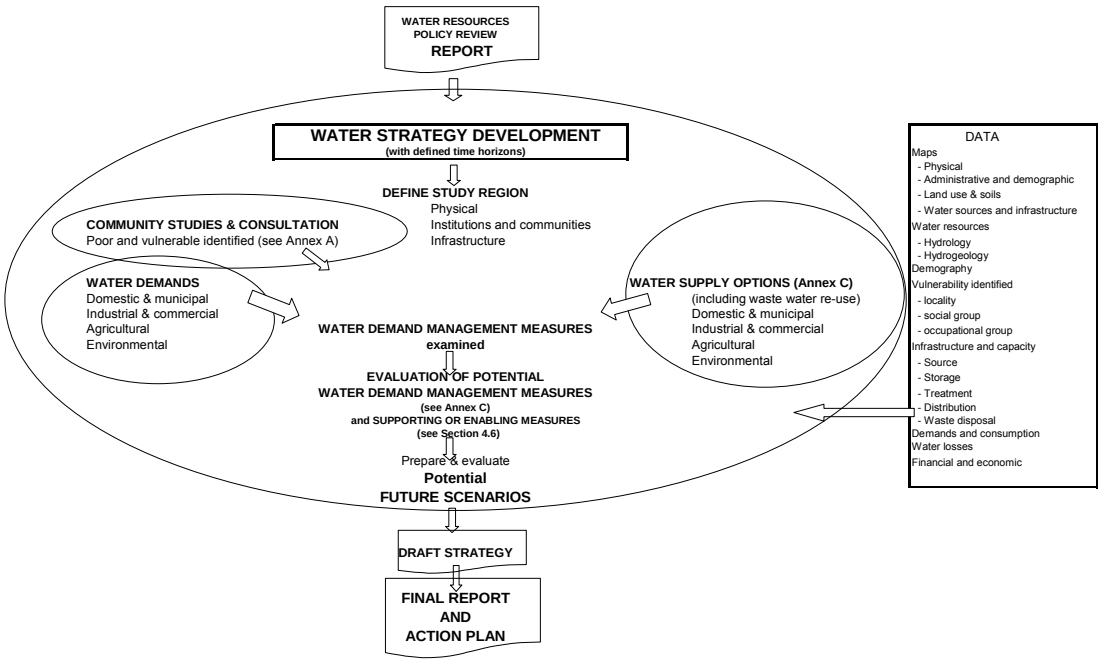
intervals in the future. At this stage, however, policy on priority consumers, including the definition of per capita consumption for domestic purposes, industrial needs, the role of agriculture and environmental needs should already have been defined.

If future demand-supply scenarios indicate that supplies already fail to meet or are unlikely to meet future demands, then demand management approaches will become an important element of the water strategy.

Understanding and determining the social and political influences on the management of the demand for water is an essential ingredient of strategy development.

There may be targets within different Government Ministries which, in themselves, may have a justifiable rationale but which are dependent on the availability of water. For instance, the Ministry of Agriculture may have annual targets for an increase in food and fibre products, the Department of Industry may have plans for new Industrial Development Zones and the Ministry of Water may also have targets to increase its supplies to domestic consumers.

These plans may have been made independently without confronting the possible competition for resources. A water resources strategy must, somehow, reconcile these competing interests, and bring stakeholders together to consider the issues raised and eliminate any potential conflict.



The planning of a national or regional strategy will require water resources assessments, demand projections over suitable periods, the facilities for data storage, system modelling, system monitoring and updating.

In this document, we are concerned primarily with the development of demand side management and the socio-economic studies which are required to support decision making in this area. The development of practical programmes and

projects, however, relies on a wide understanding not only of the supply-side options but also of agreed macro-economic and sectoral policies and the appropriate enabling environment.

The approach to demand side management has often been neglected in the past for a number of reasons, for instance:

- the promise of providing new supplies rather than influencing demand is more acceptable to consumers;
- difficult choices may have to be made with regard to alternative development scenarios; implementation is often seen to be complicated;
- acceptance by stakeholders can be difficult to obtain;
- legislation may be enacted but effective enforcement and monitoring may be required.

Despite these reservations, it is important to examine and determine options for managing demand within the available supplies. Without a clear approach to managing demand, over-exploitation of aquifers and surface resources is almost inevitable. Longer term problems, which reduce sustainability of a resource or produce irreversible changes in quality, may arise.

4.2 Institutional and Community aspects

The implementation of water policy and the management of water supplies depend fundamentally on the institutions, agencies and communities involved. Different situations require different institutional arrangements. For example, public-private participation with the involvement of the private sector in implementing, operating and maintaining infrastructural development is becoming increasingly common where efficiencies of scale and management can be made.

At community level, where public authorities or public-private partnerships fail to deliver the services required, NGOs working with communities may take on a role in the provision and distribution of water and in managing the demand. The majority of water demand management options, however, will generally be introduced or encouraged by central or local government.

It is important to cultivate an integrated approach to the introduction of water demand management measures if they are to be effective. The diagram below illustrates the range of agencies and stakeholders who may be involved in policy review and strategy development and the need to establish links between those involved.

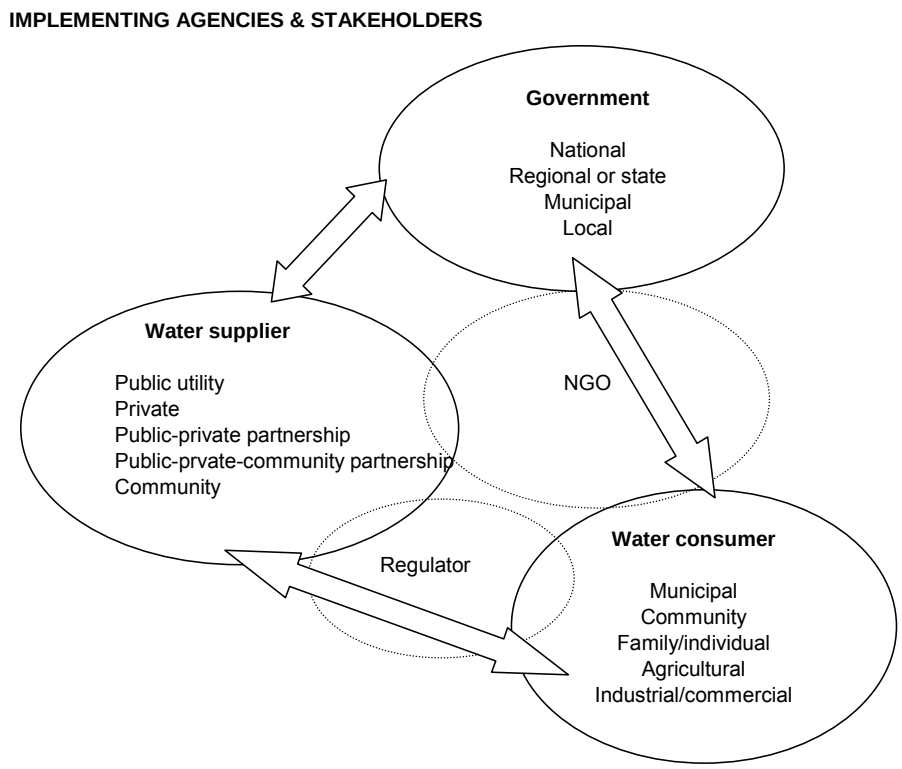
Where community involvement is a significant element, an approach which ensures that different stakeholders understand and agree their roles is important because:

- community groups themselves are unable to undertake comprehensive water demand management tasks, having neither the skills nor the wider vision necessary to integrate planning of multiple uses of a single source such as groundwater;
- although devolution of rights and responsibilities outside traditional management structures can have benefits, they also carry risks. (For example, active participation of a profit-driven private sector needs to be negotiated to protect the

needs of the poor who are unlikely to represent a profitable option to water managers);

- large-scale technical interventions are beyond the scope of most water users;
- community management could be used by government to abnegate some of its responsibilities;

- the expectations of water users differ according to the amount of water available and the user's socio-economic standing; when introducing water demand management measures, these expectations need to be recognised.



Special attention is necessary because:

- the poor also have rights to safe water, but lack the socio-political assets to make their voice heard;
- other stakeholders' demands may outstrip those of the poor when accessing the same water source;
- vulnerability can be specific to a location as well as to a socio-economic category;
- levels of vulnerability vary considerably in different environments, e.g. gender and age considerations, socio-cultural factors, rural/urban environments, different degrees of socio-political awareness, etc.

Where groundwater has traditionally been tapped for domestic and agricultural purposes and no water rights exist, an argument may arise over the ownership and control of water.

When demand exceeds supply, or where scarcity has been a seasonal feature, the value of water increases as a negotiable asset and the issue arises as to who has the right to negotiate the use of this asset. If there has been a tradition of unregulated local use, then negotiation is needed between those who seek to control the asset and those who use it. Where negotiation breaks down, force may be viewed as a means of winning the right to control the asset.

Agreement may be achieved, in some cases, where the informal and private sectors are engaged, particularly where this is through community-funded and community-managed initiatives. A starting point for local NGOs engaged in water issues is to seek to co-ordinate efforts to meet immediate community needs and to develop a future vision. Factors for NGOs to consider include:

- the extent to which local people are willing and/or able to become involved in different sorts of water demand management strategies;
- how far should the public be responsible for management and control of water-demand management;
- how much communities are willing to pay for the capital costs of a water project and to bear the risks of project development;
- what are the relevant experience and capabilities of intermediary organisations (public or private) and are they willing and/or able to be involved in community-level water demand management;
- how will the poor benefit by such strategies.

In urban environments, where water is short, community level water management groups may be established. With the advantage of local knowledge, they may have multiple functions, including:

- the equitable management of water distribution;
- as a contact point for awareness campaigns;
- as a working group to access resources for water-saving devices and practices;
- as a self-help group to support savings schemes to assist poor families;
- as an organisational point for source protection activities.

All water demand management measures, whether community-based, private, or implemented through local government, need integration with national and regional government objectives. It is important to ensure that water demand management measures are not isolated from state or regional planning.

An agreed overall approach should be adopted whereby legitimately different but conflicting water demands can best be reconciled. Moreover, government is

responsible for policy instruments (e.g. legislation and regulation, institutions, central project investment) and is able to develop formal water allocation policies, including contingency plans for emergency situations such as droughts.

Institutional capacities invariably need modifying or strengthening where water demand management measures are to be adopted. This may take time and, meanwhile, practical measures may be required to encourage water users to adapt to conditions of scarcity and to impose a degree of self-regulation in exploiting the resource base.

4.3 Poor and vulnerable identified

Protecting the rights of poor and vulnerable water users should be accepted as an integral part of any water demand management strategy formulation.

When developing a strategy, which is to take into account the poor in the community and those who are vulnerable to water shortage, a methodology is required to identify those groups and relate their problems to other less disadvantaged groups in the community. On the basis of this, a suitable approach can be built into demand management options to safeguard these groups.

Vulnerability may be defined in terms of:

- Locality
- Social group
- Occupational group

Participatory methodologies can be applied to identify who are most vulnerable, and the reasons why. Tools such as Wealth Ranking, semi-structured interviewing, rating/ranking of water use issues, and problem/solution identification, are useful in this respect (see Annex A).

Box No 4.1 Groups vulnerable to water shortage in Chennai, India & Al Jafr, Jordan

Chennai:

- Elderly persons living in high rise apartment blocks in notified slum areas
- Women-headed households from low income groups with no adults of working age
- Women of child-bearing age
- Low income groups in particularly densely populated inner city localities
- Residents of areas with poor public supply
- Non-formalised slum dwellers or squatters
- Households dependent on daily wage earning

Jordan:

- Women-headed households with no working adult males
- Women of child-bearing age
- Elderly persons with no working adults in the family
- Families with little or no education and limited work options

Examples are given in Box 4.1 above of the sections of society who were identified as most vulnerable in Chennai, India and Al Jafr, Jordan, using these tools.

Data from fieldwork which define community stakeholders can then be linked to technical, institutional and economic data gathered during a study. Using these data, a workshop[28] may prove useful to help planners evaluate the conditions they confront, alerting them to issues likely to cause difficulties in future, and helping them to prioritise water demand management methods with the highest overall probability of success.

An options assessment of this type enables development needs and objectives to be introduced through an open and participatory process. It reinforces the need to take into account a full range of development objectives, rather than to marginalise the needs of the poor and vulnerable as something addressed solely by NGO's and thus irrelevant to sectoral planning.

4.4 Data requirements

Good water resources planning and management relies on access to up-to-date reliable data and the ability to forecast future conditions based on those. These data are often lacking and predictive tools may be weak. Key data requirements for strategy development are summarised in Box 4.2.

Key data storage requirements for strategy development include:

- A database to handle the various types of information required for the project. The complexity will depend on the volume of data available. The guiding principles must be to ensure that the data are entered correctly and that they can be easily made available to the user.
- A Geographical Information System (GIS) allows geographic or spatial data to be displayed along with attribute data relevant to a particular location. This is a powerful tool in understanding all the various components that help develop a strategy.

Maps — Maps are the best medium to show the boundaries of the area or region under study and the geographical relationship between different information. The data may be grouped together and included on thematic maps.

Water resources — Water resources data are fundamental to understanding the historical development and response of the available water resources and the existing situation in the study area. The greater the length of record and accuracy of the data, the more reliable the understanding will be. The data will normally be sub-divided into two main categories: hydrological data and hydro-geological data.

Demographic — Demographic data are fundamental for knowledge of the composition, distribution and numbers of the various groups identified within the study area.

[28] Workshop on "Water demand management in areas of groundwater over-exploitation", Chennai Workshop 20 November 2004, Black & Veatch, DFID (Ref 19).

Poverty & vulnerability Socio-economic data are also fundamental. These data allow options to be assessed in terms of their ultimate community acceptability and the relative probability of their adoption. They also indicate the potential for community-level management of types of water demand management measures, including information and awareness programmes.

Infrastructure Knowledge of the infrastructure in the area will allow options to be assessed to modify and improve the situation.

Box 4.2 Data requirements

Data set	Components
Maps	Physical boundary and boundary conditions Population centres Administrative boundaries (national, regional and local) Land-use (current and proposed/planned) Water features (main rivers, lakes and reservoirs, canals, barrages) Soil types and vegetation cover (remote sensing data and field verification) Hydrological and hydro-geological data source locations
Water resources	*Hydrological data* Rainfall station data (rainfall, evaporation and transpiration rates, temperature, wind direction) Stream or river flow data (discharge hydrographs), variation in discharge down the main water courses through the study area, inflow/outflow discharges along the main water courses *Hydro-geological data* Ground water levels from the existing groundwater monitoring network from all agencies within the study area Ground water quality data Pumping test data Pumped well discharges (agricultural, domestic and industrial supply) Aquifer and aquicludes, distribution vertically and horizontally within catchment, hydraulic properties variation Groundwater recharge estimates for each of the aquifers identified within the study area Catchment water balance Model of catchment, surface and groundwater
Demography	Population distribution, socio-economic indicators and growth prediction
Socio-economic	Water- user needs, localities of water users under stress, reasons why some sectors of society are more vulnerable to water stress than others, socio-economic reasons for increased impoverishment due to water-poverty links
Infrastructure and capacity	Source facilities (water supply, wastewater and treatment) – layout and condition, as well as the capacity (design, actual and potential for increase) Storage facilities (water supply, wastewater and treatment) – layout and condition, capacity (design, actual and potential for increase) Distribution facilities (pipe network, distribution centres) - layout and condition, capacity (design, actual and potential for increase) Disposal facilities (water supply, wastewater and treatment) - layout and condition, capacity (design, actual and potential for increase)
Demands and consumption	Irrigation water demands and consumption Domestic per capita water demands and consumption Municipal and environmental water demands and consumption Commercial and industrial water demands and consumption
Water losses	In irrigated agricultural systems In domestic systems
Financial and economics	Capital costs Operating costs Maintenance costs Discount rates and Inflation predictions

Demands and consumption

These include data on domestic per capita water demands and consumption, municipal, environmental, commercial, industrial and irrigation water demands and consumption

Water losses Knowledge of the magnitude, seasonal and diurnal variation of the water losses will allow better development of strategies to minimise them.

Economic & Financial These data sets provide the basic information for the financial and economic analyses.

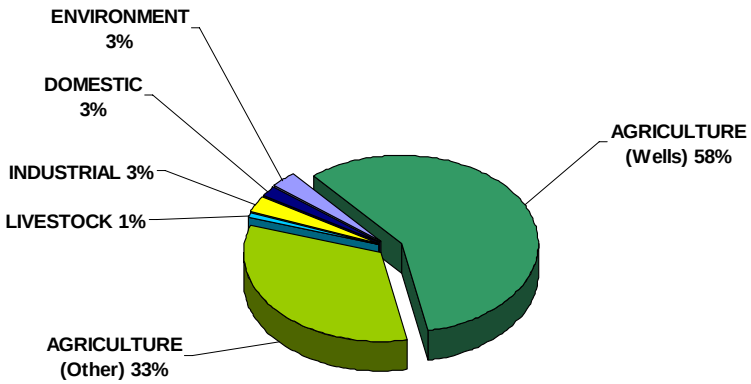
4.5 Water demand management options defined

A list of generic water demand management measures is discussed in Section 2.2.

Three categories of measures are defined:

- Developmental and technical measures;

- Allocative, financial and market based measures;



and

- Other socio-economic measures

These are distinguished from supporting or enabling measures which are discussed in Section 4.6 below.

During the study a wide variety of water demand management options were identified, categorised and examined. Descriptions of these are given on Data Sheets in Appendix C. They are categorised below in a table below which corresponds to the generic table given in Section 2.2.

In the study period, preceding the preparation of this document, a number of the measures listed in the table were seen in practice. The developmental and technical measures are all widely used, either voluntarily or at the behest of government.

The assessment and introduction of sector allocations and quotas is becoming essential in many countries or regions with efforts being made to encourage consumers to adapt consumption to meet targets by adopting measures such as crop prohibition and land-use changes (e.g. in Oman and Yemen) or through transfer of water rights (e.g. from farmers to the Metropolitan Water Authority in Chennai, Tamil Nadu).

Water tariffs, as a means of demand management (rather than for cost recovery), are being considered and introduced in a number of countries. Their effectiveness in reducing water use is still to be evaluated but there are clear indications that in the domestic sector they can be effective. Their effect on reducing water consumption in the agricultural sector by introducing water tariffs is far from certain and the literature lacks examples of success in this field.

The “other socio-economic measures” listed at the bottom of the table are not normally listed under water demand management measures but can prove to be an important component of a water demand management strategy.

Community management, to influence the demand and improve the equity of distribution, is generally an effective way or regulating demand in areas where there is water shortage and where the community is not served effectively through public supply. This may be particularly important in village communities and slum areas of cities.

Where supplies are severely limited, regional planning and controls on population and its distribution and restrictions on the development of domestic and industrial infrastructure may prove to be necessary.

Planned migration or resettlement may be necessary where supplies can not be made available. Spontaneous migration may occur in areas where water shortages are so severe and conditions prove to be unacceptable to a community.

Table 4.1 Water demand management measures

	WATER DEMAND MANAGEMENT			
	Domestic/municipal		**Agriculture**	
Developmental and technical measures	DT1	Reduce water losses	AT1	Reduce losses from surface irrigation systems
	DT2	Water saving devices and fittings	AT2	Introduce sprinkler/drip systems a) with subsidy b) without subsidy
	DT3	Recycling of industrial water		
	DT4	Use of "grey" water		
Distributive, financial and market based measures	DA1	Inter-sectoral water quotas and allocations	AA1	Inter-sectoral water quotas and allocations
	DA2	Intra-sectoral water quotas and allocations	AA2	Intra-sectoral water quotas and allocations
	DA3	Land development control	AA3	Change land use by: a) land purchase b) re-zoning/classification c) well buy-out (transfer of water rights)
	DA4	Water tariff: a) progressive b) differential	AA4	Crop area prohibition
			AA5	Change cropping patterns by: a) extension b) tax c) market support
			AA6	Introduce water markets
			AA7	Water tariffs: a) volumetric b) on power to pumps c) area based
Other socio-economic measures	DS1	Community level management	AS1	Water users associations
	DS2	Population distribution	AS2	Population distribution
	DS3	Migration	AS3	Migration

4.6 Enabling and supporting measures

Each of the water demand management measures listed in the table above will require corresponding policy instruments, support or enabling measures. These are listed below and are related to the appropriate demand management measure. For example, the introduction of subsidised sprinkler or drip irrigation systems (AT1a) will require supporting measures which may include increased extension services (SA1), introduction of subsidies (SA3) and consideration of licensing/registration of wells, water rights and associated legislation (SA7).

The broad categories of measures that may have to be considered, in addition to the institutional changes that accompany these, include:

- Legislation and regulation
- Agreement on water rights, licensing of abstraction, and water metering
- Monitoring and enforcement of measures
- Subsidies
- Advice to industry
- Community mobilisation
- Public awareness campaigns

There is often some confusion in the literature in differentiating between water demand management measures, by which the demand for water is influenced, and the supporting measures (e.g. legislation, institutional changes) which are required to bring about the change. A clear distinction is made above.

Table 4.2 Supporting and enabling measures

		Domestic/municipal		**Agriculture**
Supporting or enabling actions	SD1	Community mobilisation (DS1)	SA1	Increase Extension Services (AT1, AT2, AA5)
	SD2	Public-Private-Community Participation (DS1)	SA2	Public awareness (AT2, AA1, AA2, AA4, AA5, AA6)
	SD3	Public awareness campaign to reduce wastage (DT1, DT2, DT4, DA1 & DA2)	SA3	Subsidy introduction (AT2a)
	SD4	Encourage industry to recycle water (DT3)	SA4	Metered agricultural wells (AA1, AA2, AA7)
	SD5	Metered water supply (DA3)	SA5	Legislation & regulation (AA1, AA2, AA3, AA4, AA5, AA6, AA7)
	SD6	Legislation & regulation (DT2, DT3, DA1, DA2, DA3, DS2)	SA6	Monitoring and enforcement (AA1, AA2, AA4, AA7)
			SA7	Licensing/registration, water rights and associated legislation (AT1, AT2, AA1, AR2, AR3, AR7)

Of all the supporting measures listed above, any new legislation or regulation has to be understood and acceptable to water users and stakeholders if it is to be effective. In many instances, restrictions on and metering of abstractions will not be easily accepted by consumers and must go hand-in-hand with a strong public awareness campaign, if they are to be effective. In areas of water scarcity, where demand management measures are being introduced, legislation and regulation will normally need to be supported by effective monitoring and enforcement.

4.7 Water savings and unit cost of water saved

4.7.1 General

The aim of introducing a water demand management measure is, normally, to control or influence the amount of water, either to restore sustainability of a resource or to make water available for other consumers. Some measures may generate large savings in water (e.g. through restricting the planting of high water using crops), others smaller, although perhaps no less important savings (e.g. through introducing water saving devices in households to reduce the consumption).

There is a cost to introducing a water demand management measure. The unit cost may be high where new infrastructure or equipment is required (e.g. treating and recycling industrial water) or small where the measure relies principally on a public information campaign (e.g. use of grey water).

Table 4.3 Cost of water saved for a range of water demand management measures

Ref	Measure	Cost of water saved (US$/m^3)		
		India	Jordan	Oman
DT1	Leakage control (reduce water losses)	-	0.31-0.35	0.98
DT2	Water Saving Devices	-	-	0.20
DT3	Recycling of Industrial Water (treatment of wastewater for re-use in industrial processes)	0.80	0.52	0.27 – 0.44
DT4	Use of “grey” water	-	-	0.18
DA4(a)	Water tariff (Progressive or stepped)	-	-	0.26
AT1	Reduce losses from surface irrigation system	0.012	-	0.008 – 0.013
AT2	Introduction of modern irrigation systems: (a) Sprinkler (b) Drip	0.08– 0.24 0.22 – 0.29	-	0.01– 0.12
AA3/AA4	Change land use/crop area prohibition	0.002	0.03– 0.94	0.002 – 0.08
AA5	Change cropping patterns	-	-	0.02 – 0.09

The amount of water saved and the costs vary depending on circumstances, the country or region of application and the inclination of the consumers concerned. In Annex A, some examples are given of water savings and the cost of water saved for a range of water demand management measures. Some of these figures are given in the table above (compared at 2005 prices).

Generally, the unit cost of saving water from the agricultural sector is less than from the domestic or industrial sectors and the potential for saving larger quantities of water is greater.

4.7.2 Financial and economic aspects

When considering the options of introducing water demand management measures, a number of financial and economic issues may have to be evaluated. These may include:

- Comparison of the cost of supply against the cost of water released through water demand management;
- Pricing and cost-recovery policies including water fee collection; pricing principles – low cost, graduated price and "block" or "step" charging, differential charges. Water tariffs for cost recovery are not always effective for demand management (but sometimes there is enough elasticity of demand in the household sector to make tariffs an effective instrument for water demand management);
- Financial and economic analyses, as well as social and environmental ones, to analyse impacts of proposed measures;
- Macro-economic and sectoral policy (markets, reduction in subsidies) evaluation together with social and environmental implications;
- Subsidies and food policy – water charges for agriculture;
- Economic analyses to select strategy options;

These may prove complex issues to evaluate, particularly those which involve an assessment of the impact of introducing or adjusting water charges or subsidies.

Development of a strategy for water demand management in any region may be supportable, however, if a comparison between the unit costs of supplying water or treating water to bring it to a quality suitable for the consumer, and the unit cost of making water available through different demand management measures shows a benefit.

An economic evaluation of a demand management measure requires an analysis of the contribution that the measure would make to the national economy. This is irrespective of who would pay the cost and who would receive the benefits generated from the proposed option.

The analysis should show whether a measure is economically feasible or a least cost alternative. To reflect this view, the economic and shadow prices of goods and services (their opportunity cost) are used in estimating costs and benefits of the option.

In a financial analysis, the costs incurred and the benefits to each party involved are evaluated. There may be several parties contributing their efforts to the implementation and/or operation of the measure (e.g. government, private

enterprises, households and individuals). The gains and losses to those affected by the measure are assessed to support policy makers in establishing rules, regulations on income distribution between parties, regions and groups of people. Financial analyses differ from economic analyses; they use the applicable market prices.

Payment of interest rates, taxes including duties and tariffs and subsidies are treated as costs in a financial analysis but they are considered as transfer-payments in an economic analysis and therefore are omitted from the economic accounts.

The main adjustment required in the economic analysis is to account for the taxes and duties that are embedded in the cost estimates. The other adjustment required is to account for the shadow price for labour, where this is appropriate. Values of less than 100 per cent of the financial cost are used to allow for the level of unemployment and underemployment in the economy.

In the same way as a Benefit-Cost Analysis is used for a development project, the comparison of all the gains (amount of water saved or produced) and losses (amount of money spent including investment and recurrent costs) of specific water demand management options, can be used to determine which one provides the most economic value and the most efficient use of resources to society. This may be done by calculating the economic unit cost of water saved (e.g. US$/m^3).

A fundamental principle in Benefit-Cost Analysis is to compare effects resulting from a development intervention from those that will occur without it. Therefore, the concept of “with” and “without” water demand management measure can be used.

When the costs and benefits have been identified, the unit cost of water saved by the proposed measure can be derived. To overcome the complication arising from the different timing of investments and benefits (i.e. amount of water saved), a discounting technique is applied to bring all values at different years to the present for comparison.

The present value of the costs stream generated by an investment, the operation, maintenance and replacement costs can be calculated: $PV = \sum C_t /(1+i)^t$ (where t = period in years of the demand management option from year 1 to year n and i = social discount rate).

A similar calculation can be used to derive the present value of water saved, using the same discount rate. The unit cost of water saved can then be calculated from dividing the present value of costs by a present value of water saved.

This methodology has been applied to calculations given in the Data Sheets in Appendix C.

4.8 Impact of demand management measures

There are few good data on the impact and effectiveness of introducing water demand management measures and the views of different stakeholders on the potential impact of water demand management measures are likely to vary as technical, economic and social or community based perspectives often differ.

At a Workshop held in Chennai in November 2004[29], the "viability", "ease of implementation" and "chance of success" of a number of measures were examined and then the anticipated impact on the poor and vulnerable of selected measures was assessed. Three groups undertook the evaluation: those with (i) "technical"; (ii) "financial and economic"; and (iii) "social or community" backgrounds. Some of the principal findings are given in Box 4.3.

Box 4.3 Evaluation of water demand management measures – Chennai, India, November 2004

Viability, ease of implementation and chance of success

Eleven demand management measures were examined. Many of these were scored similarly by three groups (those with (i) "technical"; (ii) "financial and economic"; and (iii) "social or community" backgrounds).

However, the "financial and economic" group rated the chance of success of DA4 (Domestic water tariffs) much lower than the other groups mainly due to their view that, in a limited supply situation, the imposition of tariffs would not influence demand and those who could pay would pay whatever was required to meet their needs.

All groups considered AA7 (Agricultural water tariffs) as the least likely to be effective in reducing water use. The "social and community" group considered DT4 (Use of grey water) likely to be the most effective.

Impact on poor and vulnerable

Three measures were then appraised for their likely impact on the poor and vulnerable: DA4 (Domestic water tariffs); DS1 (Community level management); and AA5 (Change of cropping pattern).

There was quite a high degree of consensus of opinion on many of the indicators, particularly for the impact of option DA4 (Domestic water tariff), with all groups suggesting that this would not have a negative impact on the poor and vulnerable.

Opinions diverged quite sharply for option DS1 (Community mobilisation) between the technical group and the economic and social groups. Key differences in option DS1 focused on technical concerns that community management would have negative impacts on livelihoods, water quality and health. The reasons for this included concern that communities would delay distribution of water, leading to reduced access, higher costs and increased risks from infection from standing water. The social and economic groups considered DS1 would have more positive than negative impact, given that many slum communities in Chennai are already managing the demand for water promptly within the community (from the limited supplies of water) upon delivery by water tanker. No-one allows it to sit for any length of time as every household needs to use it immediately. These groups did not consider that costs would be higher than the poor are currently required to pay.

The water demand management impact assessment exercises undertaken in Chennai, demonstrated that stakeholders may have differing views on how different water demand management measures would affect the poor and vulnerable.

The challenge to planners is how to integrate informed and useful opinion into an overall decision-making process on water demand management measures which safeguards the poor and vulnerable without alienating some sections of society.

[29] Workshop on "Water demand management in areas of groundwater over-exploitation", Chennai Workshop 20 November 2004, Black & Veatch, DFID (Ref 19).

By developing methodologies which draw upon public opinion and by acknowledging where differences of opinion lie and why they are different, planners in the water sector can become better informed and better equipped to develop practical and realistic water sector policies for circumstances of water scarcity.

4.9 Comparison of the impact of measures and their likelihood of success

4.9.1 Impact of measures

Comparisons of the value and impact of alternative measures and the likelihood of their success are important considerations when developing a water demand management strategy. An appropriate approach is required.

In practice, both quantitative and qualitative evaluation of different aspects of a water demand management measure will be required and the comparison of alternatives will rely, in part, on some subjective assessments of the potential effectiveness of the measure. A number of steps can be applied in the evaluation process.

The following factors can be used to define the effectiveness of a measure

- Potential amount of water saved per year
- Unit cost of water saved (including subsidy and tax issues)
- Groups and number of persons affected
- Their impact, particularly on the poor and vulnerable

Evaluation of the first two factors is discussed in Section 4.7 above. They can usually be established with some certainty after assessing the relevant data.

Details of the third factor (i.e. the different socio-economic groups or sub-groups affected, including those assessed as poor or vulnerable) can usefully be recorded in a simple table as described in Annex C. Clear definition of the groups affected is an essential preliminary to the evaluation of the impact. Where the water demand management measure is intended to redress an imbalance in water consumption between one group and another (e.g. improving access of the vulnerable), a detailed understanding of the groups or sub-groups affected is required so that the impacts may be assessed.

Six indicators of the social impact of a measure are suggested through which the measure can normally be shown to be positive, negative or to produce little or no change on the group concerned. The impact indicators relate to: (i) Access to water; (ii) Quality of water; (iii) Effect on livelihood; (iv) Affordability; (v) Sense of empowerment; and (vi) Health. Details of how to assess these impacts are given in Annexes A and C.

The financial impact for the individual domestic consumer or farmer, family or enterprise is also an important consideration when comparing options.

This financial impact is covered broadly in the “livelihoods” and “affordability” classifications in the social impact assessments. However, it is valuable to examine in more detail the net financial benefit (or loss) arising from the proposed measure and the financial impact of a water demand management measure may be derived by comparing the current situation with that which would apply after its introduction.

A firm financial figure can be calculated for domestic consumers and farmers which will demonstrate the size of the positive or negative outcome of the introduction of a measure.

A similar process (using appropriate elements of the budget) may be applied to derive the financial impact on industry or other businesses where this is required.

4.9.2 Preconditions and likelihood of success

In addition to the evaluation of the water saved, the cost, the associated supporting measures and the impact of the measure, there are a number of other issues to be considered when introducing a water demand management measure. These can broadly be described under the headings of “Pre-conditions to implementation” and the “Likelihood of success”.

“Pre-conditions to implementation” may include items such as: the will of the implementing agency or agencies; the availability of funding; or the availability of appropriate technology.

The assessment of the “Likelihood of success” is an important consideration when comparing measures. Qualitative and subjective assessments may be required but these will generally address two key indicators: (i) the viability of the water demand management measure; and (ii) the ease of its implementation.

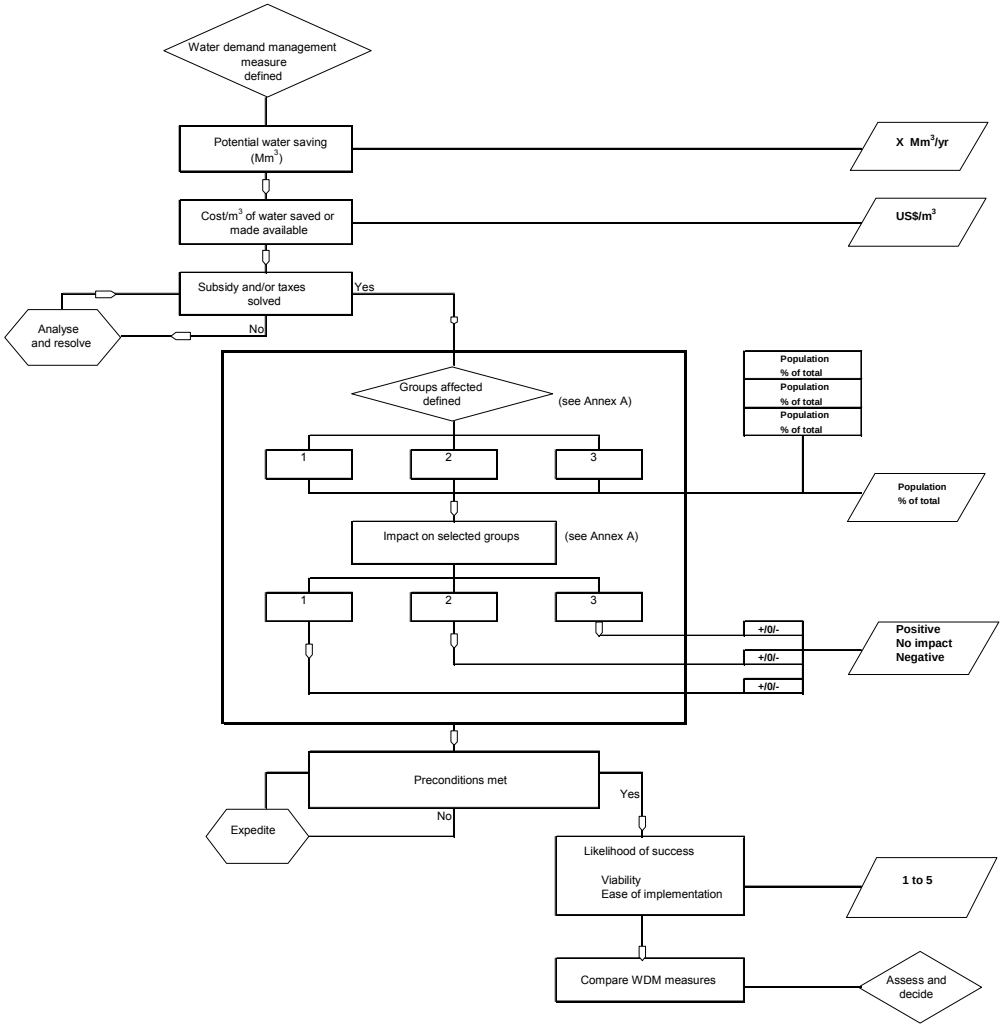
The assessment of viability may include, for instance, consideration of:

- Stakeholders and consumers likely future compliance with legislation and regulations
- Maintenance of new infrastructure and equipment (e.g. water meters)

The ease of implementation may include, for instance, an assessment of:

- Likely resistance of consumers to implementation of the measure
- Institutional changes required and the introduction of new financial systems
- Effectiveness of participatory approaches

Water demand management measures
Evaluation process



The evaluation of these is discussed in Annexes A and C and the figure above summarises the process to be followed when assessing the impact of a water demand management measure.

5.0 STRATEGY DEVELOPMENT AND IMPLEMENTATION

Step-by-step approach

The principal processes involved in undertaking a water resources policy review and developing a water demand management strategy are discussed above. The process can be complex and a step-by step approach is required if sectoral goals and critical issues are to be addressed in strategy development.

The basic steps are illustrated in a flow diagram (Figure 5.1). The approach adopted is one which recognises that decisions on water demand management measures need to be arrived at through a process of consultation and negotiation and implemented within a legal and institutional framework that provides for a free and informed negotiation process. This approach recognises that the rights of different stakeholders intersect and overlap.

The process involves an integrated approach to managing scarce resources, with technology being but one factor among others in managing the demand and supply of services effectively.

Broadly, the process falls into three main stages:

(i) Water resources policy review

(ii) Water strategy development

(iii) Strategy finalisation

Water demand management, as well as the status of and impact of proposed measures on the poor and vulnerable, should be considered during all these three stages.

Water resources policy review

During the first stage, the Water Resources Policy Review, planning and analysis are undertaken within the confines of the legal and institutional enabling environment and the region's macro-economic policies. It will be important at this stage to ensure that the lead institution undertaking the review should involve key stakeholders and community leaders in the policy review. The outcome should reflect their views, so that any critical issues that are identified and relevant policy guidelines are acceptable to them.

Drawing on the available data bank, a water balance for the prescribed region may be developed, the water demands, consumption and the water supply and augmentation options can be examined and the role of water demand management measures can be defined. Additional data needs should also be identified.

During this phase, the evaluation should establish the identity of the range of consumers within the region, and the communities and stakeholders involved, examine rights claims asserted by stakeholders and identifying risks involved for these stakeholders. Where there is a "poverty reduction strategy" to draw upon, this should be incorporated into the review. Where there is no poverty reduction strategy, the review should define one in relation to water or identify this as a critical issue which should be examined during the strategy development phase.

An understanding of the institutional enabling environment should be developed at this stage and the policy review report should indicate the changes that should be considered during the strategy development.

The Review, should conclude in a report which provides policy guidelines, sets goals for the water sector and identifies critical issues which will need addressing when developing a water strategy.

Water strategy development

In the second stage, Water Strategy Development, detailed assessments are made of water supply options and water demands for each of the sectors and the detailed needs of water demand management will begin to become clear. At this stage, sectoral water requirements or allocations should be calculated.

With each demand management option, the corresponding supporting or enabling measures should also be assessed. The future development scenarios should be costed and evaluated and the unit costs of water supplied or "saved" through water demand management should be compared. A number of potential future scenarios, with defined time horizons, can be developed. These may include, for instance, comparing the options of what may be relatively expensive development of new resources and supply schemes against the re-allocation of water between water consuming sectors or introducing other water demand management measures. The step-by-step methodology for comparing measures is described in Annexes A and C.

The Policy Review should have defined the current institutional and community roles in water supply and management. Ministries or agencies with overlapping responsibilities should be identified and the need for any specific agreements negotiated to allow an acceptable strategy to be developed. This phase should yield a Draft Strategy Report.

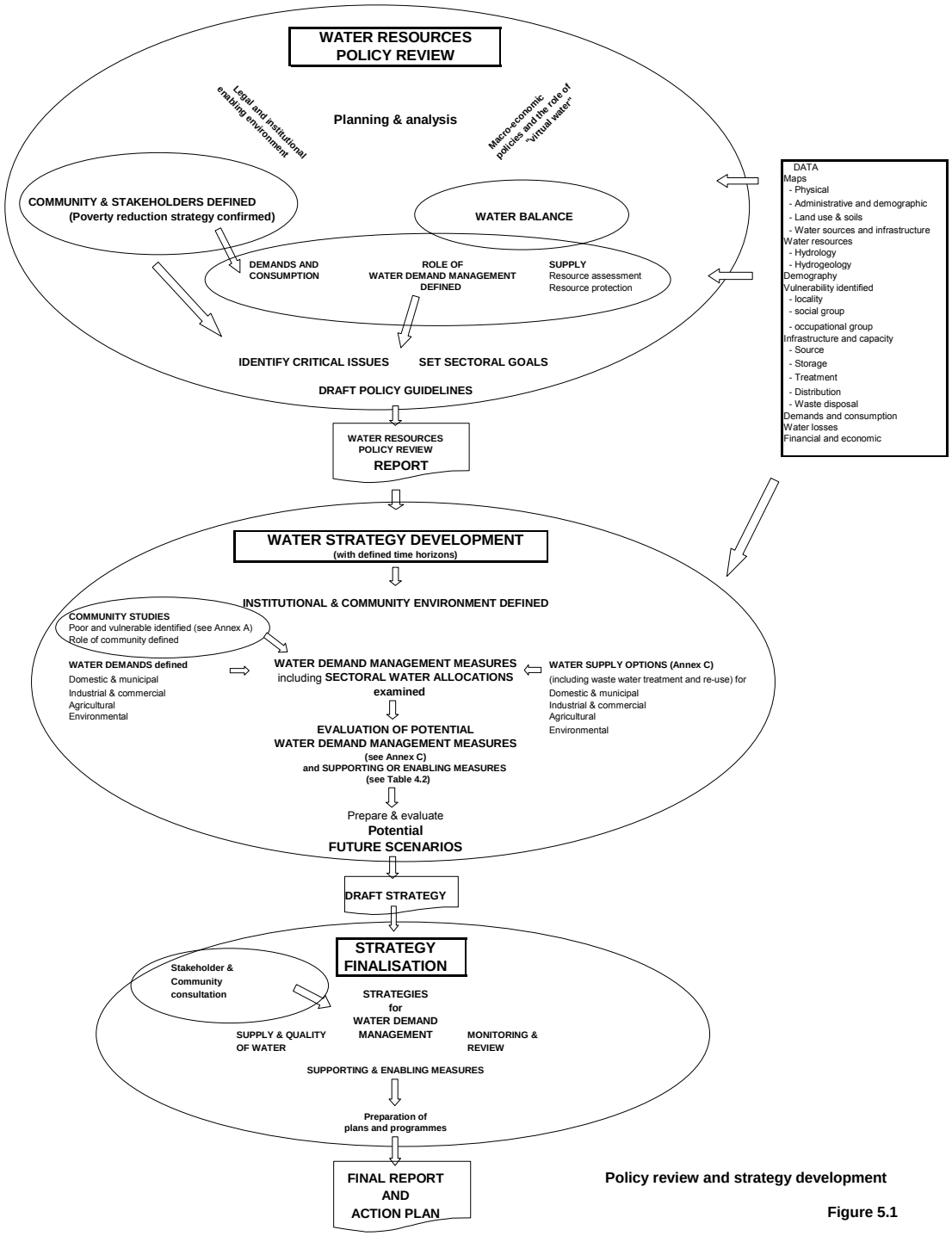
Strategy finalisation

In the third and final stage, Strategy Finalisation, there should be an opportunity for the scenarios to be discussed and commented upon by stakeholders. Where, for instance, community management is considered an option, involvement of the appropriate parties will be required before a strategy can be finalised.

The choice of participants in the three stages outlined above needs careful consideration and will depend on the boundaries and scope of the review and strategy development being undertaken. In large and complex areas, the policy review and strategy development is likely to be undertaken by National, Regional or Local Government with their advisers. Even in these studies, consultation with community leaders, NGOs and other stakeholders will be required at policy review and strategy development stages. In smaller and more homogeneous areas (e.g. remote villages or small farming communities), the reviews and strategy may be developed by a community themselves with guidance from NGOs, local government and advisers.

This stage should culminate in a Final Report and Action Plan

The final strategy and action plan should provide the plans and programmes for improving supply and quality of water, for implementation of water demand management measures and for periodic future monitoring and review of the proposed development programme and of the impact of the measures on the communities to be served.



Policy review and strategy development

Figure 5.1

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Glossary of terms

Aquifer	a geological stratum which stores or transmits groundwater
A-K aquifer	Aquifer underlying the Araniyar, Kortalaiyar river basins
Chennai basin	River basin comprising Araniyar, Kortalaiyar, Cooum and Adaiyar rivers
Consumption	for the purposes of this document it is the amount of water withdrawn from the hydrological cycle for human, agricultural and livestock uses

(From the point of view of water supply companies, consumption is conventionally considered as the amount of water delivered to consumers and it includes wastage on their premises. The disposal of wastewater to the ground, however, may provide return water to the groundwater resource)

Consumptive use (of a crop)	the amount of water used productively by a crop through evapo-transpiration
Irrigation efficiency	The "Consumptive use" of the crop(s) grown as a percentage of the water supplied from the source
Irrigation system efficiency	The "Consumptive use" as a percentage of the "water supplied from the source less the water returned to a surface water or groundwater body which can be re-used"
Stakeholder	An individual or a governmental, non-governmental or private organisation who has an interest in, would participate in or be affected by the implementation of measures (relating to water resources development)
Virtual water	the amount of water consumed in the production of imported foodstuffs or goods

Abbreviations and Acronyms

DFID	Department for International Development, UK
FAO	Food and Agriculture Organisation, Rome
ha	hectare (10,000 m^2)
lpcd	litres per capita per day
MLD	Million litres per day
m^3	cubic metres
Mm^3	Million cubic metres
NGO	Non-governmental Organisation
UNDP	United Nations Development Programme
CMWSSB	Chennai Metropolitan Water Supply and Sewerage Board
MWI	Ministry of Water and Irrigation (Jordan)

WATER DEMAND MANAGEMENT
STRATEGY FORMULATION
FINAL REPORT
ANNEX A - POVERTY AND VULNERABILITY

FEBRUARY 2006

Contents

ANNEX A – POVERTY AND VULNERABILITY

ANNEX A: POVERTY AND VULNERABILITY

A1. INTRODUCTION

This Annex comprises two sections.

The first outlines the steps required to incorporate poverty analysis into water strategy development.

The second section presents a methodology which links poverty and vulnerability with water stress. The link is made by identifying:

- Local definitions of poverty;
- Why being poor makes some more vulnerable to water stress than others;
- Complexities of different priorities among different water users (stakeholders) and reasons for the differences;
- Water-user perceptions of what can and cannot be done to address water stress.

Water demand management options can then be examined, using this information, to assess their impact on water-users. This is discussed at the end of this Annex and developed further in Annex C.

The methodology employed draws on qualitative approaches, using participatory tools. Applying these approaches is reasonably straightforward, though requiring familiarity with participatory techniques. Analysis of results and interpretation of data require experience.

Approaches explained in this Annex were first developed through fieldwork in Chennai, India and Jordan[30]. They were subsequently field tested early in 2005 in Afghanistan[31]. Modifications were made and re-tested in three further locations in India during June and July 2005[32]. The simplified methodology is included in Section A2.2. Relevant steps to incorporate poverty and vulnerability analysis into developing an overall water strategy, are outlined in Figure A1.

A2. WATER RESOURCES POLICY REVIEW & STRATEGY DEVELOPMENT

A2.1 The role of stakeholders in policy review and strategy development

The development of water policy and strategy will normally require inputs from a range of stakeholders. In the past, water policy has often been based on analyses of mainly

[30] DFID Engineering Knowledge & Research Programme, KaR 8332, *Water Demand Management in areas of groundwater over-exploitation: Report on Case Studies, Annex A to D, January 2005*, Black & Veatch et al

[31] *PPTA Western Basins Water Resources Management and Agricultural Irrigation Development Project, Gender Report*, SMEC, March 2005, Asian Development Bank TAR:AFG 36252

[32] Two locations in Andhra Pradesh (Madanapalle and Rayachottay), and one in Pondicherry.

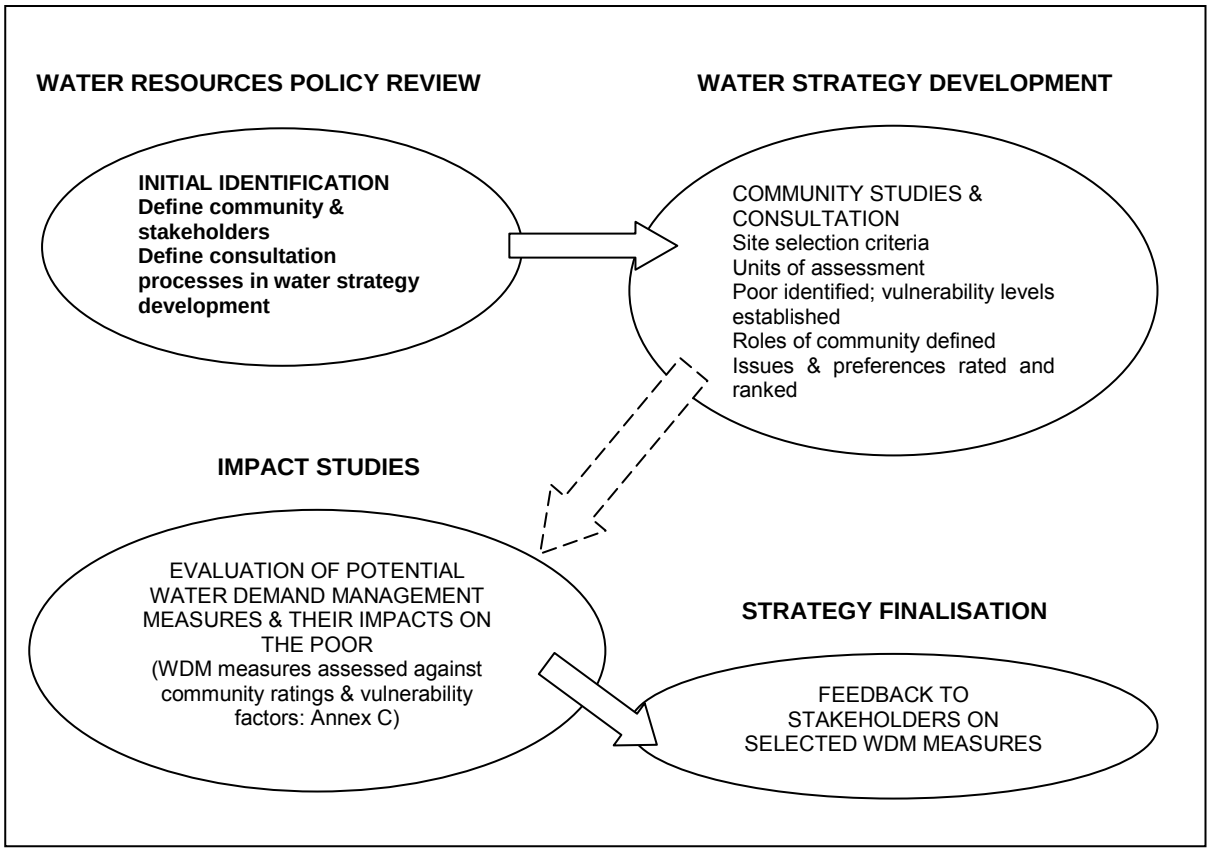
technical and financial factors. Current approaches recognise that these analyses should include equally important socio-economic factors. These may be identified through consultative and participatory processes with stakeholders.

Stakeholders are water users and/or decision makers who affect and/or are affected by water related development policies, programmes and activities. They can be women or men, communities, groups or institutions of any size and from any level of society. The poor and vulnerable are an important section of any community and their needs should be considered among those of other stakeholders.

With this in mind, water resources policy should be prepared with due regard to any existing poverty reduction strategy. Where this does not exist, a first stage should be to establish the principles by which poverty and vulnerability assessments can be integrated into the overall development of a water strategy.

Each type of stakeholder has particular needs and resources. Each, therefore, should be represented in the process of deciding about development activities.

Figure A1: Steps to incorporating poverty/vulnerability analysis in water strategy development



Stakeholders may also include people or groups outside a community, such as neighbouring villages, business people, district administration, and those who may have interests in the success or failure of certain development activities.

Stakeholders include both those who stand to gain and those who may lose from a particular water resource development or water demand management measure. The easiest way to identify who are stakeholders, is to focus on: (i) water users; and (ii) those who control or distribute resources; (iii) decision-makers and those whose land or property is affected by the availability of water.

Once stakeholders have been identified, the process whereby they are engaged in water strategy development should be clarified.

Where this process requires participatory methodologies and consultation, it is important from the start to ensure that the inputs and outputs are accepted as a legitimate contribution to the development of water policy and development strategy. Sometimes, this may need encapsulating in a set of principles to be agreed between decision makers and stakeholders.

A2.2 Water Strategy Development

A2.2.1 Vulnerability and the poor

The second step is to obtain the sort of qualitative and quantitative socio-economic data that represent the context in which planning decisions are to be made. Community studies, including consultation with stakeholders, will be needed. The determination of water user vulnerability will be an important component of these studies.

Studies and consultation processes provide socio-economic data which can then be used alongside other data (e.g. technical, economic, financial) to support the decision-making process on water resources development, the most appropriate water demand management options and to determine the likely impact of their introduction.

Site selection criteria

The study area and the locations where community consultations are to be held, must first be defined. These may be in urban or rural communities. Site selection criteria for community consultation may include:

- Seasonal accessibility
- Representation of different agro-ecological systems
- Socio-economically defined localities (e.g. slum locations/prosperous locations)
- Availability of infrastructure and services

Units of assessment

It will be necessary to define who should be selected and assessed. Groups may include, for instance:

- Domestic and agricultural water users from low, medium and high income groups
- Those dependent on water for immediate livelihoods (e.g. farmers, hotels, tea shop owners, washermen)
- As equal as possible numbers of male and female respondents

An example is given in Box A1.

Box A1

In testing the revised vulnerability rating and ranking methodology in three locations in India[33], ten groups of different types of water user[34] in each of the three survey locations were required. These included:

- Urban domestic consumers
- Rural domestic consumers
- Farmers/farm labourers using irrigation water
- Industry/small business (e.g. hotels, teashops)
- Occupational consumers (e.g. washermen, dyers, tanners, etc.)

Each group was further sub-divided into categories of rich and poor, based on local definitions of wealth/poverty

Poor and vulnerable identified

Characteristics of poverty

Poverty is a highly complex issue with different levels of intensity. Poverty may be long-term or transient. A variety of influences create its conditions and may be affected or adapted to lift people out of its circumstances. The relationship between water and poverty is characterised by the nature of the links between water availability, water demand, and the ability of households to use their different types of assets most effectively to satisfy their different demands for water within the constraints on its availability.

Water users with greater economic, social or political weight, access water and influence water resource and demand management strategies more significantly than those without.

Gender Dimensions of Poverty

Within economically deprived groups, gender considerations serve to marginalise women and girls in such a way that they experience the impacts of poverty differently. These different experiences are related to their roles and responsibilities in the household and community, their economic activities, their access to resources and basic services, and their participation in decision-making.

Differences are similarly reflected in women's lack of involvement in decision-making on almost all matters and through long working hours in poorer households. They are often further affected by low or non-existent educational levels, high workloads, higher mortality rates than males in some countries, and social exclusion from those with relevant knowledge and information. In addition, cultural practices may exclude women

[33] These consist of two locations in Andhra Pradesh (Madanapalle and Rayachottay), and one location in Pondicherry.

[34] Each discussion group consisted of not less than ten persons, and represented a typical cross-section of that type of water user. A total of thirty sample focus groups.

from property ownership, information, decision making and income generating activities. These all serve to create gender defined sub-groupings of the poorest.

The poorest, with least access to decision-makers, have little opportunity to promote their views to management levels. They are the most vulnerable to water stress and often the first to lose from poorly thought out water demand management measures. It is therefore essential that, not only are their opinions sought *before* finalising a water strategy but also that, these opinions are drawn upon and allowed to influence the final decisions made.

Defining Vulnerability

Being poor does not always make a person vulnerable. However, the poor tend to be more vulnerable because they exhibit characteristics which reflect lack of access to and lack of ownership of natural resources, and lack of influence over their use. These characteristics make some more susceptible to adverse impacts than others. The degree of vulnerability depends on local environmental and social characteristics and may be measured by an ability to anticipate, cope with, resist, and recover from what might happen.

It is thus important first to identify not only characteristics of poverty, but among the poor, who might be more vulnerable to water restrictions than others, and why. This can be done through a "vulnerability assessment". Once this is understood, the water needs of the most vulnerable can be adequately expressed and represented in strategic planning. 170

Vulnerability Assessment

The assessment provides a framework for identifying or predicting the underlying causes of natural-resource related impacts. Over-extraction of groundwater, for example, may only be one factor among other adverse social, economic, and environmental conditions that creates vulnerability. Vulnerability assessment does not just look at the consequences of vulnerability, it looks at the reasons why some persons are more vulnerable than others.

The correct selection of sample sites will help to identify sectors of society classified as poorer than others. For example, land used by squatters or classified as slum areas, has a higher incidence of the poor. Upstream sites in a river basin are often geographically more isolated and, like many highland areas, proportionately poorer than downstream areas.

An additional useful fieldwork tool to identify community definitions of poverty is Wealth Ranking. This method of collecting data is simple. It can usually be carried out in one day with a great deal of participation on the part of the community. It is most effective in smaller communities or groups.

However, the tool does have limitations:

- it does not work well in heavily populated areas as it is too difficult to get everyone's name and to find sorters who know everyone;
- the system gets cumbersome with too many names;

- because different groups may have very different self-images, scores between villages cannot be compared;
- some relatively well-off communities may rate themselves worse off than communities that are very poor;
- in communities with an egalitarian ideology, wealth ranking may not be feasible and villagers may object to being divided into different wealth groups;
- in communities which are accustomed to receiving benefits from a development organisation, wealth ranking may not produce reliable answers about the stratification of a community because the sorters may try to play down their wealth.

Box A2 - Wealth ranking – Chennai, India

Rich Households:
- use gas and wood for cooking and heating
- healthy
- own household or irrigation well
- landowners
- own good house
- owning livestock, particularly large animals (cows, oxen, donkeys)
- have ready cash
- transport (car/motorbicycle)
- young people are working

Middle income households:
- own house
- own small amount of land
- own some livestock (goats/sheep)
- use gas, wood, twigs, animal dung for cooking and heating
- have some ready cash
- have several working adults
- can afford to buy water

Poor Households:
- own poor quality house or rent house/room
- no land
- own some livestock (1/2 sheep/goats, chickens)
- many children
- few working adults
- use twigs and animal dung for cooking and heating
- poor health
- take water from other households or from various public water sources

Poorest households:
- no house, living in another's house or squatters
- taking water from other households or from various public water sources
- use twigs and animal dung for cooking and heating
- higher incidence of diseases – cannot afford medicines/transport to clinic
- no household water supply
- female-headed households
- elderly living in high-rise apartments who cannot afford to hire help
- dependent on charity
- many children (more than 5)
- no male working adults
- no animals
- no food
- no young to look after elders
- no assets

Wealth Ranking is better applied in small, homogeneous communities. If the study area is very large with diverse, heterogeneous populations, this can be simplified by asking respondents what are the things that mean being rich, middle income, poor and very poor (Box A2 gives an example from Chennai, India).

Role of community

Studies help to reveal the nature and extent of community involvement in water management, and the importance of either family labour (particularly adult males) or supportive community environment in alleviating the vulnerability of poorer households.

For example, in Al Jafr and Shoubak (Jordan) as well as in Afghanistan, there are strong differences in community perceptions relating to rights of ownership and use of domestic as compared to irrigation water. Conflict levels over irrigation water use are much higher than over domestic access. By contrast, there is a strong sense of corporate community responsibility which provides an important safety net for poorer households to water livestock and obtain domestic supplies. When comparing the situation in Chennai to that of Jordan, the role of the community in water demand management is negligible, but the role of working adults is very important. The urban population is heavily dependent on outside providers, whether government or private tanker suppliers. A household[35] is viewed as an autonomous unit responsible for its own water collection. Adults of working age are important assets in managing payment and collection of domestic supplies. Households (e.g. the elderly living alone, women-headed households) without such assets are proportionately more vulnerable than those with them.

Understanding existing roles of communities in water use and demand management is vital. Without this, it is impossible to consider reliably the implications of proposals for any community or NGO-managed measure.

Issues and preferences rated and ranked

In gaining an understanding of community roles in water use and management, it is important to recognise the priorities that different water users, and different socio-economic levels of societies, place on the resource. These priorities reflect levels of vulnerability experienced by different types of water user.

A method of determining the degrees of vulnerability was developed through a rating exercise which was field tested in Jordan, Chennai[36] and Afghanistan[37]. Based on results, six final vulnerability indicators were selected as the most important, described in Box A3:

[35] Defined here as a single residential unit, sharing income, food and water

[36] DFID Engineering Knowledge & Research Programme, KaR 8332, *Water Demand Management in areas of groundwater over-exploitation: Report on Case Studies, Annex C, January 2005* , Black & Veatch et al

[37] *PPTA Western Basins Water Resources Management and Agricultural Irrigation Development Project, Gender Report*, SMEC, March 2005, Asian Development Bank TAR:AFG 36252

Box A3	
Vulnerability indicator	**Indicator explanation**
1. Access to water	Is the quantity of supply sufficient for the poor and vulnerable? Is the frequency of supply good? Is the source of supply more or less accessible and easy to reach?
2. Quality of water	Is the quality of potable water good or not?
3. Affecting livelihood	Does the current state of water shortages have an impact on people's livelihoods? Do people have to spend a lot of money on different water sources?
4. Affordability	Can people afford to pay for the water at present? Are they able to pay connection charges, water bills etc? Can they afford water saving devices, e.g. storage tanks?
5. Sense of empowerment	Is water distribution to the community fair or not? Can poor households obtain water easily? Can the community manage water supply themselves?
6. Health	Are there a lot of water related health problems? Have these increased or decreased over the last year or so?

A.2.3 Methodology for determining vulnerability

The following step-by-step method can be used to determine vulnerability.

1. Data Sheet 1 (General Data) must be completed by first entering details of the type of water user, location, date of interview, number of participants (male and/or female). If it is possible, note the ethnic/tribal/caste identity or identities of the discussion group, and approximate length of time they have lived in the locality.

2. The Data Sheet 2 (Assessment of Indicators) should be completed as follows. Note: "Order of priority" on the Data Sheet must not be filled in until the following exercise has been fully completed.

3. Cut out 6 large pieces of card. On each piece, write the title of one indicator. Do not include the explanation, only write, for example, "Health", on one piece of card.

4. In non-literate communities, each indicator can be identified by a picture illustrating the meaning of the Indicator[38]. Make sure all the facilitators understand the meaning of each indicator so that consistent information is obtained.

5. Show the first card/picture, "Access". Explain to the group what it means (i.e. Is their source of water easily accessible for both men and women? Is it nearby or far away? Does the source from which they take water provide enough quantity to meet their needs at any time of the day and in all seasons of the year?)

6. Ask members of the group how important is water "Access" to them. Place the card on the ground.

7. Take the second card, "Quality of water". Once again, explain the meaning. Ask participants in the meeting to discuss this from the point of view of importance to them.

[38] Pictures were used for both male and female group discussions in Afghanistan

8. Ask whether "Quality of water" is more important, or less important, or of the same importance, as "Access". When they have decided, ask them to place the "Quality of Water" card above the "Access" card if it is more important, or below it if less important.

9. Ask participants to place all the cards/pictures in order of importance, with the most important issue as Number 1, and the least important is Number 6.

10. Listen to their discussion and make notes of any disagreements between them of why one card should be more or less important than another.

11. If participants select more than one Number 1 (e.g. four pictures as the most important), ask them out of these four, which would be most important of all.

12. Make a record of the indicator list of importance on the record sheet.

13. Once you have the 6 indicators finally in order of importance, ask the meeting to explain the reasons why they have listed each one in a particular place.

14. Make a record on the data sheet of their reasons why one issue is more important than others. **Do not make any suggestions of your own why an issue might be more or less important – simply record their opinions.**

    For example, if a group places "Access" as Number 1 in importance, ask them "why is the question of Access more important to you than any other?" Recording an answer like "water is sufficient for us" does not give an answer to this question. In Afghanistan, men and women had different priorities. Men put "Access" first, because both the domestic and irrigated water supply was seasonal and irregular, causing them to travel further for water at different times of the year. Women put "Livelihood Impact" first because they are culturally excluded from many forms of income generation and could not buy necessary items for the family.

15. Ask participants what they think could be the solutions to any of the problems they have identified. Make a record of what their ideas are. **Again, do not prompt them for solutions or make suggestions. These should be THEIR solutions, not the interviewer's.**

DATA SHEETS

1. General Data

	IDENTIFICATION	
1A	Type of water user	
1B	Meeting location:	
1C	Village/locality name	
1D	District	
1E	State	
1F	GPS Ref	
1G	Date of interview	
1H	Number of participants	
1J	Male	
1K	Female	
1L	Identity (ethnic/tribe/caste etc.) of participants	
1M	Number of years resident in location	

2. Assessment of indicators

INDICATOR	INDICATOR MEANING	ORDER OF PRIORITY	COMMUNITY REASONS FOR LEVEL OF IMPORTANCE	COMMUNITY SUGGESTED SOLUTIONS TO PROBLEMS
ACCESS TO WATER SOURCE	Is the quantity of supply sufficient for water users, particularly for the poor and vulnerable? Is the frequency of supply good every day and in all seasons? Is the source of supply more or less accessible and easy to reach?			
QUALITY OF WATER	Is the quality of water good or not?			
LIVELIHOOD IMPACT	Does the current state of water shortages have an impact on people's livelihoods? Do people have to spend a lot of money on different sources of water?			
AFFORDABILITY	Can people afford to pay for the water at present? Are they able to pay connection charges, water bills, etc? Can they afford water saving devices, e.g. storage tanks? Can they afford to buy bottled water?			
EMPOWERMENT	Is water distribution to the community fair or not? Can poor households obtain water easily? Can the community manage water supplies themselves or not?			
HEALTH	Are there a lot of water related health problems (e.g. diarrhoea, malaria)? Have these increased over the last year or so?			

A3. ASSESSMENT OF WATER VULNERABILITY BY THE COMMUNITY

By understanding community priorities through the steps outlined above and probing further with stakeholders the reasons behind prioritisation, it becomes possible to assess where different stakeholders consider themselves most vulnerable and to identify where communities can be strengthened.

This type of information is essential when reviewing water demand management options. It should allow:

- Decision-makers to determine social and political consequences of different water demand management measures;
- Improved understanding of which types of water demand management measure are publicly acceptable and which are not;
- Cost issues and potential financial impacts on water users, particularly impacts on the poor, to be factored in;
- Feasibility evaluation to be made of including community management as part of any water demand management option;
- Identification of what types of capacity-building should be incorporated into the strategy, including strengthening civil society, enabling both men and women's needs and concerns to be addressed, and enhancing institutional capacities;
- Identification of where negative impacts are most acute and thus which locations need water demand management priority;
- Gender-disaggregated indicators for monitoring progress and impacts to be identified

A3.1 Water vulnerability rating and ranking

Water vulnerability rating was carried out in Chennai and Al Jafr during the Case Studies (Annex B). The results are shown in Boxes A4 and A5.

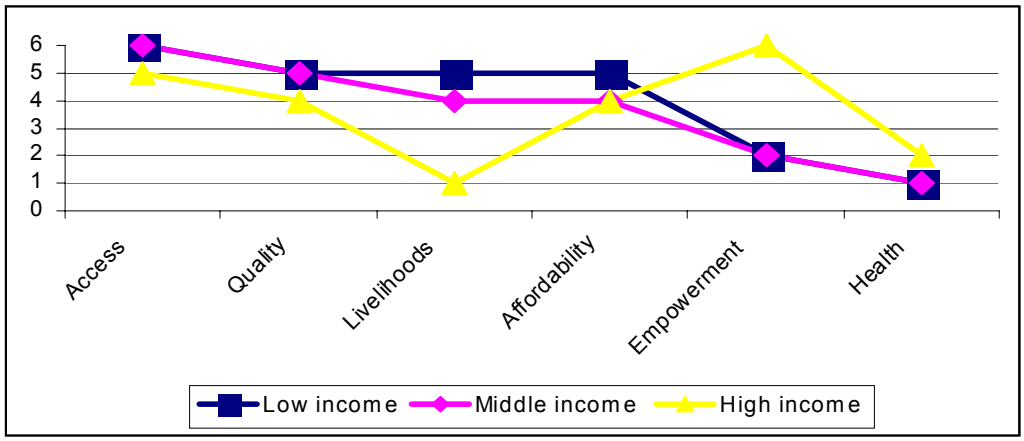
Rating can be conducted of different types of stakeholders. In Chennai and Al Jafr, the differences between locations and between different socio-economic groupings were examined; results in Boxes A4 and A5 explain the diverse priorities.

In Chennai, lack of **Access** to domestic water and its poor **Quality**, affects so many that all urban income groups put these as most important. Any water demand management option tackling access and water quality would thus present a popular choice to the largest number of persons in the city.

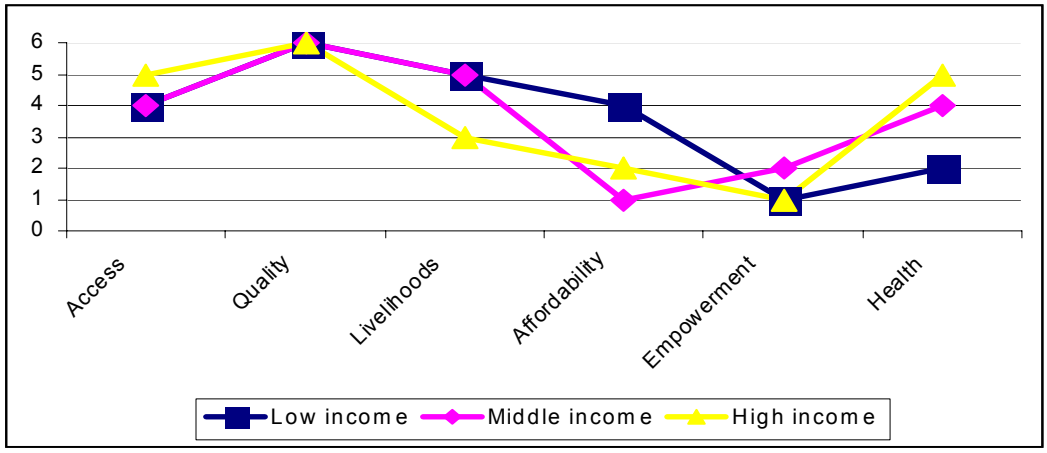
Middle and low-income groups subsequently prioritised **Livelihoods** and **Affordability** almost as high as their first two choices. However, this was not an important consideration for high-income groups. Water shortages have far less impact on the livelihoods of the high-income groups as they have the capacity to pay. The rich can afford to store water, can afford to pay for services such as domestic staff who can wait for water tanker deliveries, and can afford more expensive water such as bottled supplies.

Box A4

Chennai



Al Jafr



Box A5

INDICATOR TOP PRIORITY - CHENNAI	COMMUNITY REASONS – MOST VULNERABLE
ACCESS	i. High rise flat dwellers rarely have piped water; the disabled and elderly who cannot afford to pay for labour to carry water up flights of stairs are very vulnerable
	ii. All water sources are heavily contaminated by sewage leakage, industrial waste disposal and random garbage dumping. Water users must find diversified water sources for different uses (e.g. a source used for bathing is not potable water)
	iii. Inner city lanes are not accessible to water tankers
	iv. Non-formalised slum dwellers or squatters have no official water supply
	v. Tanker supply distribution is often controlled by local power brokers
	vi. Daily wage workers may not have someone at home to wait for tanker supplies or timed handpump releases; they must spend evenings and nights travelling to find other pumps
	vii. Rapid urbanisation has constructed over former groundwater recharge areas, reducing levels and contaminating existing sources, thereby reducing traditional sources of supply
QUALITY	i. All water sources are heavily contaminated by sewage leakage, industrial waste disposal and random garbage dumping. Timed release supplies (e.g. for 3 hours a day per handpump) are often wasted with communities spending the first hour pumping water down the drain to 'flush' out the supply
	ii. The poor cannot afford clean, bottled water
	iii. Those living close to canals or rivers are more affected, as these are used as random dumping sites for industrial and household waste. This leaks into groundwater, making it unfit for any use
INDICATOR TOP PRIORITY - AL JAFR	**OVERALL COMMUNITY REASONS**
QUALITY	i. Increase in salinity due to excessive agricultural extraction

A3.2 Wider Applications

The methodology outlined in Section A2 is not limited to groundwater assessment, nor to evaluating socio-economic differences among stakeholders. It is a participatory method to evaluate a water situation, whatever the type or source of water, or whatever the differences between stakeholders.

This method was tested in Afghanistan[39] where gender differences were explored. The priorities of men (primarily responsible for agricultural water management) were compared to those of women (primarily responsible for domestic water management). Men identified as of joint No. 1 importance, Irrigation Access and Affordability. Women identified as joint No. 1 Livelihood and Health impacts

INDICATOR	PROBLEMS		SOLUTIONS	
	MALE	FEMALE	MALE	FEMALE
ACCESS	1. Poor quantity and reliability of irrigation and domestic water		1. More seasonally reliable water	
	2. Wells drying up in summer		2. More quantity water	
	3. Irrigation water failure at critical crop maturation periods		3. More bridges to access facilities	
	4. Physical access limitations, limited farmer access to any irrigation system			
AFFORDABILITY	1. High and variable costs of canal water along the system		1. Better earning opportunities to build up capital to instal independent irrigation methods through wells	
	2. Different payment methods for irrigation water			
	3. High costs of maintenance due to erosion and neglect		2. More consistent water pricing along the system	
	4. Many landowners absent and not paying contribution			
	5. Market access costs			
	6. Increased commodity prices during drought periods			

[39] *PPTA Western Basins Water Resources Project: Gender Report*, ADB, op cit

INDICATOR	PROBLEMS		SOLUTIONS	
	MALE	FEMALE	MALE	FEMALE
LIVELIHOOD IMPACT	1. No income generation opportunities beyond agriculture	1. No income generation opportunities beyond agriculture	1. More wheat productivity	1. More income generation opportunities for women, particularly • Livestock • carpet weaving • sewing
	2. High dependence on livestock, many lost during drought/winter	2. High dependence on livestock, many lost during drought/winter	2. Improve quality/quantity livestock	
	3. Poor returns on agricultural produce (wheat): WFP destroyed local markets	3. Male attitudes restricting women's ability to earn	3. Plant more trees, particularly backyard gardens	2. Improved awareness raising with men to allow women's i/g activities
	4. Lack of young men (Iran)		4. Improve market access	
HEALTH	1. High infant mortality	1. Maternal health difficulties	1. Better health awareness	1. More bridges to enable better medical access
	2. Lack of awareness as to cause of diseases	2. Lack of accessible clinics or medical practitioners	2. More village level clinics and medical practitioners	2. Better health awareness
	3. Lack of accessible clinics	3. Unaffordability of medicines for poorer families		3. Better access to affordable medicine
	4. Not enough young people to look after the elderly	4. Lack of awareness as to cause of diseases		4. More village-level clinics and medical practitioners

The respective choices reflect men and women's social world and their different involvement in different aspects of water management. It also underlines the need to understand and accommodate these differences in development planning. Although the methodology is simple, it can alert planners to prime complexities of social perceptions and priorities regarding water use, not merely differences between socio-economic groupings, but between men and women of different groups, between locations, and between different types of stakeholder.

A3.3 Water Demand Management measures assessment against community ratings

Findings can subsequently be linked to water demand management options outlined in the main body of the report and discussed in Annex C. Community-level data are evaluated by representative stakeholders against potential water demand management through the process outlined in Annex C.

For example, if Access and Quality are the most important issues to the largest number of people in Chennai, planners might want to select measures to address these first of all. Relevant water demand management options could include:

WDM Option		Supporting/enabling measure	
DT1	Reduce water losses (leakage control)	SD1	Community mobilisation
		SD3	Public awareness campaign to reduce wastage
DS1	Community level management	SD2	Public-Private-Community participation
			Source protection measures by community

Leakage control could go a long way to improve water quality, as poorly maintained pipes may be contaminated by leaking sewerage. In some slum locations, shared hand-pumps can only be used for 3 hours a day. At least one-third of this water is wasted by households flushing out the system before they can begin to use more potable water.

For low income households in Chennai, the impact on livelihoods and affordability can also be seen as high priority. A water demand management option to address this could include DA4: Progressive or differential water tariffs.

Pro-poor strategies, as a supporting measure to low income groups and to protect the most vulnerable, might include:

- Sending water payment bills out on a monthly, rather than quarterly or six-monthly basis (the poor live from day-to-day and often cannot afford to save for longer than a few weeks);
- Allowing connection fees for low income groups to be incorporated into bills in manageable instalment amounts (not demanding an initial capital sum which is beyond the resources of the poor)
- Allocating an initial fixed amount of litres per household per day free (for any income group) to account for basic human need;

- Thereafter introduce a steep cost increase per litre (effectively ensuring the rich subsidise the poor, while simultaneously limits on household use)

Other water demand management measures can be assessed against rating results. For example, “Empowerment” was rated low among all income groups in Chennai and Al Jafr, with the exception of richer groups in Chennai where it was rated highest. This may indicate that community-level management could be problematic among poorer communities in societies with already well-defined leadership roles. On the other hand, it could be more successful in urban contexts where localities are more clearly defined socio-economically.

A3.4 Strategy Finalisation

Acceptance of water demand management measures by those on the receiving end is important if options are to be cost-effective, environmentally sound, and socially and politically acceptable. It is critically important to understand “what is important to whom” in order to arrive at an acceptable water demand management measure or to know how to modify a proposed measure to make it more acceptable to different social or income groups.

Communities may identify a variety of issues when being consulted, some of which are not relevant for sectoral planning. Different stakeholders are frequently unaware of limitations on decision makers. A good understanding of community priorities is also vital to developing a comprehensive water strategy when it has to cross sectoral boundaries.

After evaluation, prioritisation and costing, water demand management measures should be discussed with stakeholders and communities. This is an important final planning step. It is the last opportunity to identify whether the planners have got it right before finalising a Water Development Strategy. It is also an important component in community consultation, and enhances the prospect of sustainability by anticipating public opinion rather than being obliged to react to it. Assessing the impact of water demand management measures is discussed further in Annex C.

WATER DEMAND MANAGEMENT
STRATEGY FORMULATION
FINAL REPORT
ANNEX B – CASE STUDIES

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ANNEX B – CASE STUDIES

B1. INTRODUCTION

Case Studies were undertaken by the research team in Chennai, India and Shoubak - Al Jafr in Jordan during 2004 and some further supplementary studies were made in Andhra Pradesh and Pondicherry in 2005.

This Annex contains:

- a summary of the Case Studies undertaken in Chennai, Tamil Nadu and Jordan (Part I Sections B2 – B5). A fuller description can be found in the report to DFID, "Water demand management in areas of groundwater over-exploitation – Report on Case Studies", Main Report plus Annexes A – G, January 2005; and

- a summary of the findings at Madanapalle, Andhra Pradesh (one of the three areas where further studies were undertaken) and an extract from the report on the Workshop on Strategy Formulation (New Delhi, November 2005), where the findings from Madanapalle were discussed (Part II, Sections B6 – B8).

The following Government institutions, donor and other principal agencies have provided advice and access to data in support of the studies and we acknowledge with thanks the assistance they have given:

In India:

The Ministry of Finance, The Department of Public Works, The Department of Municipal Administration and Water Supply, Chennai Metropolitan Water Supply and Sewerage Board (CMWSSB), The Institute of Water Studies, World Bank, Asian Development Bank, DFID, Delhi, Madras School of Economics and several NGOs in Tamil Nadu.

Government of Pondicherry, Public Works Department, Water Resources Division and Department of Agriculture.

Madanapalle and Rayachotty Municipalities and the Government of Andhra Pradesh Municipal Administration and Water Supply Department and Department of Rural Water Supply.

In Jordan:

The Ministry of Planning, The Ministry of Water and Irrigation, The Ministry of Agriculture, UNDP, USAID, EU, GTZ, The University of Jordan

PART I – CASE STUDIES, CHENNAI, TAMIL NADU AND JORDAN, 2004

B2. FEATURES OF THE CASE STUDY AREAS

B2.1 General descriptions of the study areas

The case studies areas in Chennai, Tamil Nadu, India and Shoubak-Al Jafr, Jordan both suffer from groundwater over-exploitation. They are different in size and character; the principal features are described below.

Tamil Nadu

The population of the project area is about 7 millions of which about 4.5 millions live in the Chennai Metropolitan Area and the remainder in the rural areas including the areas overlying the A-K aquifer to the north of Chennai.

Domestic and industrial water supplies for the area come from a variety of sources which include surface water run-off collected in large but shallow reservoirs, groundwater abstracted from the A-K aquifer and from the city area, water from the Krishna river in Andrah Pradesh (when this is available), groundwater pumped from aquifers surrounding the city which is then transported by tanker lorries to the city. The last three years rainfall has been low and there has been insufficient water to supply the city via the distribution network. At present, water from the treatment works is delivered to water distribution centres and then supplied to consumers to households or tanks at the end of the street by tanker.

In the rural areas, paddy rice (two or three crops per year) is the dominant crop, irrigated mainly from groundwater. Other crops grown include sugar cane, groundnuts and vegetables. Change is taking place in rural Thiruvallur and Kancheepuram. Labour is leaving the land and turning to alternative employment opportunities, such as the construction industry, local factories sited in peri-urban districts of Kancheepuram and Thiruvallur, and weekly migration to Chennai Metropolitan Area. Abolition of inter-state tariffs has introduced a harsher level of competition, with cheaper and better quality agricultural products being transported from other Indian states.

The urban poor are classified as low-income or slum residents and these groups comprise nearly 1.5 millions about one-third of the Chennai Metropolitan Area. Focus group meetings indicated that low income households' (monthly income Rs 3,300) consumption of water was 34 lcpd. The demand for water and the increasingly expensive supply options indicate that further demand management options will have to be considered and the impact on vulnerable groups will have to be considered both in the city and rural areas.

Shoubak and Al Jafr, Jordan

The population of the study areas in Shoubak and Al Jafr are about 13,000 and 12,000 respectively, settled in small villages in Shoubak but concentrated in and around the town in Al Jafr. Annual rainfall in Shoubak is abut 250 mm/yr but Al Jafr is a desert area which has no surface water resources

Shoubak is an important fruit growing area with over 2,000 ha of drip irrigated fruit farms which have been established since the 1980s. In Al Jafr, there is a government farm of

250 ha which was set up to settled nomadic Bedouin where they can grow fodder crops and some olives. This is surface irrigated using groundwater. A number of other farmers are active in the Al Jafr area growing vegetables and olives using groundwater supplied through drip systems, some growing crops using plastic mulch under cloches.

Water supply in Shoubak is provided through the Water Authority and supplies are used by householders for domestic water supply and to water gardens.

The aquifers at Shoubak and Al Jafr are over-exploited and restrictions will be required on both aquifers if agriculture in these areas is to be sustainable.

In the Governorate of Ma'an in which Shoubak and Al Jafr lie, 21% of the population is estimated to live below the poverty line (less than JD 156 per family per month) and this percentage is reflected in the Case Study Area.

B2.2 General findings

Tamil Nadu

The Chennai Case Study has revealed some interesting insights into the management of water both at the public supply authority and community levels. Water supplies to the city are limited, unreliable and have been seriously affected by the poor monsoon rainfall of the last few years.

The A-K aquifer, to the north of Chennai has traditionally been used to provide water for irrigated agriculture, but in 1969, wellfields were developed to supply water to the industrial area of Manali and, from 1987, new wellfields were established to supply water to Chennai city. The aquifer is currently over-exploited, abstractions exceed the sustainable yield and saline intrusion now penetrates up to 12km from the coast.

The water supply situation is complex and exacerbated by the recent drought conditions but it is clear that managing the demand is an essential ingredient of any water policy for the area if the domestic, industrial and agricultural sectors are to be satisfied. A Water Master Plan, which introduces a demand management policy, is required for the area.

Shoubak and Al Jafr, Jordan

The studies in Shoubak and Al Jafr have demonstrated different characteristics and a range of water supply and management issues.

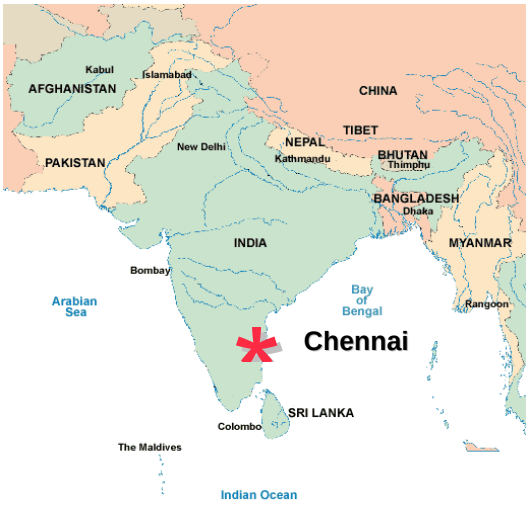
The principal issues relate to the over-abstraction of water from the aquifers: (i) in Shoubak where the fruit farmers are abstracting more than the renewable resource in this area; and (ii) in Al Jafr where there is a less obvious but significant drop in the water table and a deterioration of the quality of the water for both domestic and irrigation water supply. Further work is required to confirm the current abstractions from these aquifers and to determine appropriate demand management options which would be effective in rendering the aquifers sustainable.

B3. THE CASE STUDIES

B3.1 Choice of case study areas

The two "Case Study" areas were selected after discussions with Government officials in India and Jordan, one based in Chennai, Tamil Nadu and the other in the Al Jafr - Shoubak region in Jordan.

Groundwater over- exploitation is prevalent in Tamil Nadu, India. Supply options are unreliable and north of Chennai the quality of water in the principal aquifer is affected by saline intrusion. In Jordan, many aquifers are being depleted because of the heavy use of water for agriculture.



The locations of the Case Study areas are shown on the maps above thus: *

B4. TAMIL NADU CASE STUDY

B4.1 The Case Study Area

B4.1.1 Description of the area

The Case Study area is centred on the city of Chennai in the north-eastern corner of Tamil Nadu State. The Chennai area is characterised as forming part of a coastal plain with hills in the west and a gentle slope towards the east and the shore of the Bay of Bengal. The ground elevations vary from 150m above sea level in the west to just above mean sea level along the coast.

There are four rivers flowing through the study area and these are grouped together to form the Chennai Basin Group. These rivers are from north to south the Araniyar, Koratalaiyar, Cooum and Adayar. The Araniyar and Koratalaiyar are the main rivers and originate in Andhra Pradesh to the north, whereas the Cooum and Adayar originate from surplus flows

within Tiruvallur and Chembarambakkam taluks and drain through the Chennai Metropolitan Area.

The climate is subtropical with mean annual temperatures of 24°C (min.) to 33°C (max.). The hottest and driest part of the year is April to May when the temperature may exceed 40°C. The average total rainfall varies between 1000mm/annum in the west and 1215mm/annum in the east and is provided by the south west monsoon from June to September and the north east monsoon from October to December. Most of the rainfall occurs as the result of one or two tropical depressions formed in the Bay of Bengal. The NE monsoon is usually the wetter of the two, providing about 50% of the annual total rainfall. The SW monsoon is more erratic and provides about 40% and the remainder of the year provides about 10% of the annual rainfall.

B4.1.2 Economic background

Tamil Nadu

Tamil Nadu consists of 30 districts covering a geographical area of 130,000 km^2 with a total population of 62.41 million (2002). The surface area of Tamil Nadu covers 4% of the India but population comprises 6% of the country.

The GDP of Tamil Nadu in 2001-2002 was Rs 1,309.2 billion at current price. The annual growth rate of the state GDP has been 5.9% in the period 1993-2002.

The Primary sector (agriculture, forestry and fishery) plays an important role in the State's economy but its contribution to the economy has reduced from 26% in 1993 to 18% in 2002 due to the growth rate of the Tertiary sector (business and services). During the period 1993-2002, annual growth rates were 0.8%, 5.7% and 8.5% per annum for the Primary, Secondary (Industry and construction) and Tertiary sectors respectively.

GDP per capita in 2002 was Rs 13,055, equivalent to about US$ 650. Summary details are given in Table III.1.

Tamil Nadu's Tenth Five Year Plan (2002 - 2007) proposes to expand the agricultural sector at a rate of 4% per annum. The target for overall growth rate of GDP is 8% during this period with a reduction of poverty level from 21% in 1999-2000 to 10% in 2007.

The net area sown in Tamil Nadu in 2001 (Ref 16) was about 5.3 million ha of which about 2.9 million ha (55%) is irrigated from canals, tanks, wells and other sources to grow principally paddy and sugarcane crops. Main agricultural production outputs were paddy (7.37 million tons), total cereals (8.55 million tons), groundnut (1.36 million tons) and others such as cumbu, rag and cholam with about 300-400 thousand tons each crop.

Export values by sea and by air through Tamil Nadu were Rs 269.8 billion in 1999-2000 (occupying 17% export value of all India) and Rs 117.4 billion in 2000-2001 (occupying 6% export value of all India)

Table B4.1 Selected Economic Indicators Tamil Nadu State

(Rs billion - 1993-94 prices)

	Sectors	93-94	94-95	95-96	96-97	97-98	98-99	99-00	00-01	01-02
I	PRIMARY	135.50	151.21	131.07	129.70	141.22	153.52	146.82	150.42	144.50
1	Agri-forest-fish	132.43	147.90	127.97	126.77	138.11	150.67	143.77	146.88	140.93
2	Mining & quarrying	3.07	3.31	3.10	2.93	3.10	2.85	3.05	3.54	3.58
II	SECONDARY	166.01	189.37	209.23	207.62	212.53	210.76	239.38	247.65	258.21
III	TERTIARY	214.25	239.27	260.04	286.87	324.42	354.44	371.69	393.14	412.14
IV	GDP	515.76	579.85	600.35	624.19	678.17	718.71	757.90	791.21	814.86
V	POPULATION ('000)	57,670	58,340	58,992	59,624	60,235	60,821	61,381	61,913	62,416
VI	GDP/capita (Rs)	8,943	9,939	10,177	10,469	11,259	11,817	12,348	12,779	13,055
VII	GDP growth (%/year)	-	12%	4%	4%	9%	6%	5%	4%	3%

Source: Statistic Hand Book, Tamil Nadu 2002

Case Study area

Most of the activities in the Case Study area are centered on the city of Chennai. Most of the farming communities comprise marginal farmers who depend on jobs in the city for their livelihood. There has been a trend of sending young people to the city for work and investing in better education for their children for better income and better social position for the last 10 years. This has resulted in a shortage of labour for agricultural activities especially at peak season demand.

There are about 18,000 small scale industries, 124 large and medium industries of various disciplines. These provide good employment opportunities for the basin population as well as to the migrants from other parts of the Tamil Nadu.

The area has great potential to attract tourists. The area is well connected by roads and rail. The Chennai harbour and Meenambakam airport provide major facilities to tourists and from other economic activities.

B4.2 Water Resources – POLICY, INSTITUTIONS & LEGAL FRAMEWORK

B4.2.1 Water policy

The Ministry of Water Resources, Government of India formulated a "National Water Policy" in September 1987 as a basis for overall planning and development of water resources.

Many of the general policy items of Central Government have been absorbed into the Tamil Nadu State water policy.

In 1993, the Government of Tamil Nadu formed a Water Resources Control and Review Council (WRCRC) to formulate water management strategies and to develop and implement a water policy. The power and functions of the WRCRC are to:

- establish allocation priority norms for water use for different sectors taken as a given that "the provision for drinking water has the highest priority";
- formulate water management policy and, after acceptance, implement and monitor;
- examine the impact of extraction, utilisation and conservation of water by its users;
- formulate water policies for the state and basin water development, control and management
- establish principles, standards and procedures for allocation of water under licences, preparation of comprehensive regional and river basin plans and for formulation and evaluation of water policy and related land resources projects using technical, economic, social, legal and environmental criteria
- serve as an advisory and co-ordinating body for the State in water related matters
- review and approve State and river basin master plans; prioritisation of different sectional water needs
- review and approve macro planning, distribution management and water resources taking into account the water needs of different sectors
- review and approve for publication an annual assessment of the adequacy of supplies of water necessary to meet the present and the projected State and basin water requirements
- issue orders as may be necessary to carry out its functions

Based on the national water policy of the Government of India (1987), the Government of Tamil Nadu formulated the Tamil Nadu Water Policy. The Institute of Water Studies (IWS) drafted the policy in January 1994 and this was approved in July 1994. IWS was appointed to act as the implementing agency for the policy. The ultimate aim of the policy was to develop a State Water Plan.

In addition, the water policy encourages participatory approaches to field level problems and training is considered as an integral part of water management. The Government of Tamil Nadu's Water Policy principally accepts that water rates are to be given a purpose; they should be such as to convey the scarcity value of the resource to the users and foster a sense of economy in water use.

Importantly, the river basin is seen to be the unit of water management and for water resources planning. The policy accepts the need for State Framework Water Resources Basin Plans. These are being prepared for each of the seventeen river basins. Four of the basin plans have been prepared (2003). The Case Study Area comes within the Chennai Basin (Araniyar, Kortalaiyar, Cooum, Adayar rivers). The Chennai basin plan is still to be prepared.

B4.2.2 Institutions

Government Institutions

The principal organisations involved in the development and management of water resources in the Case Study Area are:

- Water Resources Organisation, Public Works Department
- Tamil Nadu Water Supply and Drainage Board
- Agriculture Department
- Agricultural Engineering Department
- Revenue Department
- Chennai Metropolitan Water Supply and Sewerage Board
- Rural Development Department
- Pollution Control Board
- Department of Municipal Administration
- Fisheries Department

B4.2.3 Legislation and regulations

Government of India legislation

The two principal Central Government Acts relating to the Case Study area are those listed below:

- Inter-State Water Disputes Act No 33 of 1956, and as Amended
- Rivers Boards Act No 49 of 1956 as Modified [relates to inter-State rivers]

These are relevant in the way that they relate to the supply of water to Tamil Nadu from Andhra Pradesh and in particular to the Krishna river supply which is the subject of an agreement between the State Governments.

Tamil Nadu legislation and regulation

There are a number of State of Tamil Nadu Acts relating to the Water Sector and the Study Area. These are concerned mainly with water abstraction, use of water from government managed schemes and pollution. The key legislation relating to the case study area is as follows:

Chennai Metropolitan Area groundwater (Regulation) Act no 27 of 1987 as Amended

Chennai Metropolitan Water Supply and Sewerage Act, Tamilnadu Act No 28 of 1978 as modified 31 August 1981

Tamilnadu Water Supply and Drainage Board Act No 4 of 1971 and as Amended

Tamilnadu Panchayat Act No 35 of 1958 as Amended

These deal principally with regulation of abstraction of water.

B4.3 Water Resources Development

B4.3.1 Water resource availability

The water supply to Chennai city is derived from both surface water and groundwater sources. The study area is shown on Figure B1. *[Insert Figure]*

Surface Water Development

The first organised public water supply was put into operation in 1772 and was designed to supply 0.635 million litres per day (Mld) from a cluster of ten shallow wells. The water supply of Chennai city was for many years obtained solely from these shallow wells and it was not until 1866 that a public water supply scheme was adopted. The scheme combined the city water supply with irrigation of 3500Ha and commenced in 1872. The surface water flow from the Koratalaiyar river was diverted to Cholavaram and then to Red Hills reservoirs located some 20km to the northwest of the city. Further development, which took place after 1907, which included construction at Red Hills, an underground conduit to convey water to the city and extensions at Kilpauk Water Works provided a design supply of 160lpcd.

To meet the increasing demand for water in the city, the irrigation supply from the reservoirs was discontinued sometime during the 1940's or 50's. The treatment capacity of Kilpauk Water Works was increased to 190Mld and the Sathyamurthy Dam was constructed between 1940 and 1944 across the Koratalaiyur river to form a third reservoir at Poondi.

The current storage capacity of these reservoirs are as follows: Poondi - 91.49 Mm^3; Cholavaram - 24.95 Mm^3; and Red Hills - 93.44 Mm^3

In 2000, water from Chembarambakkam reservoir (103.21 Mm^3), which is located some 25km to the southwest of Chennai city was also utilised for city water supply.

In March 2004, due to insufficient rainfall, only water from dead storage is available from all the reservoirs. Only 10 to 15Mld from the dead storage in the Red Hills reservoir is being diverted to the city, treated at Kilpauk Water works and put into the distribution system.

Groundwater Development

In the 1950's, the water supply was augmented by groundwater supply from shallow wells within the city boundaries, particularly in the suburbs. Further groundwater development occurred after 1968 based on a UNDP/PWD study, which recommended development of well fields in the Araniyar-Koratalaiyar (A-K) aquifer to the north of the Chennai Metropolitan Area.

The A-K Basin aquifer comprises alluvial deposits of an old buried channel of the Palar river. This aquifer extends from the vicinity of Poondi reservoir to the north east of Chennai to the Minjur area to the north of the city over an area of roughly 750km^2, which includes the course of Koratalaiyar river and the lower reaches of the Araniyar river. Groundwater occurs under unconfined or confined conditions in the A-K Basin. In its lower part, roughly downstream of Tamaraipakkam, the aquifer is layered and further downstream it is confined. An impervious base of Gondwana formation comprising shale, clay, underlies the alluvium. Recharge into these alluvial aquifers is mainly from precipitation, flow through the river beds, water bodies, return flow from the irrigated fields. The quality of water is generally good.

Based on the UNDP/PWD study recommendation, three well fields, Tamaraipakkam, Panjetty and Minjur were developed in 1969, with a designed total capacity of 125Mld (Tamaraipakkam 50Mld, Panjetty 42.5Mld and Minjur 32.5Mld). The groundwater from these well fields mainly supplied water to the industrial area at Manali, which is to the north of Chennai city, contributing only a little to the city supply.

To meet the additional demand in the early eighties, CMWSSB (Metrowater) with the assistance of UNDP reassessed the groundwater potential in the A-K Basin and looked for new sources. This resulted in the commissioning of three new well fields during 1987, with a designed total capacity of 55Mld (Poondi 28Mld, Flood Plains 13.5Mld and Kannigaiper 13.5Mld). The total designed capacity from all six well fields is 180Mld. However, the maximum reported abstraction from these six well fields was 120Mld in the year 1987, when the additional three well fields were made operational.

A second groundwater source is utilised for public supply to parts of the the city. This aquifer is located to the south of Chennai city and extends along the coast of the Bay of Bengal for about 20 km between Thiruvanmiyur and Muttukadu. The groundwater from this aquifer is pumped from 22 dug wells and supplied to the southern part of Chennai city.

B4.3.2 History of water resource studies

There have been a number of studies carried out since the early 1980's. These are summarised below in chronological order. Further details are given in Annex E.

1. Hydrogeological and Artificial Recharge Studies, Chennai, UNDP/CMWSSB Studies (1982-91)

2. Groundwater Resources and Development Potential of Chengai MGR District, Central Ground Water Board (1991)

3. Groundwater Resources and Development Prospects in Chennai District, Central Groundwater Board (1993)

4. Hydrogeological and sea water Intrusion studies between Thiruvanmiyur and Muttukadu by RITES – CMWSSB (1995-96)

5. State Frame Work Water Resources plan of Tamil Nadu, Public Works Department (1998).

6. Groundwater Exploration in Tamil Nadu and Union Territory of Pondicherry Central Ground Water Board (1998)

7. A profile of Thiruvallur district, Tamil Nadu Water Resources Organisation (Public Works Department), 2000

8. Second Chennai Water Supply Project, Scott Wilson Piesold, for CMWSSB (2002)

The consultancy services to reassess the groundwater potential and transferable water rights in the A-K basin were awarded to Scott Wilson Piesold (SWP). In Phase I of the study, the firm has to carry out a hydrogeological investigation to establish a sustainable yield for Chennai City water supply of 100 Mm^3 per year or 270Mld. On recently establishing

this sustainable yield, Phase II of the study, which includes presentation of proposals for introducing transferable water rights in the A.K basin has yet to be taken up.

B4.3.3 Development and current use of water resources

Surface sources

The main source of water supply to the city of Chennai is from three reservoirs namely Poondi, Cholavaram and Red Hills, located to the northwest of the metropolitan area. These reservoirs receive surface water flows during monsoon rains, particularly during the North East monsoon, from a system of anicuts and canals as well as from their direct catchment areas. Chembarambakkam reservoir, to the southwest of Chennai city, has also been included in the Chennai water supply system since 2000.

The water supply to the city from these reservoirs depends upon the storage available. The appreciable increase in water supply during 1996 to 2002 is attributed to the additional storage available in the reservoirs due to contributions from Krishna Water Scheme.

Groundwater sources

The City gets its groundwater supply from two main sources:

(i) Well fields in the Araniyar-Koratalaiyar (A-K) Basin
(ii) Southern Coastal Aquifer.

(i) Well Fields

There are six well fields in the A–K Basin extracting groundwater. The locations of these well fields are shown on Figure B1.

The Tamaraipakkam, Panjetty and Minjur well fields were established during 1969 and the other well fields, Poondi, Flood Plains and Kannigaiper were established in 1987. There are 74 bore wells in the six well fields. The major part of the extraction from these well fields goes to the industrial area at Manali Town

The average extraction from the 21 production wells is 20Mld (7.3Mm^3/yr).

Due to the limited supply of surface water and ground water from the six wellfields available to CMWSSB, agricultural wells are now being hired from farmers to extract groundwater to manage the current severe drought situation. This system of renting agricultural wells was started in April 2001 and at present about 60Mld (21.9Mm^3/yr) is being extracted from these wells.

Where it is not possible to get a cluster of bored wells, groundwater from two or three wells is collected and transported to the city by tankers/lorries. At present around 50Mld (18.3Mm^3/yr) is supplied to the city in this way from villages within a 100km radius of Chennai city.

(ii) Southern Coastal Aquifer

This aquifer, to the south of Chennai city, extends along the coast of the Bay of Bengal for about 20 km between Thiruvanmiyur and Muttukadu. The groundwater from 22 shallow

open/dug wells is pumped to the Thiruvanmiyur head works for further distribution to the southern part of Chennai city. Presently about 3.5Mld (1.28Mm^3/yr) is being extracted from these wells.

B4.4 The Abstraction and Management of Groundwater

B4.4.1 Historical trends

Groundwater in the A-K Basin

Groundwater is abstracted from the A-K basin for both irrigated agriculture in the basin area and for transfer to Chennai City for domestic and industrial consumption.

A summary of the abstraction and management of water used for the city water supply from the six well fields of the A-K Basin is given below.

Poondi

The total depth of the aquifer ranges from 24 to 35m and the average aquifer thickness is 31m.

At the start of operation in 1988 the average water level was 19.3m below ground level. The water level declined to a low of 22.5m by 1993. There was gradual recovery from 1994 onwards. This was partly due to reduced abstraction of groundwater in 1998 and 1999, when an additional source of surface water from the Krishna Water Scheme was put online. Due to insufficient rainfall from 1999 onwards, lack of surface water storage in the reservoirs and a return to the earlier higher abstraction rates, the water level in the well field started to decline again and the average water level in March 2004 was 24.3m below ground level.

The maximum annual abstraction from this well field was 16.38Mld (6Mm^3/yr)in 1994. The present average annual abstraction from this well field is 10Mld (3.65Mm^3/yr).

Tamaraipakkam

The total depth of the production wells ranges from 28 to 38m, with an average aquifer thickness of 35m. The average water level during 1969 at the start of operation was 12.8m below ground level and since then it fell until 1993 but improved again to 1999. The average water level during 1999 was 2m above the 1969 level.

Due to insufficient rainfall since 1999, lack of surface water storage in the reservoirs and twice the normal abstraction from the wellfield in 2000 the water level in most of the production wells has now fallen below the minimum required pumping level. The average water level for the month of March 2004 was 30.8m, which is the lowest recorded level in the past three decades. The maximum abstraction from this well field was during the year 1969 (34.2Mld), the initial year of operation, and second to this was during the year 2000 (32.2Mld).

Flood Plains

The total depth of the production wells range from 29 to 36m and the average aquifer thickness is 35m. The average water level during 1988 at start of operation was 21.5m below ground level and then there was a slight decline until 1993 when like other well fields,

it started showing an improvement until 1999. Due to the reduced abstraction over the period 1993 to 1999, the water level during 1999 was nearly 8m above the 1988 level. However, due to insufficient rainfall since 1999, lack of surface water storage for supply and the above normal abstraction in 2000, the water level has fallen and in March 2004 was 32.2m below ground level. The average water level in 1988 (21.5m) was more or less maintained and it had not fallen below the 1988 level until 2000. The average water level in March 2004 is 32.2m below ground level. Since the average depth of the aquifer in this area is 35m, the water column available for pumping is not sufficient and hence no production wells in this well field have been working since September 2002. The maximum pumped quantity was achieved in the initial year of operation in 1988 (9.12Mld), after that it has gradually reduced and finally during 2002, it was only 0.69Mld.

Kannigaiper

The average thickness of aquifer in this area is 33m. The average depth to water level during 1988 was 22m and this was maintained until 1999. Since 2000, there has been a gradual depletion and the water level in March 2004 was 31.8m. Since there was not sufficient water column for pumping, none of the wells has operated since December 2002. The maximum annual abstraction from this wellfield was during 1988 (9.42Mld). Since the initial year of operation the quantity abstracted has gradually reduced and finally during 2002 the abstraction was only 0.72Mld.

Panjetty

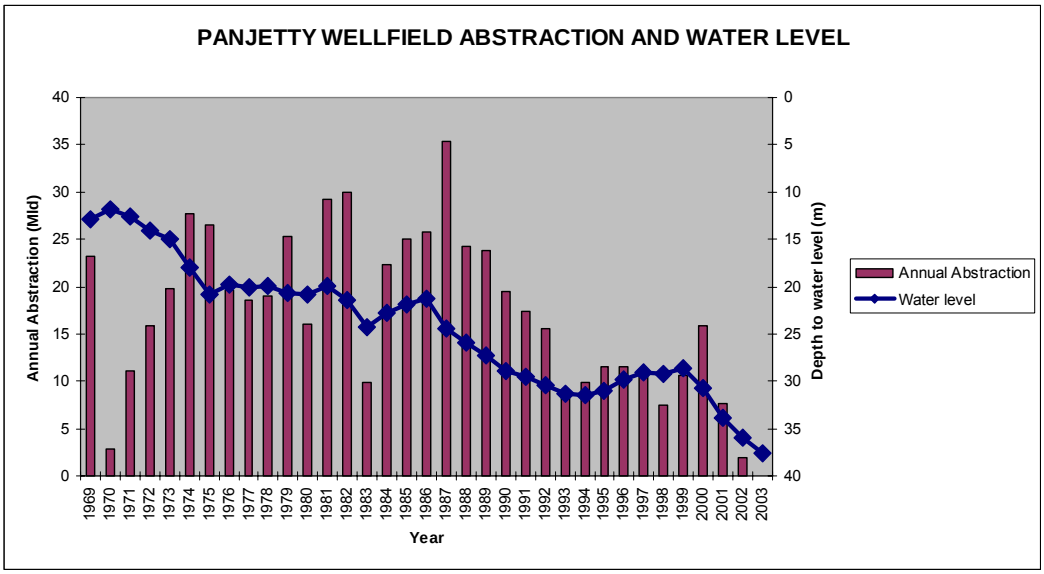
The average water level during 1969 was 12.9m and it is shows a gradual depletion since then with some minor short-term fluctuations until 1993. Then as with the other wellfields there was a slight recovery of water level up to 1999. The water level in March 2004 is 39.4m below ground level and the average thickness of the aquifer is 42m. None of the production wells has operated since December 2002. The maximum abstraction achieved was 35.36Mld during 1987 and the lowest extraction was 1.99Mld during 2002.

Minjur

About 22 wells have been constructed in the Minjur area since 1969. At present only eight wells are operational and all the other wells have been abandoned due to salinity. Even though this part of the aquifer has the highest groundwater potential because of thicker aquifer and larger saturated thickness, the quantity abstracted is restricted due to the threat of seawater intrusion. The average water level during 1969 was 11.8m below ground level and was below Mean Sea Level. The ground elevation of this well field area ranges from 2.9 to 12.2m above MSL. The average water level has fallen to 23.8m during 1993. Due to the continuous depletion of water level and progressing seawater intrusion, the abstraction rate has been gradually reduced since 1987. Because of this measure and the above normal rainfall, the water level rose again to 16.2m during 1999 (i.e. 7m rise). However, due to the present drought condition, the abstraction has been slightly increased. The maximum withdrawal from this well field during 1978 was 28.42Mld, but at present the withdrawal is limited to 10Mld. The average water level during March 2004 is 30.2m below ground level.

Graphs were prepared showing annual abstraction and annual rainfall plotted against average depth to water level. A typical situation is illustrated in Figure B2.

Figure B2 Panjetty wellfield – abstractions and water level



Southern aquifer

Groundwater from this aquifer is being extracted by 19 shallow open/dug wells with a total depth ranging from 7.75 to 11.60 m. There are eight wells in the Neelangarai area and eleven wells in the Akkarai area. Abstraction from individual wells ranges between 0.06 to 0.50Mld. The wells are located along the coastal area between the East Coast Road and the Bay of Bengal. Groundwater abstracted from these wells is pumped to the Thiruvanmiyur head works for further distribution. Presently about 3.5Mld is being pumped from these wells.

B4.4.2 Current groundwater resource abstractions (2002-3)

The A-K Basin

The average abstraction from the 21 operational production wells in the six wellfields is now 20Mld (7.3Mm^3/yr).

Due to the limited stored quantities of surface water and decreasing yields from the wellfields, agricultural wells are hired from farmers to extract groundwater to manage the current severe drought situation. At present, there are 15 collection sumps in the A-K basin and there is a proposal to have more. Each collection sump supplies about 5 to 8Mld. This system of hiring agricultural wells was started in April 2001 and at present about 60Mld (21.9Mm^3/yr) is being extracted from these wells.

In addition, around 50Mld (18.25Mm^3/yr) is collected from village wells within a 100km radius and transported to the city by tankers and lorries.

Southern aquifer

Groundwater from this aquifer is being extracted by 19 shallow open/dug wells located along the coastal area between the East Coast Road and the Bay of Bengal. Presently about 3.5Mld is being extracted from these wells.

B4.4.3 Groundwater source availability

The A-K Basin

A number of estimates have been made of the annual recharge to the A-K aquifer. The UNDP study in 1987 estimated that the annual recharge to the A-K Basin was 450Mm^3.

This included recharge from rainfall, infiltration from river beds and irrigation returns. The UNDP study also gave an estimate of average annual abstraction over the period 1980 to 1984 of 350Mm^3.

Based on these figures, they concluded that during normal or above normal rainfall recharge exceeds consumption. The UNDP study also made estimates for well field areas for the same period (1980 to 1984). The average recharge for this period was calculated to be 367Mm^3 and abstraction 354Mm^3. In dry years such as 1982, where recharge was estimated as 172Mm^3 and pumping abstraction was estimated as 382Mm^3, the difference was met from groundwater storage.

In the SWP study, the A-K aquifer was modelled and estimates were made of the annual recharge to the aquifer. The annual recharge for the period 1970 to 2002 was calculated and varied from a low of 209Mm^3 in 1974 to a high of 585Mm^3 in 1976 with an average over the whole period of 350Mm^3. The calculated total annual abstraction (irrigation and municipal) from the aquifer varied from a low 260Mm^3 in 1995 to a high of 430Mm^3 in 1980 with an average over the whole period of 344Mm^3.

An inspection of the average depth to water level plots for all six wellfield areas shows that there was an overall increase in depth to water level indicating over abstraction was taking place.

The modelling of the aquifer has indicated that, for City water supplies, a yield of 100Mm^3/year under normal rainfall conditions and 70Mm^3/year during drought periods is sustainable. For planning purposes, the SWP study has recommended that the sustainable yield for the A-K Basin aquifers should be taken as 70Mm^3/year.

B4.4,4 Treatment and distribution

There are two water treatment plants at present treating the raw water from the three reservoirs Poondi, Cholavaram and Red Hills: 270 Mld Kilpauk water works and 300 Mld Treatment plant at Red Hills. A third treatment plant (530Mld) is under construction and situated beside the Chembarambakkam reservoir.

CMWSSB is in the process of implementing a Water Supply and Sewerage Master Plan that will;

- endeavour to meet the water demand for the projected population of Chennai city for the year 2021 and

- ensure equitable distribution of water throughout the city.

Apart from four existing water distribution stations, located at Kilpauk, K.K. Nagar, Southern Head Works and Anna Poonga a further 12 additional water distribution stations were planned as part of the master plan for utilisation of additional supply from Krishna river. Out of the 12 stations, five stations at Valluvarkottam, Triplicane, Choolaimedu, Kannaparthidal and Ekkattuthangal were taken up under HUDCO funding and are now completed. The balance of seven stations, Koluthur, Vyasarpady, Patel Nagar, Pallipattu, Mylapore, Nandanam and Velachery were taken up under World Bank assistance as part of the Second Chennai Water Supply Project.

At present, the water from the treatment works is delivered to the Water Distribution Stations by the transmission mains and is then being supplied to the surrounding areas only by tanker lorries, due to shortage of water.

CMWSSB (Metrowater) decided to expand its area of operation around the city into the Adjacent Urbanised Area (165km^2) and in the Distant Urbanised Area (142km^2) expecting the receipt of Krishna water. The work was to be undertaken in two phases.

Due to the prevailing drought condition, there is not sufficient water even to meet Chennai city's requirements. Therefore, the water supply to the AUA and DUA will be undertaken when there will be enhanced water storage in the four surface water reservoirs from rainfall and Krishna water transfers. Figure B3 illustrates the water balance in the study area for a normal year and [for a dry year]. The figures given are approximate and are based on the recent studies by SWP and others

B4.5 The Poor and Vulnerable

B4.5 1 Surveys undertaken

Site Selection and Focus Group Discussions (FGDs)

Discussions were first held with Government and non-government agencies to determine areas within the study area which were (i) under significant stress due to over-extraction; (ii) serve as primary domestic and irrigated water sources for dependent communities and urban consumers. Within the Study area which includes the Araniyar/Koratailaiyar (AK) aquifer within the Chennai Basin and the Chennai Metropolitan Area (CMA), urban and rural locations were selected for fieldwork. Survey areas were selected in both rural and urban areas and represented five location types;

- slum localities in CMA
- prosperous localities in CMA
- designated industrial zones of peri-urban areas of CMA in and Kancheepuram districts
- rural sites in AK aquifer
- rural sites in the AK basin

The locations of Focus Group Dicussion sites surveyed are shown on maps in Annex D. 153 (46 rural agriculturally-dependent and 107 urban domestic households were represented in the Focus Groups with an overall average household size of five. Three industries, one large business and one small enterprise were also interviewed.

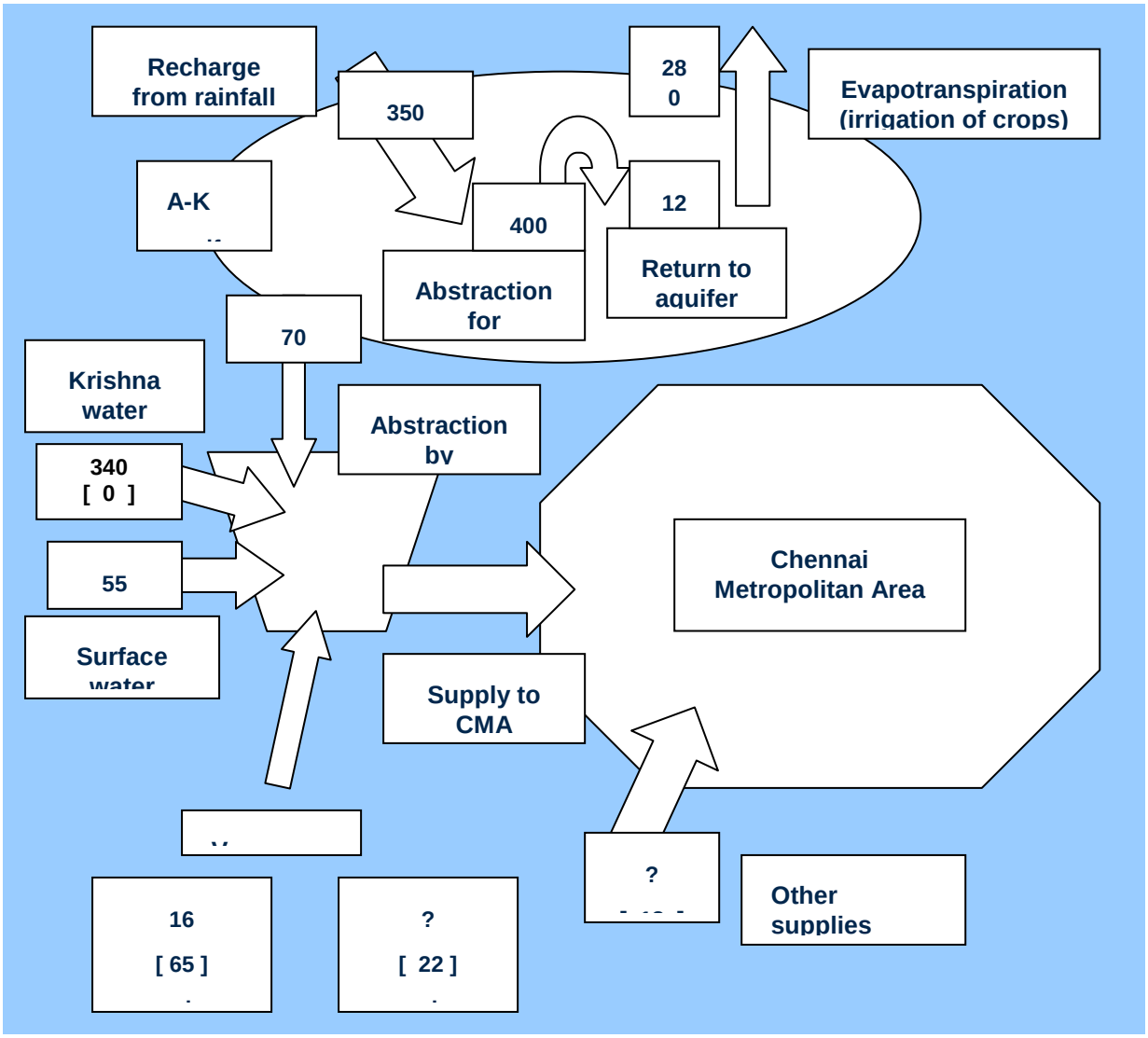


Figure B3 Study area water balance during normal year [and dry year] (Mm^3/yr)

Demography of the Survey Areas

The population of Chennai Metropolitan Area (CMA) and peri-urban areas is given in Table B4.2. The overall urban growth in CMA and its two neighbouring districts has been 35% in the last decade, reflecting CMA overspill and growth of a peri-urban area which supports industries and, increasingly, residential areas.

Farm land in peri-urban districts are now giving way to housing plots, boosted by the presence of the metropolitan area as a work location, proximity to good communication and transport facilities, and better availability of water. The latter is a strong factor in house and land values.

Table B4. 2 Urban growth rates, 1991-2001

District/ Metropolitan Area	Urban Growth Rate '91-'01	Total Population 2001	Total Urban Population 2001
Chennai Metropolitan Area	13.07%	4,343,645	4,343,645
Kancheepuram	55.77%	2,754,756	1,500,082
Thiruvallur	36.05%	2,877,468	1,534,966

There is regular urban migration from peri-urban districts, on a weekly or daily basis, creating a weekly water demand bulge which may not be reflected in official figures. There are also scores of informal and uncounted squatter colonies of semi-permanent nature whose residential status has not been formalised as have those termed as "slum dwellers".

The poor, classified as low-income or slum resident groups, officially totalled 1.4 million in 2001[40]. This is approximately one-third of the total 2001 Census population of the CMA.

Poverty in the Survey Areas

Tamil Nadu prepared a Human Development Report (TNHDR) in 2002, in co-ordination with the Union Planning Commission, which prepared the first all-India Human Development Report in March 2002. In the foreword to the TNHDR, the Chief Minister points out that development objectives are defined not just in terms of increase in GDP or per capita income but more broadly in terms of enhancement of human well-being (indicated by factors such as attainment of education, health, life expectancy, access to safe drinking water, sanitation facilities).

Development of a national and state perspective on human development, and by association, poverty alleviation, is a positive step taken. The next step is to link these perspectives to practical poverty alleviation targets and pro-poor actions to reach them. A key action was the establishment of the Tamil Nadu Slum Clearance Board in 1984, which continues to play an important role together with the Public Works Department in implementing various housing, slum improvement and rehabilitation and resettlement programmes to improve living conditions of urban slum families.

However, the needs of the poor outstrip resources available, and under circumstances of stress, such as the current water shortage, whether households can meet their daily needs highlights key poverty issues. These were identified first through wealth ranking exercises, which provided community criteria of socio-economic differences.

From such criteria it was possible to make the links where and how water stress is experienced by the poor as compared with other income groups. In Chennai, key features relating water and poverty include:

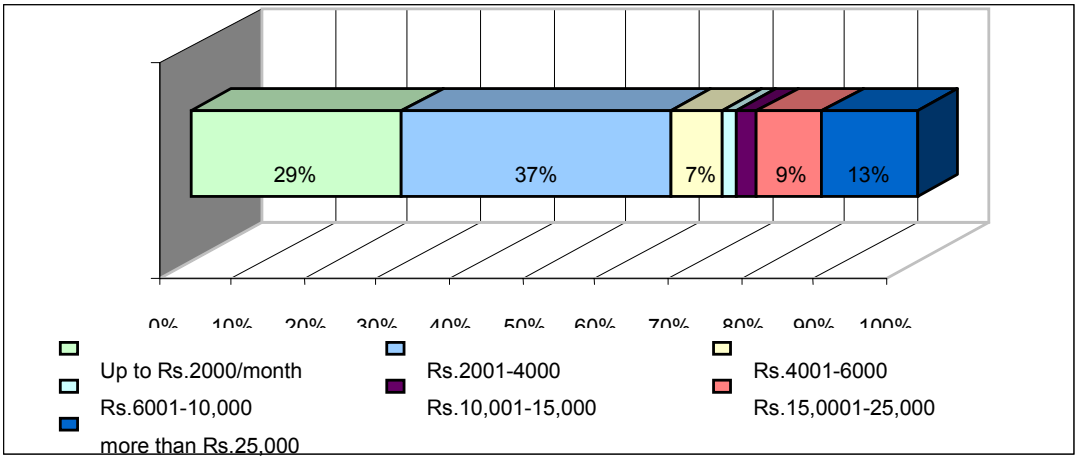
[40] Sources: Tamil Nadu Slum Clearance Board 2001 and Continuing Education Department, Corporation of Chennai, 2004

- lack of human assets (too few adults mean no-one is available to wait for water deliveries)
- lack of financial assets (insufficient household funds to pay for direct water connections, water storage facilities, independent borewells, or bulk purchase)
- lack of socio-political assets (no power to influence service providers)
- lack of natural assets (dwellings are rented, small and in crowded areas. There is no space to install borewells and tankers cannot negotiate the narrow lanes)

Poor urban localities are characterised by crowded conditions and large number of families in small spaces. This means a higher dependence on external water providers, particularly via piped supplies to street tapstands and handpumps, as larger water transport (ie. tankers) cannot negotiate the narrow lanes.

Figure B4 shows income classification (2004) of the total number of FGD participating households.

Figure B4 Representative income categories, FGD respondent households

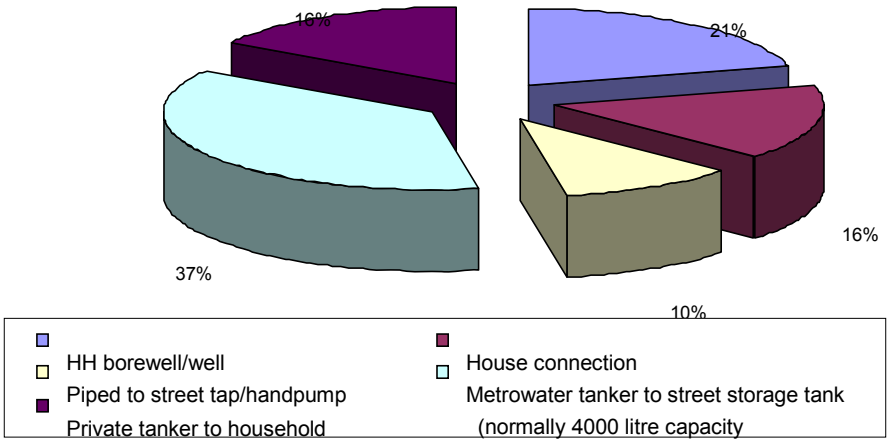


B4.5.2 Domestic water use, Chennai

Diversification of Sources

Thirteen separate domestic water supply sources were identified. The most favoured are shown in Figure B5.

Figure B5 Prioritised water sources (% FGDs identifying)



Rainwater harvesting methods have been made compulsory by the State Government, although all respondents expressed frustration that since implementing recommended measures there has been very little rainfall. Among low-income households, 43% of respondents are implementing simple forms of rainwater harvesting, such as catching and storing rooftop runoff. 100% of high income households have installed improved guttering and well recharge equipment.

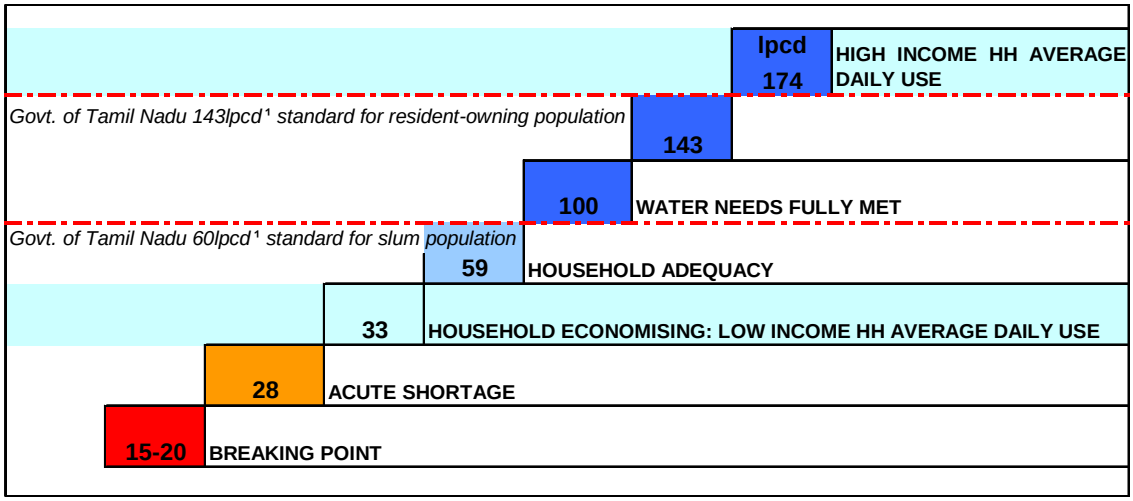
Water Security

Figure B6 illustrates differences in water security between households from different income groups, and the proportionately greater vulnerability of the poor. Boxed numbers show average household water consumption rates according to FGD respondents, though some localities in CMA are reported to receive only 10 litres per person per day. North Chennai is worst affected.

Respondents were asked what constituted water security to them, and how much less could they manage with before their condition became worse than it was at the time of the survey. Poor households were easily able to identify stress levels. High income households could not identify these as easily and already considered their present situation one of acute shortage, despite average consumption being 31lpcd over Metrowater's standard for higher income households.

There appears to be no shortage of water supply for those that can pay for it. Not only can higher income households afford the more expensive bottled water as well as regular tanker deliveries, they can achieve economy of scale with storage tanks which are filled regularly (on average every 3-4 days, depending on storage capacity). Prosperous localities are also better served by roads which can accommodate large private tankers.

Figure B6 Water Stress Thresholds among FGD Households



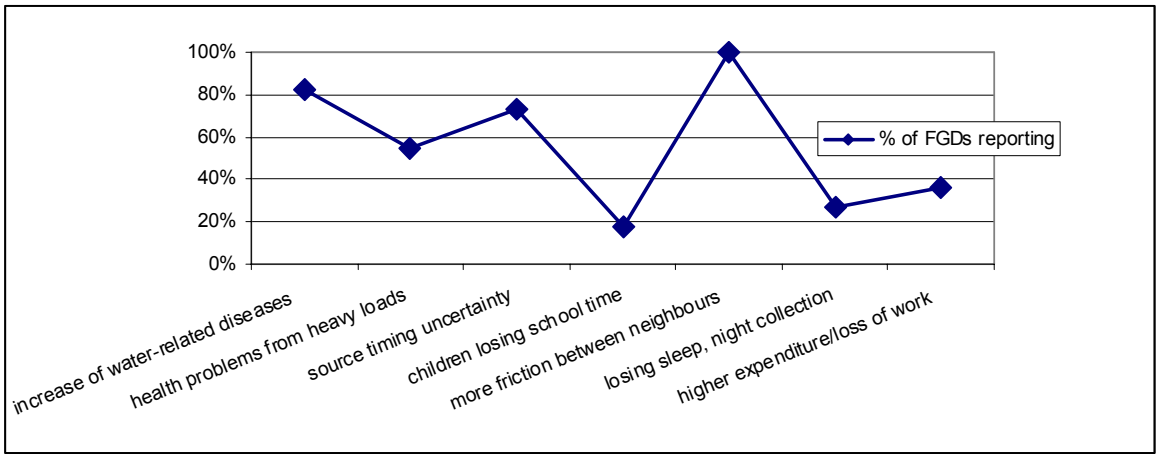
1: lpcd = litres per person per day

Many household wells in all parts of Chennai have been dry for some 2-3 years. For those with financial capital and land space, existing bores are deepened or new ones dug. The difference in well depth (depending on location) ranges between 25-40ft. five years ago, up to 80ft. at present.

Household connections in all FGD locations have been cut off for the past 2 years, with the exception of one high income locality. All FGD respondents said water supply from direct connections and wells decreased in the past three years, while dependence on tanker delivery and bottled water has increased by 81% and 54% respectively.

All FGD respondents said they took 1-2 hours daily in fetching or waiting for water. One particularly poorly served area (Taramani) and some households in Pullianthope reported spending more than 4 hours a day in fetching water. Reports of water problems are summarised in Figure B7.

Figure B7 Focus Groups reporting increases in water problems in the past year



Costs

Basic costs of domestic water supply and water connections are set out in Tables B4.3. The price varies from location to location, and the sort of payment differs from area to area; prices given are averages from all used sources.

Table B4.3 Recurrent household domestic water costs

Type of water supply	Average price per litre
Private tanker	Rs. 0.06
Metrowater tanker load to shared street Syntex tank subsequently distributed to households by pots	Rs. 0.02
Tricycle trip to water loading station (including tricycle hire charge)	Rs. 0.08
Bottled/Canned water	Rs.1.20

The cost of a household water connection is well beyond the means of poor households. The average monthly household water expenditure of respondents (excluding costs, such as waiting times, livelihood impact, electricity charges for pumping, energy consumed in water treatment (e.g. boiling)) was calculated as a proportion to total monthly disposable income. Low income households (consumption 34 lcpd; income Rs 3300) pay about 4% and middle income families (consumption 110 lcpd; income RS 7,500) around 1% of their income on water.

Conflicts

All households said they experience higher levels of conflict over water, sometimes between communities and water authorities or controllers of supply, but primarily between each other over distribution. The importance given by focus groups to types of problem, were inequity of distribution 44%; irregularity of supply 20%; failure of supply, 12%; water quality 12% and water quantity 12%.

Most households attempt to resolve water shortage difficulties by complaining direct to Metrowater, either collectively or individually. However, many FGDs pointed out their dependence on intermediaries to address their needs and their powerlessness to effect any change independently. Some of the poorest areas have resorted to direct action by blocking roads.

Coping Strategies

Higher income households respond to shortages from their normal supply sources by purchasing more bottled water and paying for private tanker delivery.

Low income households cannot afford to purchase more and cope by spending more time looking for alternative water sources. This involves longer distances to collect water from a wider number of supply sources. Many slum areas have been re-built as tenement blocks, and carrying buckets of water up flights of stairs is laborious. Intensive labour in accessing

domestic water automatically represents a water management technique; if water is easily available from a tap, people tend to use this more freely and with less regard to amounts used.

Poor households are also the first to start making economies in their time, budgets and water use. 57% of poor FGD respondents said water shortages have had a negative impact on livelihoods. Livelihood impacts include:

- loss of wages due to non-attendance at work while waiting for water supplies
- loss of work opportunities due to irregularity of water delivery timing
- loss of work due to illness from water-related diseases
- reduced labour capacity due to poorer nutrition
- higher expenditure for medical treatment
- higher expenditure to purchase meals outside (no time to prepare food at home)
- higher expenditure for water purchases
- higher expenditure to local water distributors
- high levels of customer dissatisfaction with water supply managers

Of those households already economising, women are the first in the family to do without. The most vulnerable are:

- the elderly who cannot afford to hire domestic help, particularly those living in blocks of flats
- women-headed households from low-income groups with no adults of working age (women earn less than men, they have responsibility for the children, they have responsibility for the domestic budget which includes water costs)
- women of child-bearing age (burden of carrying heavy loads)
- low income groups in particularly densely populated inner city localities relatively inaccessible to large vehicles
- those residing in poorly served areas
- non-formalised slum dwellers
- households dependent on daily wage earning

The most serious limitations of water shortages from the point of view of poor respondents are inequity of distribution of existing water supplies and timing uncertainty of deliveries, regardless whether the supplier is Metrowater or from a private source.

Satisfaction Levels

Overall satisfaction levels proved lower among high income households than middle and low income households. Expectations among the poor are very low and are related to their perceptions of empowerment. Poor respondents felt their only strength was in numbers and through direct action. Expectations concerning competence and representation of local leaders were correspondingly low.

Dealing with Change

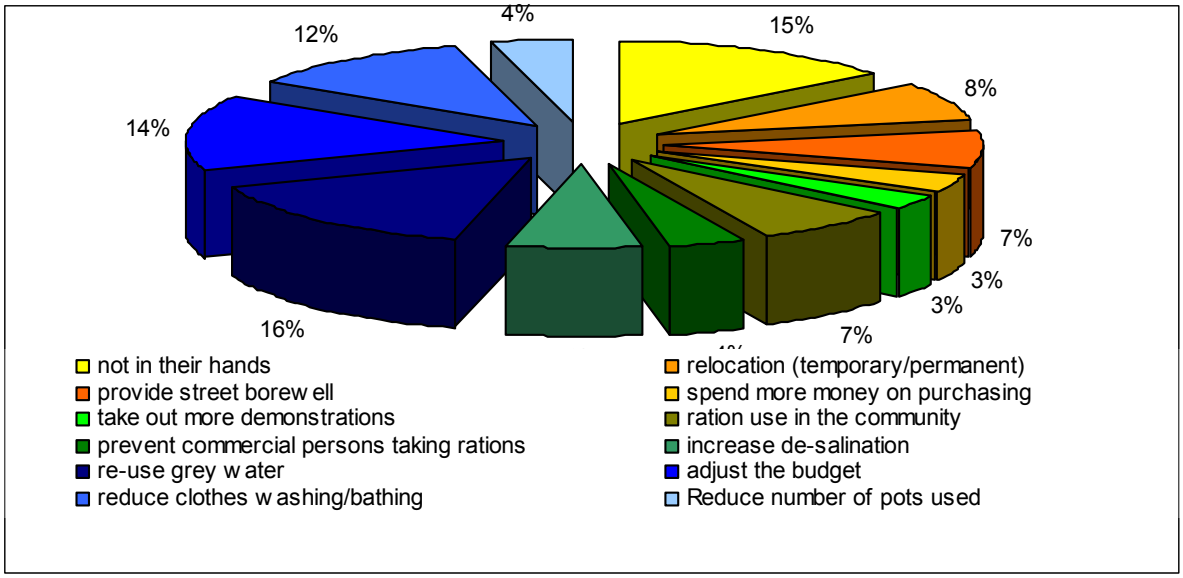
The water supply situation has become worse in Chennai over the past two years. Household economies and coping strategies thought to be temporary have now become established.

Respondents were asked the question: "If water supply stays the same or becomes even less, what methods will you adopt to cope with this?"

Responses fell into roughly three categories:

- how to obtain more water, revealing low levels of awareness about causes of groundwater scarcity (yellow wedges)
- how to deal with current water access grievances, indicating dissatisfaction levels about the equity of existing water supplies and improving neighbourhood water demand management (green wedges)
- how to manage with less water, implying acceptance of a worsening situation and adopting household water demand management measures (blue wedges)

Figure B8 Respondent attitudes to dealing with water quantity changes (%FGD responses)



B4.5.3 Agricultural water use, Chennai

In the six FGD locations in the AK basin, approximately 92% of households own or rent land for agricultural purposes. Of the 46 agriculturally-dependent respondent households in the FGDs, landholdings averaged 14 acres per household. The smallest average landholding was in Pandeswaram (2 acres), the largest in Jothinagar (40 acres). The majority of land is cultivated (89%); very little has been left fallow as a consequence of water shortage. The lowest rate of cultivation was in Orakkad, at 62% of landholdings.

The principal crops are all water-intensive. Paddy is the most important, with 86% of FGD locations cultivating. Sugar cane is also grown together with fruits (mangoes, guava, banana) and pulses. Increasingly, farmers are cultivating low water-intensive and high profit crops such as groundnut and green gram. 66% of farmers practised three cropping seasons, the remaining 34% two seasons.

Diversification of Sources

The main source of irrigation water is farmer-owned borewells (66%). 17% of FGDs identified some farmers sharing or purchasing water from another's well. Only 17% of FGDs reported dependence on traditional rainfed tank irrigation.

In the FGD locations, most farmers do not practise water-saving techniques, though a small number in two villages do water their fields via pipes to reduce evaporation. Two households use drip irrigation for fruit trees. No-one used sprinkler irrigation, or mulching as a means to reduce water loss. Only one farmer pipes rainwater to recharge his well.

Water Security

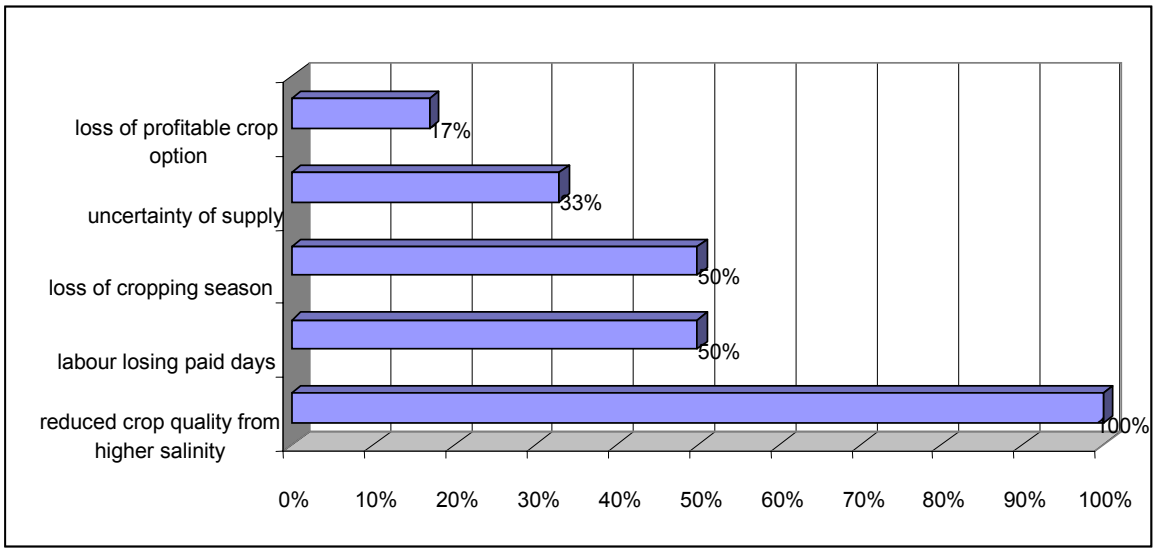
67% of households said irrigation water was regularly available, and average pumping time per household was 17 hours a day. One FGD reported borewells dry up to six and nine months of the year. The other FGDs stated borewells are never dry, but perceive a decrease in water availability. A third of FGDs complained about uncertainty of water supply. FGD responses to questions about borewell water quality indicated that groundwater quality is variable, even within the same village. (17% reported very saline water; 50% slightly saline water; and 33% good to very good water). Most farmers have deepened their wells in the last five years by an average of 40 feet. Some villages are involved in selling water to urban suppliers, both to Metrowater and private suppliers.

Conflicts

There is virtually no conflict between farmers and government, though there is much grumbling, particularly over the failure to maintain the tank system and to construct rainwater catchment checkdams. Farmers from all villages complain of the demise of tank irrigation due to lack of maintenance or alternative use by cultivators or sand extractors, both of which they regard as illegal. Excessive pumping from river beds by both Metrowater and private companies is also a grievance.

Other identified shortcomings relating to groundwater as illustrated in Figure B9.

Figure B9 Key shortcomings with groundwater (% FGDs identifying)



Coping Strategies

Despite the stated availability of irrigation water, 66% of FGDs claim water problems (overdraft of the aquifer and poor water quality) have affected their livelihoods. However, they acknowledged that livelihood decline was set in train by other factors such as non-availability of agricultural labour, and water difficulties have simply accelerated the process. Livelihood impact in the rural context is not all directly attributable to water problems, nor as severe as it is in the urban context. Even so, there are livelihood impacts which include reduced productivity, reduced crop quality, reduction in area planted and increasing debt, and farmers have adopted corresponding coping strategies.

Satisfaction levels

There are much higher levels of confidence among farmers as water-users than among urban dwellers. Despite their stronger sense of empowerment compared with urban dwellers, satisfaction levels over aspects of water is universally low. Those with higher dependence on tank irrigation are least satisfied with both availability, quality and quantity of tank water. However, most farmers no longer depend on tank irrigation and are independent with their own borewells. FGD results on satisfaction levels with borewell water indicated that more than 80% were dissatisfied with water quality and 50% with water quality and availability.

Dealing with Change

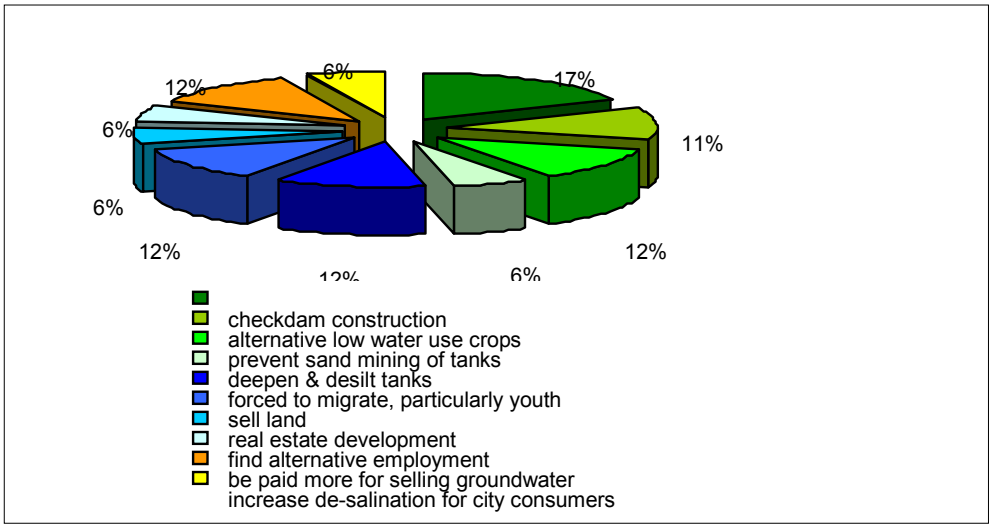
Change is taking place in rural Thiruvallur and Kancheepuram. Labour is leaving the land and turning to alternative employment opportunities, such as the construction industry, local factories sited in peri-urban districts of Kancheepuram and Thiruvallur, and weekly migration to Chennai Metropolitan Area. Abolition of inter-state tariffs has introduced a harsher level of competition, with cheaper and better quality agricultural products being transported from other Indian states. On top of this has come several years of low rainfall and an ever-increasing urban demand for water. The combination has proved an unhappy one for farmers in Thiruvallur and Kancheepuram, many of whom see the future, for their children if not for themselves, as an urban one.

The impact has not really been felt so much by the poorest landless agricultural workers. Presented with alternatives, they are increasingly leaving the land. The impact is most felt by marginal farmers with few financial and human assets to work the land, who find themselves increasingly indebted with no apparent way out. Water scarcity and decreasing quality is pushing them into a state of economic non-viability, and landowners reported distress sale of cattle due to non-availability of fodder.

During the period of fieldwork, Tamil Nadu state declared a moratorium on bank loans for six months, in an effort to support farmers until harvests were in. Despite these efforts, state agricultural production targets are maintained without compromise, reflecting a need to improve co-ordinated water demand management across sectors. Respondents also complained the agricultural sector has been run down through lack of traditional irrigation infrastructure maintenance, and failure to promote water saving land use methods such as transfer to profitable drought resistant crops and promotion of water saving irrigation techniques. Some forward-thinking farmers have pursued these alternatives and report positive and profitable results.

FGD respondents were fairly gloomy about the future of agriculture in their villages. When asked the same question as urban water users about water supply levels and standards remaining the same or becoming worse, replies reflected an approximate balance between those who want to stay on the land and improve agricultural opportunities (green wedges), and those who would choose to give up agriculture as a way of life (blue wedges). A small proportion responded on the relationship between rural groundwater supplies and urban demand (yellow wedges).

Figure B10 Respondent attitudes to dealing with groundwater situation (% of FGD responses)



Industrial Water Use

Industry is an important water user in Chennai, 40 large industries accounting for CMWSSB's main sources of revenue. Some industries re-use wastewater and have installed on-site recycling plants for the purpose. Madras Fertiliser Ltd. and Chennai Petrochemical Corporation Ltd. are the best known, having set up their own tertiary treatment plants to reuse secondary treated water, resulting in a saving of 19Mld.

However, wastewater recycling is not pursued as actively as it might, and both large and small industries are responsible for major contamination of both ground and surface water sources. Hundreds of small industries discharge untreated effluent directly into waterways, such as the Cooum River and Buckingham Canal, and FGDs reported significant variability in borewell quality depending on proximity to contaminated sources.

B4.5.4 Vulnerability assessment, target groups identified

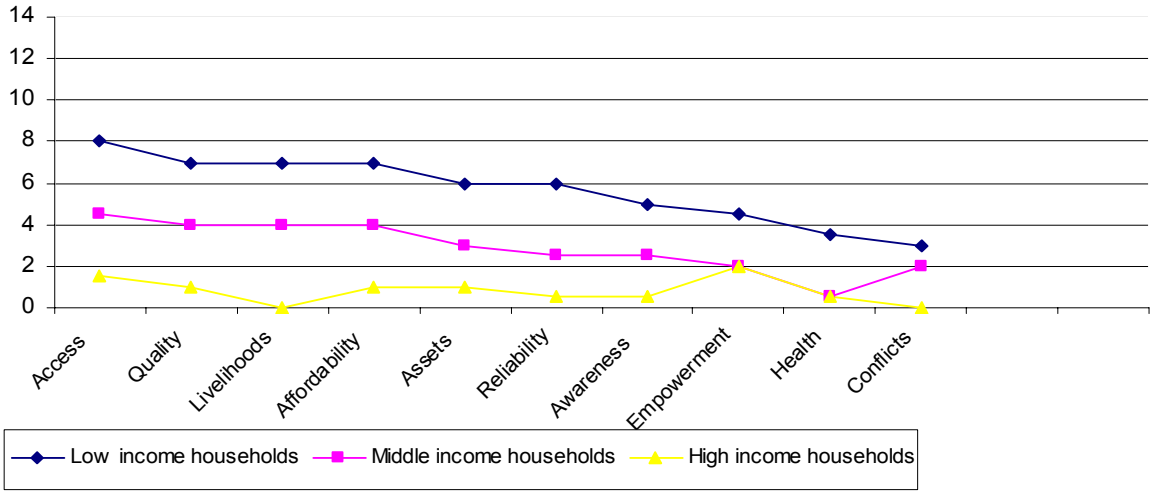
On the basis of the methodology described above, a test assessment of vulnerability was prepared for Chennai for socio-economic categories of low, middle and high income households.

Using fieldwork data collected from Focus Group Discussions, an assessment of how respondents in different localities might have assigned values, was made. A certain amount of external judgement combined with community assessment is needed with this

exercise in any case, as some sections of the community may project their situation as better or worse than it actually is.

The result of the vulnerability appraisal for Chennai is given below.

Figure B11 Vulnerability assessment, Chennai



The chart shows us that the highest impact for poor and middle income households is "access", followed by "poor water quality", "impact on livelihoods" and "affordability". For high income households, all these issues have some, but not much impact. The highest rated issue for rich households is empowerment, with low presence of effective community representation and inadequate ability to protect the water source.

Overall, we can see that low income households are severely affected at all levels in comparison with high income households. Middle income families are also affected, though to a lesser degree.

The rating and ranking exercise can be employed to evaluate vulnerability in relation to a variety of water demand management priorities and this theme will be discussed during the Workshop to be held in Chennai in November 2004. In complex water demand management situations, this enables vulnerability assessment to be incorporated into overall planning to manage a situation with multiple types of water users and multiple reasons for water scarcity.

The methodology is simply a way to systematise and record qualitative observations and judgements related to water and vulnerability. There is nothing fixed about the rank or rate of indicators. Indeed, it is expected that different stakeholders will assign ranks and weights in different ways. It is through comparison of these differences that planners can be alerted to critical differences, enabling them to adjust their planning accordingly.

It should be stressed, however, that this exercise does not replace other qualitative and quantitative information gathering exercises. Indeed it can be more valuable when taken in conjunction with other tools, to enhance understanding of any given situation.

B4.6 Water Demand Management

B4.6.1 Current management strategies

The water resources development of Chennai and the agricultural areas to the north of the city are described above. The demand for water for domestic, industrial and agricultural use exceeds the available supply. Water supply to the Chennai Metropolitan Area (CMA) is currently inadequate and unreliable. The Chennai Metropolitan Water Supply and Sewerage Board (CMWWSB), Metrowater is now looking at ways of increasing resources. These include:

- increased abstraction rights from the A-K aquifer, an aquifer which is currently over-exploited and which is used extensively for irrigated agriculture;
- desalination of seawater and blending with existing supplies;
- construction of recharge dams;
- rainwater harvesting;
- further water transfers from Andhra Pradesh (from Krishna river);

Although a wide range of supply options are being considered by the Government of Tamil Nadu to provide water for Chennai, a number of issues arise with regard to the water supply for domestic and industrial use and provision of water for agriculture in the area. These include:

- unreliability of monsoon rainfall
- unreliability of supply from inter-State water transfer
- over-abstraction from A-K aquifer, falling groundwater levels and saline intrusion
- competition for water between agriculture and city water supply requirements
- inequity of domestic water supply distribution between different socio-economic groups in Chennai
- expanding urban population (1.3 % per annum)

Further consideration will have to be given to introducing appropriate water demand management measures. The potential options for the domestic, industrial and agricultural sectors are given in Table B4.4 below.
Measures in place include those shaded below. These are:

- changing land use; well buy-out or rental by CMWSSB from farmers (the transfer of water rights is now under consideration); and
- in response to the shortages, communities within the City in some areas have taken on an informal role in managing the demand from domestic users by organizing equitable distribution and in effect implementing a quota system at community level;

In addition, some sectoral and intra-sectoral water demand quotas are planned by CWMSSB (e.g. for Chennai Metropolitan Area: 60lpcd for slum population, 143 lpcd for residential population, 133 lpcd for commercial organisations with 18,000 l/ha/day for institutional/industrial demand, although these can not be met at present);

B4.6.2 Demand management options

If we look at the range of options which could be considered or encouraged, a first step would be to define inter-sectoral and intra-sectoral water allocations and quotas more precisely (measures DA1/AA1, DA2 and AA2 shaded below).

Table B4.4 Water demand management options - Chennai

	WATER DEMAND MANAGEMENT			
	Domestic/municipal		**Agriculture**	
Developmental and technical measures	DT 1	Reduce consumer water losses	AT1	Improve efficiency of surface irrigation systems
	DT 2	Water saving devices and fittings	AT2	Introduce/improve sprinkler/drip systems a) with subsidy b) without subsidy
	DT 3	Recycling of industrial water		
	DT 4	Use of "grey" water		
Allocative, financial and market based measures	DA 1	Inter-sectoral water quotas and allocations	AA 1	Inter-sectoral water quotas and allocations
	DA 2	Intra-sectoral water quotas and allocations	AA 2	Intra-sectoral water quotas and allocations
	DA 3	Land development control	AA 3	Change land use by: a) land purchase b) re-zoning/classification c) well buy-out (transfer of water rights)
			AA 4	Crop area prohibition
			AA 5	Change cropping patterns by: a) extension b) tax c) market support
			AA 6	Introduce water markets
	DA 4	Water tariff: a) progressive b) differential	AA 7	Water tariffs: a) volumetric b) on power to pumps c) area based
Other socio-economic measures	DS 1	Community level management	AS 1	Water users associations
	DS 2	Population distribution	AS 2	Population distribution
	DS 3	Migration	AS 3	Migration

The basic steps in this process are:

(i) define the priority demands (e.g. domestic water quotas per capita, population and demographic trends; industrial demands; environmental demands)
(ii) calculate an appropriate allocation for the priority demands
(iii) determine the supply options and sustainable yields
(iv) calculate the water availability for other uses (i.e. principally agriculture)
(v) define the allocations to the different water using sectors.

With priority being given to domestic water supply, it is important that this water is distributed with minimum loss and wastage. Items DT1 Reduction of consumer water losses, DT2 Water saving devices and fittings and DT3 Recycling of industrial water become of importance here and DA3 water tariffs may become an instrument in controlling these.

The current domestic water situation in Chennai is extremely serious, especially with regard to the poor and vulnerable. Community Level Management, is an essential ingredient of the water demand management approach with consideration being given to equity of distribution.

Thereafter, further consideration could be given to measures AA3 to AA7:

- Change land use by: a) land purchase b) re-zoning/classification; c) well-buy outs/transfer of water rights
- Crop area prohibition;
- Change cropping patterns by: a) extension b) tax c) market support;
- Introduction of water markets;
- Water tariffs: a) volumetric b) on power to pumps c) area based

Some of these measures are already being introduced in one form or another (e.g. water rights at some sites are effectively being transferred to CMWSSB through agreements with farmers to buy or lease their rights to water abstraction). In addition, the change in farming patterns in the A-K aquifer may favour a more co-operative approach to water abstraction which might be strengthened through the encouragement of farmer groups or water users organisations.

Supporting measures

Implementation of the measures above would require supporting actions (or policy instruments)

The legislation and regulation for the abstraction of groundwater in Tamil Nadu was introduced in 1987. Sectoral water allocations and water quotas have not been introduced as yet and these would require further licensing and legislation, metering of abstractions and the introduction of monitoring and enforcement measures. Currently piped domestic water supply is metered but abstractions from agricultural wells are not. Supporting measures have their place and need considering alongside the corresponding demand management actions described above.

B4.7 Impact of Demand Management Options

B4.7.1 Introduction

The Chennai Case Study has revealed some interesting insights into the management of water both at the public supply authority and community levels. Water supplies to the city are limited, unreliable and have been seriously affected by the poor monsoon rainfall of the last few years.

The A-K aquifer, to the north of Chennai has traditionally been used to provide water for irrigated agriculture, but in 1969, wellfields were developed to supply water to the industrial area of Manali and, from 1987, new wellfields were established to supply water to Chennai city. The aquifer is currently over-exploited, abstractions exceed the sustainable yield and saline intrusion now penetrates up to 12km from the coast.

Currently, studies are being undertaken to establish the sustainable yield of the aquifer so that up to 100 Mm^3/year could be supplied to the city. There is competition for water for domestic/industrial water supply and for irrigation.

The other sources of water supply to the city are from surface water run-off via reservoirs, inter-State transfer of water from Andhra Pradesh (Krishna River), tanker supplies from borehole supplies outside the A-K aquifer. A pipeline from Veeranam (230 km south of Chennai) is under construction to supplement supplies. A desalination plant to serve Chennai is also planned. Rainwater harvesting has recently been introduced to the city to improve recharge to the city aquifer. A wide variety of supply options have been considered, but the provision of water is becoming increasingly expensive.

The water supply situation is complex and exacerbated by the recent drought conditions but it is clear that managing the demand is an essential ingredient of any water policy for the area if the domestic, industrial and agricultural sectors are to be satisfied. A Water Master Plan, which introduces a demand management policy, is required for the area.

At this stage of the Research Project, we can only point to demand management measures that should be considered and their potential impacts. A full impact study should follow the approach outlined in the Main Report.

B4.7.2 Water provision, savings and unit costs of water saved

Some preliminary cost estimates of components of a number of water supply options, based on data made available in Chennai, are given in Table B4.5.

Table B4.5 Cost of components of water produced (Rs/m^3)

Option	Description	Cost of Water (Rs/m^3)	Water made available at
SD1/SA1	Develop additional groundwater (wellfield)	6.1	at head of distribution system
	Develop additional g.w. and supply to city (Veeranam)	17.7	at head of distribution system
SD2	Desalination	45.0	at plant
SD4	New water treatment facilities	2.9	at treatment plant (cost of facility only)
SD5	Extend water distribution system	7.4	average for city supply system
SD6	Extend tanker distribution		
SD7/SA3	Retention dams and reservoirs	11.0	at aquifer
SD8/SA4	Aquifer recharge (dam)		
SD9/SA5	Increased surface water diversion		
SD11/SA7	Trans basin water transfer		
SA2	Treat/use wastewater	2.2-2.9	at treatment plant (cost of facility only)

Where demand management measures are introduced, there is a cost in so doing and, where agriculture is curtailed, an amount saved per hectare of land can be estimated. The table below gives some initial estimates of the cost of water saved and potential savings per hectare for a number of demand management measures which could be adopted in the Case Study area.

Table B4.6 Cost of components of water produced (Rs/m^3)

Option	Measure	Cost of water saved (Rs/m^3)	Quantity of water saved (m^3/ha)	Water made available at
DD1	Reduce consumer water losses			
DD2	Water saving devices and fittings			
DD3	Recycling of industrial water	36		plant
DA1	Improve efficiency of surface irrigation systems	0.54	3,600	aquifer
DA2	Introduce sprinkler irrigation	3.5-10.9	269 - 676	aquifer
	Introduce drip irrigation	9.7-13.0	676	aquifer
AR3	Change land use	0.09	22,208	aquifer
AR4	Crop area prohibition			aquifer
AR5	Change cropping pattern		8,320	aquifer

B5. AL JAFR-SHOUBAK CASE STUDY

B5.1 The Case Study Area

B5.1.1 Description of the area

The two case study areas, Al Jafr and Shoubak, are in the Al Jafr basin. The basin is located in the southern part of the Hashemite Kingdom of Jordan between latitudes 19°30'N and 20°30'N and longitudes 35°30'E and 37°00'E.

The Al Jafr basin is to the west of the Wadi Araba and Southern Ghors rift valley system and is part of the Central Jordanian Plateau. The basin shows a centripetal drainage pattern with all wadis draining from the surrounding highlands to the central desert playa at Al Jafr. The ground elevations vary from 1200m above sea level in the western highlands around Shoubak to 860m above sea level at Al Jafr.

The central part of the basin is a peneplain with occasional hills and weakly incised wadis with intermittent flows resulting from local precipitation that is usually intense and caused by scattered storms.

The climate varies between semi-arid desert for most of the basin with a Mediterranean type climate in the highlands in the west. The basin plateau of the eastern desert is hot in summer and cold in winter. The temperature may reach more than 40°C during summer days and drop to a few degrees below zero in winter, especially during the night. In the highlands, the climate is more temperate, cold and wet in the winter with temperatures reaching a few degrees below zero during the night and hot dry summers with temperatures reaching 35°C at midday.

The average total rainfall varies between 300mm/annum in the west and less than 40mm/annum in the east and is provided by winter rainfall from October to May with the majority falling in January and February. Snowfall does occur once or twice a year in the highlands with up to 75 days of frost. The mean annual potential evaporation rate varies from 1150mm/year in Shoubak to 2500mm/year in Al Jafr. The annual rainfall varies significantly about the mean value and in a cycle between 1 and 5 years, with drought periods that continue for 3 to 5 years.

The water supply to the Al Jafr – Shoubak areas is derived from both surface water from a limited number of spring sources in the western highlands and groundwater sources.

Demands for water supply in Shoubak come primarily from a number of small villages where water is required for domestic water supply and garden irrigation. Rainfed agriculture is confined to the winter season when wheat and barley are grown, yields of which are variable and dependent on the rainfall pattern. The irrigated agricultural sector is dominated by large fruit farms (about 2,000 ha) in the east of the study area which rely on groundwater.

Al Jafr relies on groundwater for domestic and agricultural use. There is a surface irrigated farm run by the Ministry of Agriculture to support settlement in the area. There are a number of vegetable and fruit farms in Al Jafr using groundwater and applying water principally by drip irrigation.

B5.1.2 Economic background

General

The population of the The Hashemite Kingdom of Jordan country was 5.33 million (2002) with the density varying from 3.1 person/km^2 in Ma'an Governorate to 586.5 person/km^2 in Irbid Governorate. The capital, Amman, serves 2.03 million, nearly 40% of the country's population.

The economy of Jordan is mainly dependent on the tertiary sector which consists of trading, business and services (73%). This is followed by the secondary sector (22%) which consists of manufacturing, construction, electricity, gas and water. The primary sector, which consists of agriculture, hunting, forestry & fishing (2%) and mining & quarrying (3%) contributes a small portion to GDP (5%).

Real GDP growth rates have grown from about 3% per annum in 1998 to 5% in 2002. GDP per capita was US$ 1,762 in 2002. The annual inflation rate is 3.3% per annum and the official un-employment rate is 16%.

Phosphate represents a significantly natural resource of Jordan and export is expected to expand considerably as pressure continues on world wide agricultural productivity. Other materials such as glass, sand, potash and bromine have shown significant growth. Tourism also presents a major source of income generation of foreign exchange.

The total agricultural area of Jordan is 260,000 hectares, 75,000 ha of which are irrigated. The remaining 71% area is rain-fed with field crops prevailing. Vegetables and fruit trees are usually irrigated and many Jordanian farmers are well experienced in drip and sprinkler irrigation.

Availability of good agricultural land and water is limited in Jordan; however the country exports high quality agricultural commodities (vegetables and fruit) with an export value of 92 JD million (2002). Jordan imported about 59,000 tons of wheat & barley and about 36,800 tons of fruit with total value of 93 JD million in 2002.

Shoubak - Al Jafr

The Case Study areas are in the Ma'an Governorate (population 104,000, 2% of the kingdom's population). The populations in Shoubak District and Al Jafr were 13,075 and 11,850 respectively (2002).

The Ma'an Governorate contributes about 5 % to fruit production and 8% to the vegetable production of the nation. The total area cropped (2002) in Ma'an Governorate was about 263,000 dunum of which about 36% of the crops are irrigated, the remainder are rain-fed with generally low and variable yields depending on the rainfall.

In Shoubak District a total of 101,386 dunum are cropped each year (19,867 dunum of these crops are irrigated and 81,521 dunum rely on rainfall). In Al Jafr the total area cropped is 40,479 dunum, all of which are irrigated. Land use details in Ma'an Governorate are given in the Table B5.1 below.

The survey carried out by the research team during April 2003 in Shoubak and Al Jafr showed that farm sizes in Shoubak are generally smaller than in Al Jafr.

In Shoubak, 40% of farming households interviewed have less than 5 ha; 28% of households have more than 10 ha. Meanwhile in Al Jafr most farming households interviewed have more than 5 ha of land and 46% of households more than 10 ha.

Table B5.1 Land use in Shoubak, Al Jafr and Ma'an – 2002

Crops	Irrigation	Trees	Ma'an	Shoubak	%	Al Jafr	%
Fruit trees							
	Irrigated	Olives	15,392	1,969	13	1,597	10
	Irrigated	Grapes	3,275	300	9	957	29
	Irrigated	Others*	33,124	17,187	52	1,540	5
	Non-irrigated	Olives	2,123	353	17		
	Non-irrigated	Grapes	589	200	34		
	Non-irrigated	Others	1,091	3	0		
Vegetables							
Winter			8,727			7,980	91
Summer	Irrigated		18,562	409	2	14,410	78
Field crops							
Winter	Irrigated		14,099			12,944	92
	Non-irrigated	Cultivated	161,677	80,240	50		
		Harvested	145,330	70,183	48		
Summer		Cultivated	4,305	725	17		
		Harvested	3,501	510	15		
Clovers/alfalfa	Irrigated		1,085			1,051	97
Total	Irrigated		94,266	19,867	21	40,479	43
	Non-irrigated		169,035	81,521	48		
Grand total			**263,299**	**101,386**	**39**	**40,479**	**15**
Fruit trees			21.1%	19.7%		10.1%	
Vegetables			10.3%	0.4%		55.3%	
Field crops			68.6%	79.7%		34.6%	

* Apples, stone fruits etc
Source: Agricultural statistics, Department of Agriculture, Ma'an Governorate.

However, irrigated land is only a small portion (37%) of the farmed agricultural land in Shoubak since rain-fed wheat/barley is widely cultivated. The information on irrigated land in Al Jafr is affected by the number of nomadic households using the Department of Agriculture's Farm who do not cultivate and irrigate their land regularly.
Net irrigation water requirement for irrigated crops are estimated to be about 1000 m^3/dunum/year for fruit trees, 500-700 m^3/dunum for vegetables and 430 m^3/dunum for wheat and barley field crops.

B5.1.3 Institutions

The primary Government Ministry responsible for water matters is the Ministry of Water and Irrigation. The Ministry was formed in 1992, under Law No 54/1992. Its main purpose is to centralise the national management of water resources which were previously regulated by multiple agencies (WAJ, JVA, Ministry of Agriculture and Ministry of Health). The MWI has responsibility for distributing and regulating the water resources in Jordan and for settling disputes between agriculturalists and water supply authorities.

The Water Authority of Jordan (WAJ) is responsible for construction, operation and maintenance of water supply and sewage facilities and for national water resources management plans.

The Jordan Valley Authority from 1977 has been the prime authority for planning and implementing water supply services in the Jordan Valley. Subsequently, JVA extended its role to infrastructure development in the Valley (to include water electricity, land and municipalities).

The Ministry of Agriculture is responsible for the promotion of agriculture and the provision of advisory services.

B5.1.4 Legislation and regulations

The principal laws, ordinances and regulations relating to the abstraction, use and conservation of water in Jordan are:

- Water Authority Law No 18 of 1988 and Amendments thereof, Law No 62 of 2001
- Municipal Wastewater Law No 12 of 1977
- Underground water control By-Law No 26 of 1977

The most recent legislation relating to the abstraction of groundwater in Jordan is By- Law No. (85) of 2002: Underground Water Control By- Law, issued in pursuance of Articles 6 and 32 of the Water Authority Law No. 18 of 1988.

B5.2 Water Resources Development

B5.2.1 Water resource availability

The water supply to the Al Jafr and Shoubak areas is derived from both surface water from a limited number of spring sources in the western highlands and from groundwater sources.

The Al Jafr basin is a completely contained depression with a catchment area of around 13,500km^2. The total surface water runoff of the catchment is reported to be between

22Mm^3/year and 15Mm^3/year of which 10Mm^3/year flows as floods into the Al Jafr depression where they either evaporate or infiltrate into the ground. There are no perennial stream flows.

Base flow in the form of spring discharge in the western highland is used for irrigation. The Ministry of Water and Irrigation (MWI) Data Bank has provided discharge data for the main springs in the area. The mean annual spring discharge was reported as between 0.75Mm^3 (JICA) and 1.3Mm^3 (Kdhier). The long term records show that there has been a general reduction in spring flow in recent decades with a number drying up completely. These include Nijil-Shoubak (G0572), Jerba el Kabira (G0554) and Udruh (G0552) that have all dried up since 1989.

Groundwater is the major source of water in Jordan. The aquifers of Jordan are divided into three main systems or complexes:

- Deep sandstone aquifer complex
- Upper Cretaceous carbonate aquifer complex, and
- Shallow aquifer complex

The Upper Cretaceous carbonate aquifer system forms the major regional aquifer system of Jordan and this is so in the Al Jafr basin. It is essentially continuous and contains productive aquifers throughout the country.

Four aquifers have been recognised within the Upper Cretaceous sequence. The main one is the Amman - Wadi Sir (B2/A7) which extends throughout most of the country. The others are the Na'ur (A1/2), the Hummar (A4) and the Rijam (B4) and are of importance locally throughout Jordan. In the Al Jafr basin the Hummar is not well developed.

The B2/A7 and the underlying older Kurnub (Lower Cretaceous) and Disi sandstones (Cambrian to Ordovician) form the deeper aquifers in the Al Jafr basin and are separated from each other by thick aquitards. In the central part of the basin, the overlying thick impervious argillaceous unit of the Muwaqqar (B3) Formation confines the B2/A7, while in the surrounding higher areas to the west it is unconfined. The different aquifers within this unit are considered to be in hydraulic continuity. The aquifer has an average thickness of 100m, 40m of Amman (B2) and 60m of Wadi Sir (A7). In general, the aquifer thins to the south and thickens to the north.

Within the outcrop area of the B2/A7 aquifer system in the Western Highlands a recharge mound has developed which is divided by tectonic and morphological features in to three flow systems (BfB). The largest part of the recharge area drains eastward towards the Al Jafr basin. The flow system of Nijil – Shoubak area drains north and that of the Wadi Musa area to the west of the surface catchment divide to discharge as springs and seepages along the base of the A7 aquifer on the escarpment above Wadi Araba.

Several tectonic structures such as the Arja-Uweina flexure act as flow barriers to the eastward direction of ground water flow. The presence of the hydraulic barriers is indicated by the marked head drop across the structures. The JICA study records piezometric levels in the Western highlands of 1200 to 1500m, while they are as low as 800 to 900m immediately east of the Arja-Uweina flexure. In the central part of the Jafr basin the piezometric elevations are reported to be between 750 and 800m with a nearly flat hydraulic gradient.

Eastward of the flexure the groundwater of the B2/A7 aquifer is confined by the impervious marl of the Muwaqqar (B3) horizon.

The main groundwater aquifer in the centre of the basin area is the B4 Formation of the Belqa group, consisting of thin beds of chert, limestones, clays and marls with a total thickness of 20-25 metres. In the central part of the basin the B4 is saturated under water table conditions, whilst in the surrounding areas it is unsaturated.

Recharge to the B4 aquifer takes place from surface runoff from the highland of Shoubak. Direct recharge to the saturated part of the aquifer in the centre of the basin is negligible because the surface area of the playa where the flood water collects is covered by very fine sediments which do not allow rapid infiltration and groundwater recharge.

The groundwater flow in the B4 and B2/A7 aquifers is generally from west to east. In the deeper aquifers, the groundwater flows in a generally northerly direction with components towards the northeast and northwest.

B5.2.2 History of water resource studies

Groundwater investigations in Jordan began in the early part of the 20th century. There have been several regional studies that included water resource evaluation for the Al Jafr Basin.

- Bundesanstalt fur Bodenforschung (1969) reported on the exploration and exploitation of groundwater in the Arja Uweina area for an irrigation project. This work was carried out in cooperation with the Natural Resources Authority of Jordan and the UN Special Fund Sandstone Aquifer Project.

- The UNDP study (1970) Sandstone Aquifer Project defined the general outlines of the hydrogeology of the region

- Agrar-und-Hydroteknik (1977) compiled all the available data on geology, hydrology and groundwater for compilation of the National Water Master Plan of Jordan (WMP).

- Howard Humpreys Ltd. (1986) studied hydrogeology and hydrochemistry of the Mesozioc-Cainozoic aquifer of the Ma'an-Shidiya-El Jafr region.

- Japanese International Co-operation Agency (JICA) with the cooperation of WAJ (1990) conducted a study of the Wadi Hasa and Jafr basin. The study included drilling new observation boreholes and groundwater mathematical modelling

- Kamel M. Khdier's doctoral thesis (1997) was an assessment of regional hydrogeological framework of the Mesozoic aquifer system of Jordan.

The bodies responsible in the past for monitoring/reporting on water resources in the Al Jafr basin include the Ministry of Water and Irrigation (MWI), Water Authority of Jordan (WAJ) and the Ministry of Agriculture (MoA). The MWI Data Bank provided water resource data for this project. In 2002 there were 159 wells in the Al Jafr basin extracting 22Mm^3. Of these, there were 28 for domestic supply, 20 industrial, 106 irrigation and 5 in remote areas.

B5.2.3 Development and current use of water resources

Shoubak area

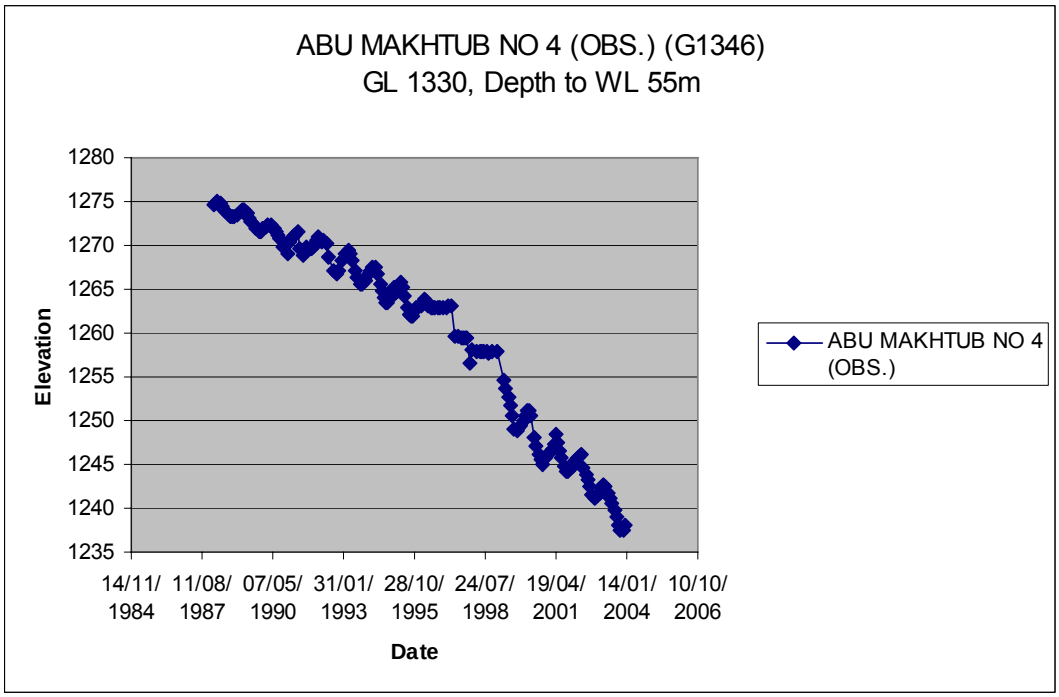
The agricultural farms 5 to 10kms to the east of the villages of the Shoubak area are the main abstractors of groundwater from the aquifer.

The observation well Abu Makhtub No. 4 (G1346) some 7kms to the southeast of Shoubak has provided a record of the water table in the area of agriculture from 1988 to 2003. Over that period the water level has fallen 40 metres. Over the period 1988 to 1996, the average annual decrease in water level was 1.5m/year. Since 1994, the average annual decrease has doubled to 3m/year.

The domestic supply for the Shoubak area is supplied by six wells belonging to WAJ. A 68kms long pipeline from Shoubak supplied Tafila until May 2003, when the replacement wellfield at Wadi Hasa came online. The water is pumped directly into supply. Each village is divided into zones to ensure delivery at the end of the pipelines. The wells are pumped for 10hours per day during the winter and 24hours per day in the summer. The summer supply is reported to be given every third day for about 5 hours.

A pipeline from the Ail pumping station (WAJ) supplies the Udruh, Jarba and Menshiye area at a rate of 1200m^3/day during the summer and 500m^3/day from November to the end of March.

Figure B12 Record from observation well Abu Makhtub No. 4 (G1346)



JICA estimated the B2/A7 abstraction in western highlands to be 9.36Mm^3/year. No significant regional drawdowns have been recorded except in the Shoubak wells. The Western Highlands are the major recharge area for the aquifer.

East of the desert highway the groundwater in the confined aquifer is untapped until the well field for Shadiya industrial area and the deeper Al Jafr agricultural wells.

The JICA study (1990) reported that an estimated 3.3Mm^3/year was being used for irrigation in the Shoubak area. Based on the abstraction records held in the MWI Data Bank, the total annual agricultural abstractions from the fruit farms in a 25km^2 area located 8kms to the south east of Shoubak (shown as the northern farms, shaded cells in the Table B8 below) varied from 4.6Mm^3/year to 2.9Mm^3/year between 1996 and 2001.

Shoubak fruit farms

There are more than twenty-three specialised fruit and vegetable farms in Shoubak abstracting water for irrigation of apples, apricots, other stone fruit and vegetables. Irrigation of fruit trees (97% of the area under crops) is by drip systems; vegetables (3%) are also irrigated by drip systems in plastic greenhouses or under cloches.

The recorded abstraction of water by the northern farms, those shaded thus  above is recorded by the MWI as between 3 and 4.5 Mm^3/year.

Based on the areas under cultivation in the northern farms, listed in Table B8 above, and the potential evapo-transpiration for the fruit and vegetables, the water consumption would be between 7 and 9 m^3/year. These figures indicate either that the fruit trees and vegetables are not being provided with sufficient water or that abstractions from the aquifer are greater than those being recorded. A combination of these explanations probably applies.

Table 5.2 Large farms – Shoubak

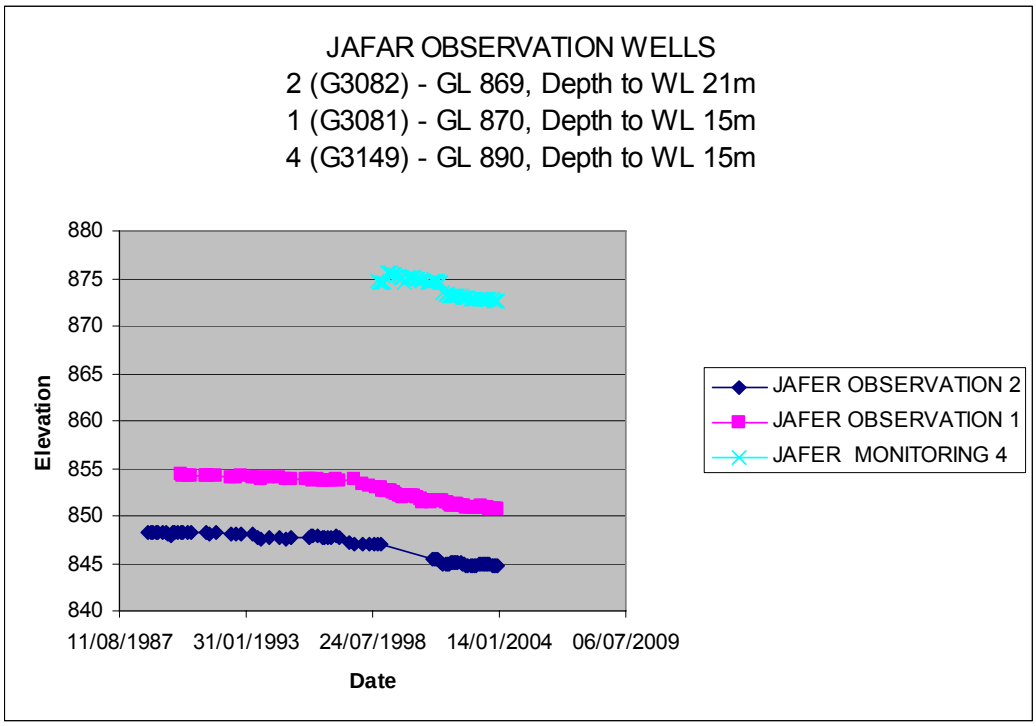
	Name	Total Area (ha)	Apples (ha)	Stone fruits (ha)	Vegetable (ha)	Olive (ha)	Pistacch-Aleppo (ha)	Other (ha)	Pump Capacity (reported) (M3/hr)
1	Sabeeh Al Masry	171	120	8	12				120
2	Abu Al-Haj Farm	400	170	10		40	10	130	180
3	Salem Jarrar	80	60	2					45
4	Khalil M. Al-Jilany	75	65	10					55
5	Mohammed F.Ali	59	50	9					85
6	Khalid Alean & Majed Hashlamoony	170	130	25					205
7	Mohammed Samoor Al-Jazy	62	45	17					70
8	Essa Jarda Al-Tarawneh	60	48			7			45
9	Yusri Al-Jazy	65	45	10		10			65
10	Zuhair Zanooneh	45	35	5		5			95
11	Samir Mahmood	36	34	1		1			44
12	Nafith Al Hashlamoony	55	40	10		5			50
13	Essa Al-Masry	40	30	3		7			55
14	Bassam Abdullah	19	15	4					55
15	Abdel Hameed Al Hashlamoony	175	125	40					125
16	Al-Tilal	20	16	4					16
17	Hassan Salem & Kholy	127	85	25		6			250
18	Khalid Alean & M,Hashlamoony	40	30	10					55
19	Saleh R. Al-Jazy	25	7	3	3				85
20	Kasib Sofouk Al-Jazy	80	30	10	10				80
21	Ganim (Farah)	73	60	13					115
22	Abdul Hameed Al-Hashlamoony (small)	45		35	10				100
23	Al-Jabra Co-operative	110	25		15				150

Al Jafr area

The Jafr basin is a desert area that has no surface water resources. Present groundwater use in the basin is 4Mm^3/year for domestic and 18Mm^3/year for agriculture (JICA 2001 and WAJ information). As the safe yield of groundwater is estimated to be around 14Mm^3/year, the overdraft is 8Mm^3/year (1989-91 data).

In 1964 groundwater was developed in the Al Jafr area to provide water for both domestic and agricultural uses. The shallow Rijam (B4) aquifer was exploited using wells up to 50m deep. Prior to 1967, abstractions were just over 1Mm^3/year. In 1990, five boreholes were used to withdraw 2Mm^3/year. Each borehole abstracted between 864 and 3629m^3/d with an average of 2400m^3/d. Water levels monitored since 1964 show water level decline 0.1m/yr to 0.36m/yr in those 16 to 22 years, corresponding to a fall of water level in the 10 to 20 years of 2 to 7 metres.

Figure B13 Jafer Observation wells



Based on the record supplied from MWI for Jafer Observation well 2 (G3082) for the period 1988 to 2003 the decline between 1988 to 1997 was 0.5metre and then until 2003 was a further 3 metres (Figure B13). This response indicates that the average annual abstraction exceeds the natural recharge.

Two wells, Jafr 29 (G3020) 50metres deep and pumping from the B4 aquifer and Jafr 30 (G3175) 60 metres deep and pumping from the B2/A7 aquifer, supply domestic water to the town of Al Jafr.

It is reported that the pumps run for 17hours per day in winter and 22hours per day in the summer. The water is pumped to an overhead storage tank (capacity of 55m^3) and delivered to 400 connections that are fitted with water meters.

Five boreholes (Jafr 17, 18, 19, 20 and 23) supply the Government Ministry of Agriculture (MoA) farm of 250 hectares. Jafr 18 is reported now to be used by the ostrich farm within the farm area. The recorded abstraction for the period 1994 to 2001, based on the MWI Data Bank, varied between 0.55 and 1.15Mm^3/year.

Within a 5km radius of the farm there are forty-six wells abstracting groundwater either from the B4 or B2/A7 aquifer. The net effect of this abstraction is a lowering of the water level.

B5.3 The Poor and Vulnerable

B5.3.1 Surveys undertaken

Survey areas were selected in Shoubak and Al Jafr for Focus Group Discussions (FGDs) to include:

- a minimum of 10 separately representative households per Focus Group;
- as equal as possible a proportion of male and female respondents (more female participants were included in Domestic Water FGDs, and more male in Agricultural FGDs).

There was difficulty in obtaining a minimum of 10 representative households in each group. It proved impossible to interview poorest households in Al Shoubak[41]. However, an employment survey recently carried out by the Household Surveys Directorate[42], indicates that 10% of the population of Ma'an earns less than JD100 per month, while 68% earns between JD100-200 per month. Respondents from this income category were well represented in Shoubak. Respondents from all socio-economic levels were included in FGDs in Al Jafr.

FGD selection criteria included areas where populations are dependent on groundwater for both domestic and agricultural use (all fieldwork sites were rural). In Shoubak, five locations were selected based on the following criteria:

- locations experiencing water stress;
- settled communities, with livelihoods depending partly or wholly on agriculture;
- domestic water users;
- a range of socio-economic levels, representing low, middle and high income households;
- formerly nomadic communities, now settled.

One FGD was sited in Udruh sub-district, also dependent on the Shoubak aquifer. In addition, separate interviews were conducted with large agricultural investors in Shoubak, owning substantial fruit and vegetable farms.

[41] *Communities were often reluctant to co-operate without some material benefit to themselves through a subsequent project.*

[42] *Employment and unemployment Survey 2003: Annual Report, Household Surveys Directorate, January 2004, Table 7.2, p. 121*

The FGDs in Al Jafr were all conducted in or close to the town. One hundred households were represented in the FGDs (63 domestic, 37 agricultural), overall average household size is 8 persons (7 in Al Shoubak, 9 in Al Jafr).

Population density is low in Ma'an Governorate, with less than three persons per square kilometre. This reflects the limitations of natural and economic resources in the area. In the survey area, population distribution is characterised by division of clans belonging to different tribes. The Hawettat tribe is dominant in Al Jafr, with its main clans of Al Tawaiha, Al Damanieh, Al Nawasra, Al Ftinah and Al Darawsheh. In survey locations in Al Shoubak, the Al Jazy clan (also from the Hawettat tribe and originally from Al Jafr area, but settled in Shoubak) was the only settled Bedouin community interviewed. Other communities included Al Zubariyah – Al Habahbieh; Al Juhaier – Al Tawara; Al Baq'a – Al Qunmieen; Bir al Dabagat – Al Amareen.

B5.3.2 Poverty in the survey areas

Substantial work has been undertaken in Jordan on defining poverty and developing poverty alleviation strategies. Jordan compares well with other countries over income levels and GDP per capita, despite having the highest population growth rate in the Middle East[43] . According to a Report published in 2000[44], poverty is not so much due to unemployment as to low income resulting from low participation in the labour force and low wage levels in the Kingdom. Poverty levels are taken from 1999 World Bank definition of JD313.50 per person per year. Based on this criterion, approximately 21% of the population of Ma'an is estimated to live below the poverty line. This compares with an overall estimate of 11% for the Kingdom of Jordan as a whole, making Ma'an the governorate with the second highest poverty concentration in Jordan and the lowest Human Development Index.

Local perceptions of poverty in Shoubak and Al Jafr were sought through a rapid wealth ranking exercise, which provided community criteria of socio-economic differences. The official national poverty line is taken as income of JD156 or less per month for a family of five persons. Communities rated it as slightly lower at JD120 or less per month.

National and regional poverty alleviation strategies focus heavily on providing statutory services (education, domestic water supply, health facilities) as well as on targeting employment opportunities. Coupled with a recently begun process of administrative devolution from Central to Governorate level, the intention is to encourage people to remain living and working in the regions rather than migrate to Amman.

Poverty is characteristically higher among households in rural areas, among households with large numbers of children and among households with low educational levels. Female-headed households are particularly prone to low income and poverty, especially as there are strong cultural restrictions to obtaining paid work outside the home. In Al Jafr, poverty is also seen as caused by[45]:

[43] *Poverty Alleviation for a Stronger Jordan: A Comprehensive National Strategy*, Jordan Poverty Alleviation Program, Ministry of Social Development, The Hashemite Kingdom of Jordan, May 2002

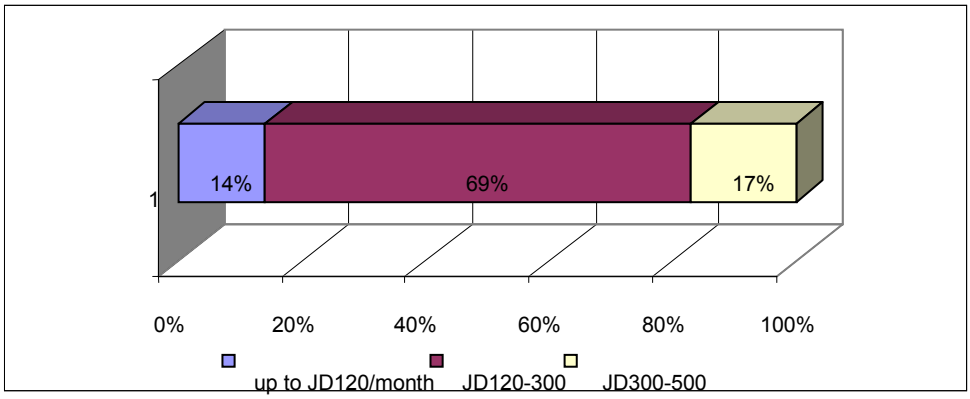
[44] USAID, *Poverty Levels in Jordan*

[45] Participatory Rapid Appraisal, Al Jafr Department of Social Development, 2003

- loss of pasture and decrease in animal resources
- high cost of fodder
- having many wives and large families
- refusal to accept certain types of work (e.g. agricultural labouring)
- comparative remoteness of the area, leading to high transportation costs

Income classifications of FGD households are shown in Figure B14.

Figure B14 Representative income categories, FGD respondent households



B5.3.3 Domestic water use

All households in Shoubak and Jafr rely on piped water to the house supplied from a well belonging to the Water Authority of Jordan (WAJ). In Al Zubayriya, management of the well has been taken over by a society composed of village members. 10% of respondents in this village also purchase bottled water, particularly for young children or in times of illness. In Al Jafr, 40% of respondent households in the FGD representing low income households estimate they need to take water from neighbours during the summer. Approximately 17% of poor households in Shoubak take water from neighbours.

Domestic water is commonly used to irrigate home gardens (On average, each household has 0.85 dunums of home garden, with rich households having an average of 1.39 dunums). Gardens are important features of women's livelihoods in which they cultivate vegetables, herbs, grapes, and a few fruit trees (apples, apricots and olives), as well as raising livestock such as chickens and a few goats. No-one uses rooftop rainwater harvesting methods.

All respondents in Al Jafr said there is no problem of water security either in winter or summer. Some poorer households have difficulties in summer when water is pumped alternate days. This is because they cannot afford storage facilities, and must take from their neighbours. However, all agreed this posed no difficulty as neighbours were always willing to assist.

In Shoubak, the seasonal picture is somewhat different. In winter, three of the four FGD locations receive water 2-3 times a week. In summer the situation is more acute; Al Baq'a, which normally receives water daily in winter, receives it 2-3 times a week, while Juhaier receives it weekly, and Bir el Dabagat once every 2 weeks.

Adequate access to water for the poor appears to be guaranteed, even if it is in smaller amounts. Community co-operation is strong in both Shoubak and Al Jafr with neighbours willing to allow access to their supply.

Sixty-two percent of the households interviewed own water storage facilities. No-one could tell how much water they used as everyone rushes to fill tanks and irrigate gardens as freely as possible when the water is flowing. Households estimated an average of 25% of their domestic water use goes to irrigate the garden.

All FGDs in Shoubak reported the quantity of water piped to the house has increased in the past 3 years. The opposite is the case in Al Jafr, where all FGDs reported the amount has decreased.

The principal difficulty associated with groundwater has been health. All FGDs, without exception, reported health problems associated with the quality of water, including diarrhoea, problems with teeth and gums, skin problems, kidney and ear infections. In Al Jafr, women reported incidences of miscarriage due to carrying heavy water loads. All complained that the water is very hard, leading to higher purchases of soap and detergents.

Costs

Costs vary depending on whether a water supply is managed by a village society or by the water authorities. Summer bills are some 59% higher than winter bills.

Table B5.3 Water expenditure (figures rounded)

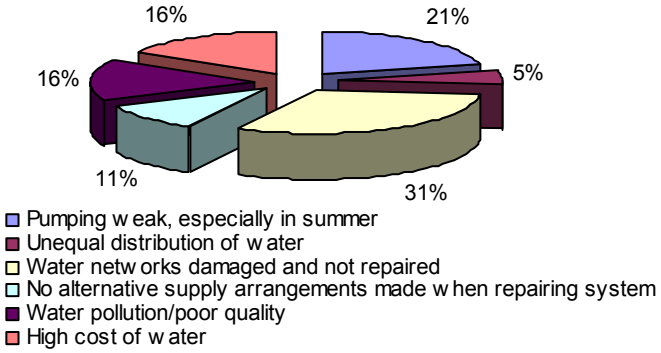
Income and expenditure	Low income	Middle income	High income
Average monthly HH income	JD120	JD120-300	Over JD300
Average monthly HH expenditure on water	JD6	JD11	JD6
% monthly disposable income spent on water costs	5%	5%	2%

With the exception of one household, all FGD respondents said they could afford to pay connection charges. Almost all households could afford to pay their water bills.

Conflicts

All FGDs confirmed there has been conflict over water. 57% of FGDs reported conflict between neighbours concerning distribution and equity of water, while all focus groups reported conflict between communities and water authorities. One FGD indicated that there had been problems between landlord and tenant in allocating water costs for shared facilities. Figure B11 shows the relative importance placed by focus groups on types of water-related problem.

Figure B15 Type of water problems important to FGDs



Most households attempt to resolve water difficulties by complaining through local leaders, or try and sort things out with each other. All FGDs pointed out their dependence on intermediaries to address their needs and willingness to bypass local water authorities go straight to higher authorities in Amman if need be. 57% of FGDs said they complained individually, 86% collectively.

Coping Strategies

85% of FGDs said that water difficulties have affected their livelihoods. For domestic water supplies, this has had a higher impact on women than on men, as the home garden is women's responsibility and one of the few ways in which they are able to earn some money. Livelihood impacts include:

- higher medication costs to treat water-related illness
- restriction on cultivating fruit and vegetables in the home garden and associated higher cost of purchasing fruit and vegetables
- increased gas expenditure to boil water
- higher cost in buying household items such as soap, shampoo, etc.

There is fortunately a strong sense of corporate community responsibility which provides a valuable and welcome safety net for poorer households. Some of the richer families lend animals to poorer families so they can use the milk. This is particularly important in Al Jafr, where livestock is an important feature of the local economy. In Shoubak, subsidised animal fodder is available from government outlets. Local shops also extend monthly credit.

In Al Jafr, the Social Development and National Aid Fund calculate they provide cash and occupational rehabilitation for about 27% of households[46].

The poorest families look to government employment and the army to obtain regular income. The most vulnerable are:

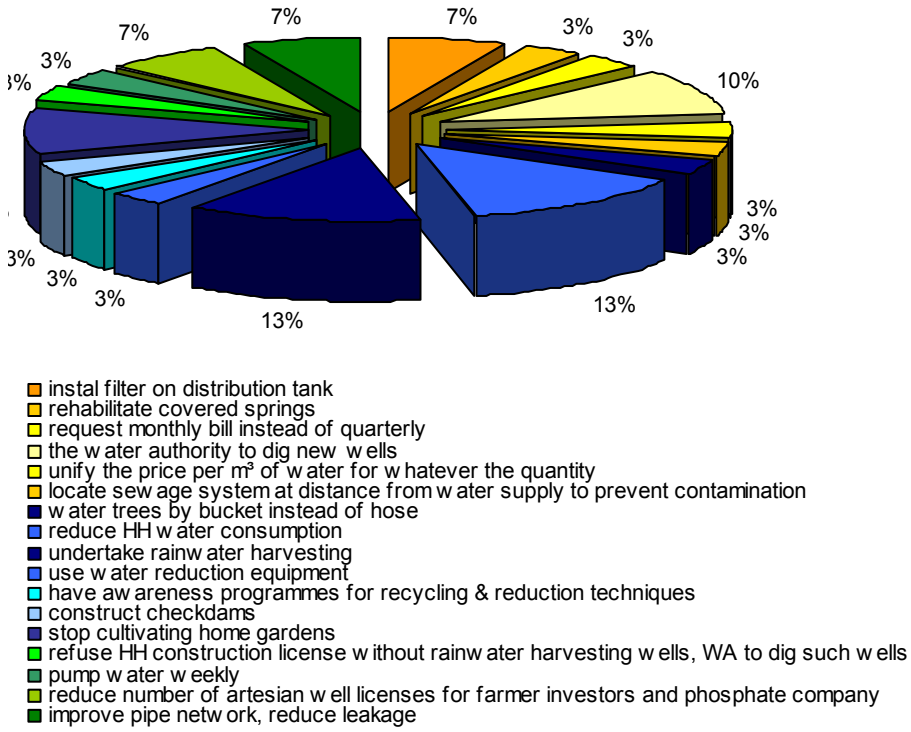
- women-headed households with no working male adults and several small children
- women of child-bearing age in households with no water storage facilities (burden of carrying heavy loads)

[46] Department of Social Development PRA, Al Jafr, 2003

- elderly people with no working adults
- families with little or no education and reduced work options

Vulnerability is also location-specific, with some areas such as Juhaier experiencing seasonal difficulties, while others such as Mansourah experience year-round problems.

Figure B16 Respondent attitudes to dealing with water quantity changes



Satisfaction Levels

For Al Jafr and Al Shoubak combined, 45% of FGD respondents were not satisfied with summer access to water, although 100% were satisfied with winter access. 71% were unsatisfied with the quality of water.

Dealing with Change

According to FGD respondents, the domestic supply situation has improved over the past three years. Figure B15 reflects the relative popularity of different suggestions by respondents on how to improve the water situation. These fell into approximately three categories:

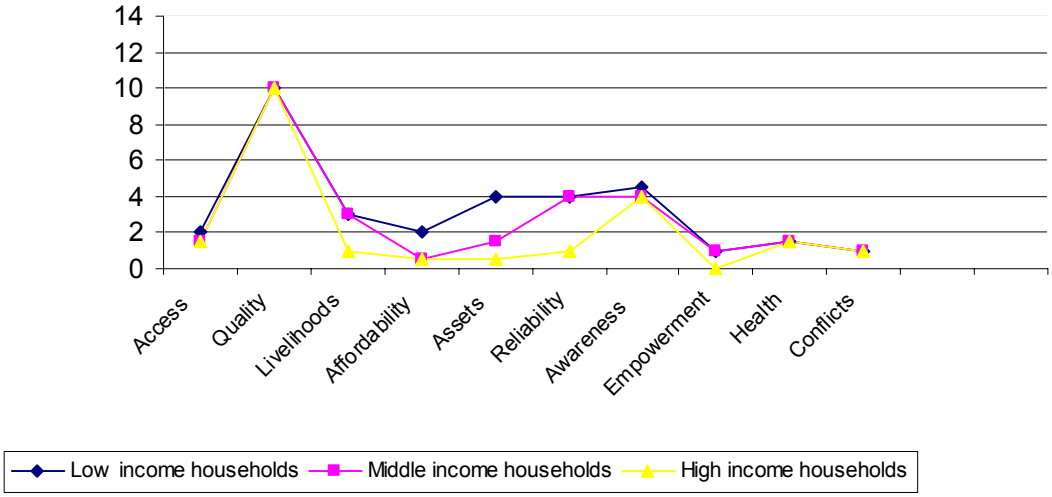
- actions reflecting low levels of awareness about causes of groundwater scarcity (yellow wedges)
- actions that could be undertaken by government (green wedges)
- actions that could be undertaken by the household (blue wedges)

B5.3.4 Vulnerability assessment, target groups identified

On the basis of the methodology described above, a test assessment of vulnerability was prepared for Al Jafr with different socio-economic categories of low, middle and high income households.

Using fieldwork data collected from Focus Group Discussions (FGD), an assessment of how respondents might have assigned values, was made. This resulted in the following vulnerability appraisal for Al Jafr.

Figure B17 Vulnerability assessment, Al Jafr



In Al Jafr, the vulnerability assessment shows far fewer impact differences between socio-economic groups. There is a reasonable standard of access for all households, and the fact that primary sources of livelihood are not water-dependent indicates a relatively low livelihood impact, though there are some differences between rich households compared to middle and low-income families. The greatest impact differences are to be seen in levels of asset ownership (e.g. water storage tanks), where rich and middle-income households are less affected than low-income households, and supply reliability, where rich households are less affected than middle and low-income households.

Location-related vulnerability is also apparent, with all income groups being equally affected by poor water quality.

B5.3.5 Agricultural water use

In the five FGD locations in Al Jafr and Al Shoubak, approximately 33% own land. Of the 37 respondent households in the FGDs cultivating land, landholdings averaged 16.5ha per household. However, sizes vary widely, with the smallest landholding being 0.5 ha and the largest 150 ha. Landholdings among high income households in Al Jafr are particularly large.

Livestock, particularly sheep, are an important part of the domestic economy. Sheep and goats are important for women's income, as are home gardens attached to the house. In

Shoubak, there are, in addition, 23 large specialised farms principally producing apples, apricots and other stone fruits and some vegetables (see above).

The FGDs were undertaken in areas outside these large fruit farms and details below refer to FGD respondents living and working outside these farms.

Diversification of Sources

The main sources of irrigation water are: (i) farmer-owned wells, (ii) wells belonging to a society or co-operative, (iii) wells belonging to the water authority in Shoubak, (iv) wells belonging to the Ministry of Agriculture in Al Jafr, and (v) natural springs in Shoubak. Farmers may use more than one water source.

Farmers in Al Jafr and Shoubak demonstrated different levels of familiarity and use of water saving techniques.

In Shoubak, non-Bedouin farmers have been settled agriculturalists for generations, and are familiar with making the most of what little moisture they have and practise drip irrigation and mulching.

Water Security

In Shoubak, there were few complaints from farmers about water security. Farmers noted, however, that some springs have dried up and water levels overall have fallen. All Focus Groups agreed the quality is very good. Most farmers depend on rainfed agriculture in the winter and on wells in the summer. Farmers will admit to one or two licensed artesian wells on their land, but all acknowledged that a far higher number of unlicensed wells are used in reality.

Figure B18 Small and large farms, Shoubak

In Al Jafr, farmers saw no change in quantity, but significant worsening of water quality with higher levels of salinity. There was no seasonal difference in quality in any of the fieldwork locations.

All farmers are well aware of the impact that extensive and unregulated extraction by the large fruit farms in Shoubak and by the phosphate company in Al Jafr, is having on their water sources. However, this does not necessarily stop farmers from continuing to pump water for their own purpose, quite extensively in some instances.

Not everyone could specify differences in well depths, but all Shoubak FGDs confirmed deepening their wells in the last five years. Respondents in Al Jafr reported that there are 74 private working wells.

Conflicts

60% of FGDs reported conflicts over water. Of these, 40% were between farmers and water authorities and 60% between farmers.

Grievances with water authorities focused entirely on water pricing. However, at the time of fieldwork it was announced that the Council of Ministers amended the regulation governing the use of groundwater in the country, reducing the price of water extracted from licensed wells from JD0.25/m³ to JD0.05/m³.

Disagreements between farmers were principally over the amount of water taken by an individual, the water schedule, and the tail end of the distribution network suffering from low pressure (Al Zubayriya, Al Jarba).

Coping Strategies

Both Shoubak and Al Jafr have always been arid and water-poor areas. Farmers are accustomed to adopting coping strategies, particularly in years of periodic drought. 60% acknowledged water problems have affected their livelihoods. Three principal coping strategies were identified, the most popular option being to reduce the cultivated area (50%), followed by decreasing the amount of water given to trees or to quit agricultural altogether and seek other forms of income generation (25% respectively).

Livelihood impact for farmers appears to be limited, though all farmers would like to cultivate more land than they are currently able to do. All respondents said agriculture is not the main or most important source of household income. Most households depend primarily on income from a salaried family member, or from government support.

Satisfaction Levels

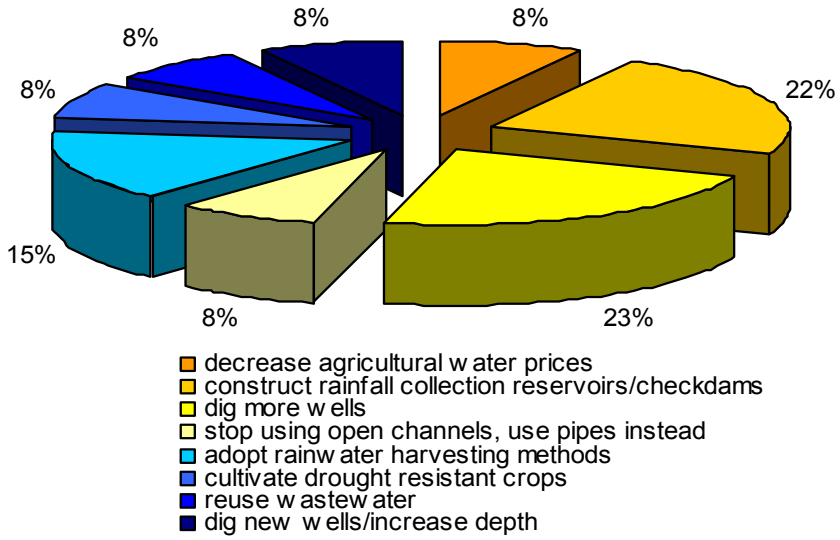
Satisfaction levels are fairly high for all categories. Those not satisfied with the quantity are mainly those accessing water from a co-operative or Ministry of Agriculture wells.

Dealing with Change

There has been little change in Shoubak and Al Jafr, and most farmers feel it is the government's responsibility to sort out their water problems. Although there are high levels of awareness of the impact of large-scale water extractors from both aquifers, the main response appears to be a desire to do the same. Attitudes towards aquifer use reflect short-term thinking, and there are very low levels of awareness about aquifer capacities and how it will affect them in both the immediate future and long-term.

When asked about water supply levels and standards remaining the same or becoming worse, responses reflected actions which could be undertaken at community level (blue wedges) and at government level (yellow wedges). Farmers consider the responsibility is more that of government than that of farmers.

Figure B18 Respondent attitudes to dealing with groundwater situation (% of FGD responses)



B5.4 Demand Management Options

B5.4.1 Current management strategies

Water resources development in Jordan has received considerable attention during the last five years and, at a national level, a countrywide demand management approach has been considered. The flow diagram below shows the approach that has been taken within the Water Resources Management Master Plan (2001). The demand for water for domestic and industrial use is given priority and currently the demand for agricultural water from groundwater sources exceeds the renewable resource.

The flow diagram shows the basic steps that have been adopted in arriving at the Water Resources Management Plan and the context within which it has been developed. Many of the measures described in Annex C are included (e.g. allocation to sectors, measures for reduction of groundwater abstraction, improvement measures for unaccounted for water, institutional and legislative improvement), and there are lessons to be learnt from the approach adopted. However, some development of the process employed is required to provide a logical strategy which could be made more generally applicable to regions where there is a shortage of resources. The particular applications to the Case Study area of Al Jafr-Shoubak are discussed below.

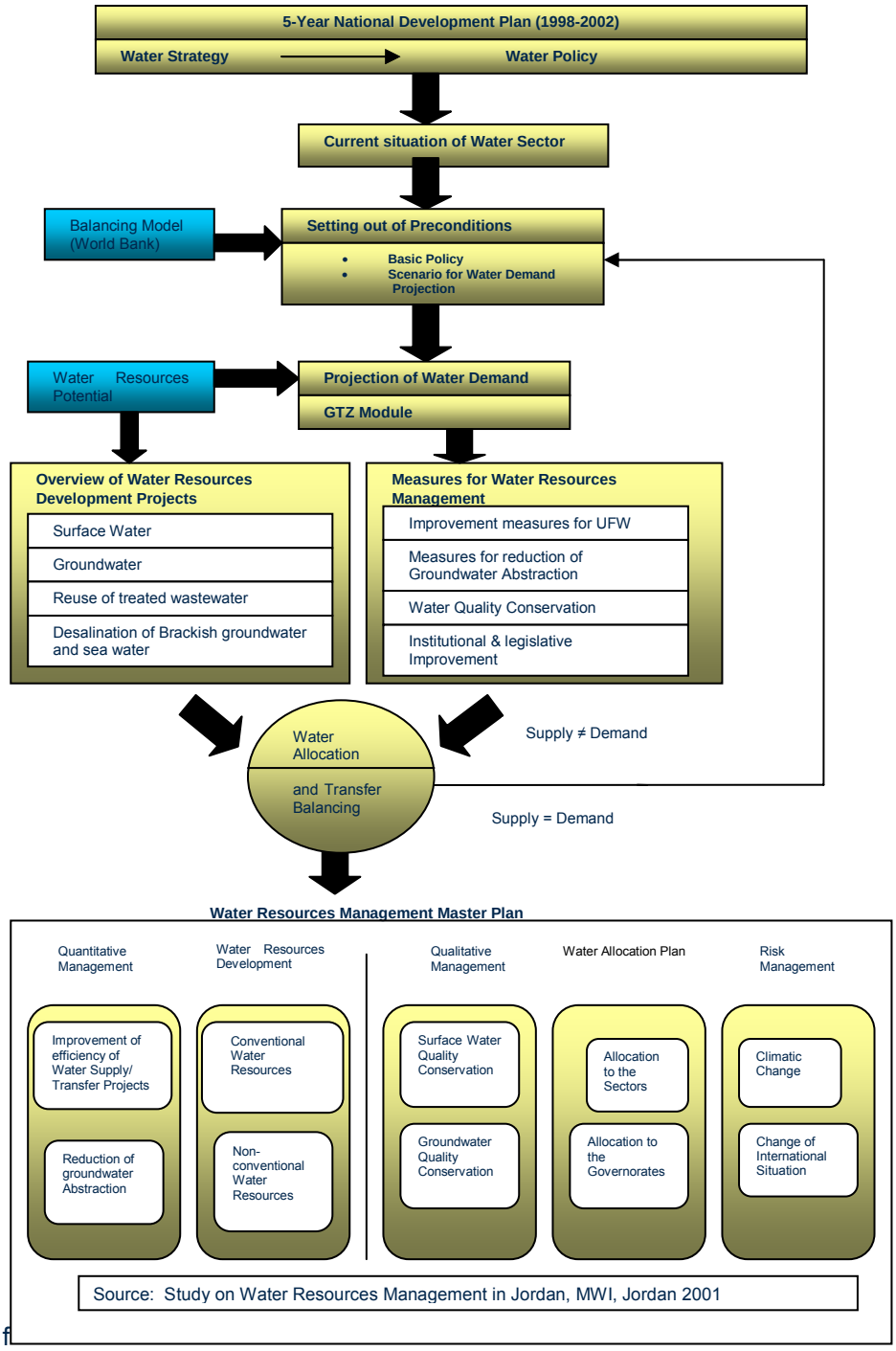


Figure B19 Steps in developing Water Resources Management Plan - Jordan

Water supply

A range of supply options have been considered by the Jordanian Government to provide sufficient water for the Ash Shoubak and Al Jafr areas but a number of issues arise with regard to the water supply for domestic and industrial use and provision of water for agriculture in the area. These include: unreliability of rainfall (and lack of rainfall in the mostly semi-arid and arid region); over-abstraction from the aquifer, falling groundwater

levels and increased salinity; and competition for water between agriculture and the Water Authority of Jordan.

Water demand management

The Jordanian Water Resources Management Master Plan (2001) addresses water demand management issues. The principal policy thrust has been given to measures for reducing irrigation water consumption and to reducing consumption for Municipal, Industrial and Tourism (MIT) uses.

Many of the measures, discussed above, are included in the MWI's approach (e.g. allocation to sectors, measures for reduction of groundwater abstraction, improvement measures for unaccounted for water, institutional and legislative improvement), and there are lessons to be learnt from the approach adopted. Further development of this process is required to provide a logical strategy which could be made more generally applicable to regions where there is a shortage of resources.

Although the range of supply options discussed above have been considered by the Jordanian Government to provide sufficient water for the Shoubak and Al Jafr areas, a number of issues arise with regard to the water supply for domestic and industrial use and provision of water for agriculture in the area. These include:

- unreliability of rainfall (and lack of rainfall in the mostly semi-arid and arid region)
- over-abstraction from the aquifer, falling groundwater levels and increased salinity
- competition for water between agriculture and the Water Authority of Jordan

These have to be seen in the context of the The Jordanian Water Resources Management Master Plan (2001). The principal policy thrust has been given to measures for reducing irrigation water consumption and to reducing consumption for Municipal, Industrial and Tourism (MIT) uses.

The aquifers in Shoubak and Al Jafr are both being over-exploited with deterioration of water quality in Al Jafr.

In Shoubak, controls on abstraction are required in the agricultural sector (particularly in the area of the large fruit farms where the abstractions are currently unsustainable). In Al Jafr, the abstractions for agriculture are again having an impact on the aquifer water levels and the quality of the water being abstracted is deteriorating having an effect on the abstraction for domestic water supply.

The range of demand management options for the domestic, industrial and agricultural sectors are given in Table B5.4.

Further examination of options is required for the two areas but a first step is to determine more accurately the sustainable yields of the aquifers and agree on sectoral allocations.

The areas shaded thus: 

indicate measures which are applicable but which need further consideration.

Table B5.4 Water demand management options – Al Jafr-Shoubak

	WATER DEMAND MANAGEMENT			
	Domestic/municipal		Agriculture	
Developmental and technical measures	DT 1	Reduce consumer water losses	AT1	Improve efficiency of surface irrigation systems (Al Jafr MoA farm)
	DT 2	Water saving devices and fittings	AT2	Introduce sprinkler/drip systems a) with subsidy b) without subsidy
	DT 3	Recycling of industrial water		
	DT 4	Use of "grey water"		
Distributive, financial and market based measures	DA 1	Inter-sectoral water quotas and allocations	AA 1	Inter-sectoral water quotas and allocations
	DA 2	Intra-sectoral water quotas and allocations	AA 2	Intra-sectoral water quotas and allocations
			AA 3	Change land use by: a) land purchase b) re-zoning/classification c) well buy-outs (transfer of water rights)
			AA 4	Crop area prohibition
			AA 5	Change cropping patterns by: a) extension b) tax c) market support
			AA 6	Introduce water markets
	DA 3	Water tariff: a) progressive b) differential	AA 7	Water tariffs: a) volumetric b) on power to pumps c) area based
Other socio-economic measures	DS 1	Community level management	AS 1	Water users associations
	DS 2	Population distribution	AS 2	Population distribution
	DS 3	Migration	AS 3	Emigration

B5.5 Impact of Demand Management Options

B5.5.1 Introduction

The studies in Shoubak and Al Jafr have demonstrated different characteristics and a range of water supply and management issues.

The principal issues relate to the over-abstraction of water from the aquifers: (i) in Shoubak where the fruit farmers are abstracting more than the renewable resource in this area; and (ii) in Al Jafr where there is a less obvious but significant drop in the water table and a deterioration of the quality of the water for both domestic and irrigation water supply.

Further work is required to confirm the current abstractions form these aquifers and to determine appropriate demand management options which would be effective in rendering the aquifers sustainable and their impact.

B5.5.2 Water provision, savings and unit costs of water saved

Some preliminary cost estimates of components of a number of water supply options, based on data made available in Jordan, are given in Table B5.5. These costs are based on schemes that have been studied or implemented in Jordan and are not all relevant to the Case Study areas.

Table B5.5 Cost of components of water produced (JD/m^3)

Option	Description	Cost of Water (JD/m^3)	Water made available at
SD1/SA1	Develop additional GW	0.07-0.09	at wellhead
	Develop additional surface	2.60	at dam outlet
SD2	Desalination	0.70-1.40	at plant
SD4	New water treatment facilities		
SD5	Extend water distribution system	0.66	at consumer (transfer to Ma'an and distribution)
SD7/SA3	Retention dams and reservoirs	2.60	at dam outlet
SD8/SA4	Aquifer recharge (dam)	0.084	in aquifer
SD11/SA7	Trans basin water transfer	0.476-1.155	Amman from Jordan river, from Lebanon
SA2	Treat/use wastewater	0.364	at treatment plant

Where demand management measures are introduced, there is a cost in so doing and, where agriculture is curtailed, an amount saved per hectare of land can be estimated. The table below gives some initial estimates of the cost of water saved and potential savings per hectare for a number of demand management measures which could be adopted in the Case Study area.

Table B5.6 Cost of components of water saved (JDs/m^3)

Option	Measure	Cost of water saved (Rs/m^3)	Quantity of water saved (m^3/ha)	Water made available at
DT1	Reduce consumer loss	0.22-0.25		at supply
DT2	Recycling of industry water	0.364		at plant
AR3	Change land use	0.02-0.77	3,500-8,000	aquifer
AR4	Crop area restriction	0.02-0.77	3,500-8,000	aquifer
AR5	Change cropping pattern			aquifer

PART II – MADANAPALLE, ANDHRA PRADESH

B6. INTRODUCTION

During 2005, further studies were undertaken by the Consultants in India to gather further data on areas where groundwater was being over-exploited. Three areas, in particular, were visited and data collected. These were at Pondicherry, and at Rayachotty and Madanapalle in Andhra Pradesh.

The data from Madanapalle was brought together by VRV Consultants, Chennai and the local government officers from Andhra Pradesh and was discussed at the Workshop held in New Delhi in November 2005.

A report on the Madanapalle study area is given below in Section B7 and notes on the outcome of the Workshop discussions are given in Section B8.

B7. MADANAPALLE STUDY AREA

The following section presents evidence of the severe shortage of water in the Madanapalle urban area and suggests solutions to address the shortage.

B7.1 Background to the Madanapalle Study Area

Madanapalle Town is located between East longitude 78^{o} 29'20" – 78^{o} 31' 00" and latitude 13^{o} 24'00" – 13^{o} 32'32" and is shown on Survey of India topography sheets 57 K/6 and K/10.

Madanapalle was built in 1618 AD by Sri. Ahobila Naidu. It was constituted as a Municipality from 1st April 1961. The town covers an area of 14.2 km^{2} comprising three Revenue villages namely, Kammapalle, Bandamida and Kammapalle, Madanapalle urban area and three hamlets of Ponnetipalem village, Sugalithanda, Nakkala Dinne. The town is an urban centre for a region covering about 175 villages that depend on it for marketing their agricultural produce (tomatoes, sericulture and groundnuts) and the sale and purchase of consumer needs. The Municipality has 17 Revenue wards divided into 35 election wards with 32 notified poor settlements and 10 non notified poor settlements. The recorded population of the town is 107,449 (2001 census) with the present population estimated at 115,000.

Madanapalle Municipality falls in Chittoor District, which is one of the four drought prone districts of Rayalaseema region.

Topography

The area has undulating topography with a general slope towards the east with an altitude of around 670m above mean sea level (amsl). The Municipality is surrounded by Basinikonda Hillock (861m amsl) to the east, Madanakonda reserve forest (954m amsl) in the south, Mallaiah konda (1010m amsl) in the south west and a rocky extension of reserved forest at 1083m amsl in the west.

Climate

The climate of the area is hot and semi-arid for most of the year, especially in the month of May, with mean maximum temperature of 40°C, a mean minimum of 24°C and mean of 30°C, while December is the coldest month. The area receives an average rainfall of 650mm. The rainfall is less during the early months of every year and it is generally more during June and December. The area has a water deficit during most of the year.

Table B7.1 Annual Rainfall 2000 to 2005

Year	Actual rainfall (mm)
2000	751
2001	668.5
2002	651.2
2003	173
2004	411.4
2005 (January to October)	912

Drainage

The drainage pattern of the area is sub-dendritic with streams originating from the hills flowing towards the municipal area, joining near Ankisettipalle and then flowing east as the Bahuda and Thettuvanka Rivers.

There used to be large quantities of ground water in sandy alluvium beds in and adjacent to the rivers and several buried valleys. Due to the over exploitation of ground water the shallow ground water in these riverbeds is almost fully exhausted. Entry of untreated sewage into these rivers has led to extensive pollution of surface and ground water bodies.

Soils

The predominant soils in the area are red soils and alluvium in the stream courses.

Geomorphology

The land forms identified in the study area are Pediplain shallow (PPS), Residual hills Pediment zone and Pediment inselberg complex (PIC).

Geology

The area is underlain by granites of Archean age, which are intruded by dolerite dykes trending in a NE-SW direction. The granites are weathered and the weathered zone extends to a depth of 20m. They are also intruded by quartz veins which are fractured. The fractured zones occur to a depth of 60m. The important rock types are granite, biotite granite, gneiss, hornblende granite gneiss. The country rock is intruded by quartz, dolerite and gabbro. In places pegmatites and quartz – feldspathic veins are also found.

Alluvium and talus are the sub-recent to recent formations present along the Bahuda River and along the Mugguralla Vanka and Allivanka. The general thickness varies from 10m to 15m.

Hydrogeology

Ground water in the area occurs under water table and semi confined conditions. The weathered zone aquifer is dry and the fracture zone aquifer, which occurs up to 300m depth is tapped by the bore wells. There are 249 bore wells in the area between 120m and 320m depth. The principal water bearing horizons of bore wells are found at the following depths:

- Allivanka area - Water can be tapped from 185m to 215m
- SBI Colony area- Water can be tapped from 85m to 215m
- Vempalle Head water works - Water can be tapped from 55m to 215m
- Rami Reddy Lay out - Water can be tapped from 20m to 185m
- Mugguralla Vanka - Water can be tapped from 55m to 215m
- D. S.P. Bangla area - Water can be tapped from 105m to 215m
- Pedda Thopu - Water can be tapped from 75m to 120m
- P & T Colony area - Water can be tapped from 140m to 230m
- Indira Nagar - Water can be tapped from 135m to 185m
- Gottigani Cheruvu - Water can be tapped from 105m to 305m
- Reddeppa Naidu Colony - Water can be tapped from 140m to 185m

B7.2 Socio-Economic Conditions

For three decades this area has been witnessing a high growth of industrial and commercial activities and as a result industries such as Clean-Foods, Spinning Mill, Silk, hand looms and power looms are established here.

Due to a number of encouraging and supportive conditions the town continues to receive large number of migrants.

The area is also known as the Pensioners Paradise.

It has all the characteristics of a cosmopolitan city and is a centre for educational, health, commercial and entertainment facilities. It attracts a considerable floating population and is located close to Bangalore City.

B7.3 Water Supply

The Municipality supplies water from about 249 powered pumps, 154 hand pumps and from infiltration galleries. Due to the increase in population, decline in rainfall and over exploitation of available water sources ground water level falls have become inevitable and result in the failure of bore wells during the summer season. There is an acute drinking water problem prevailing in Madanapalle town. There are no perennial water sources within 100km radius of Mandapalle town. The main source of water supply is ground water. The ground water level is more than 260m deep at present, due to the acute shortage of rain fall over the last six years. As a result, only 90 out of 153 hand pumps and only 67 out of 249 powered bore wells are providing the drinking water needs of the urban population.

The Municipality is not in a position to supply water through pipelines to the entire population. A piped water supply is being provided to about 15,000 of the 115,000 population.

To meet the water needs of the population of the Madanapalle, the Municipality has provided tankers to supply drinking water to 35 habitations with arrangements made with private irrigation bore wells located in surrounding villages.

Water Supply Sources

The current water supply is nominally provided by the following sources

Table B7.2 Water Supply Sources

Sl. No	Source	Water supply position during	
		Normal Season	Summer season
1	Vempalle Head water works	1.36 MLD	0.45 MLD
2	Hand pumps	0.64 MLD	0.55 MLD
3	Powered Bore wells	8.00 MLD	3.29 MLD
	Total	10.00 MLD	4.29 MLD

Present water supply situation

1. Water supply through the headworks and seven OHSRs : 4.40 MLD
2. Transportation of water through tankers : 0.54 MLD
3. Hand pumps : 0.54 MLD

TOTAL : 5.48 MLD

The town area is divided in to three zones and water is supplied two days a week to each of the zones.

Present water demand

For a population of more than 107,500 in 2001, the daily demand and anticipated consumption is 14 Ml/d but under normal conditions only 10 Ml/d is supplied, leaving a deficit of 4 Ml/d. In the summer the deficit is 9.71Ml/d.

Table B7.3 Water Demands

	Year	Population	Water Requirement @ 140 LPCD	Supply MLD		Deficit MLD	
				Normal	Summer	Normal	Summer
1	2001 Present	107,449	14.00 MLD	10.00	4.29	4.00	9.71
2	2016 Prospective	146,000	20.44 MLD	14.60	6.28	5.84	14.16
3	2031 Ultimate	199,000	27.68 MLD	19.90	8.55	7.96	19.31

B7.4 Reasons for the Water Shortage

Reasons for the present severity in water supply are considered to be:

- The town has not prepared well for the demand for water.
- Rainfall which was found to be sufficient in the past is not able to support the water demands of the present day population.
- There are no assured water resources in the form of permanent flowing rivers.
- The only source is ground water and ground water availability has decreased due to excessive exploitation and as a result the ground water table has sunk to much deeper levels.
- The area is in a rainfall shadow region.
- Irrigation cum percolation tanks at Gottigani, Cheruvu, Komativani and Cheruvu, are encroached upon and they have no inflow of water due to shortage of rainfall and development in their catchment areas.
- 16 surface water tanks surrounding Madanapalle town are totally neglected and fallen into disuse. They are not receiving any appreciable inflow of water. A couple of the tanks were breached in 1996 and remain unrepaired.
- The River Bahuda that passes through the town has remained dry for the past seven years, with maximum area being encroached upon.
- There are no proper water harvesting structures on the River Bahuda. The water flows down to the Bahuda project which is located 20km away. Similar is the case with Mugguralla vanka, another stream that joining Bahuda River.
- There has been migration of people to the Madanapalle town from surrounding rural habitations for a wide range of reasons.
- Deforestation in the catchment area has reduced the recharge potential to the aquifers.

B7.5 How the Government is Tackling the Water Shortage

98% of water needs are supposed to be met by the Municipality (Civic Body). The remaining 2 % is met by individuals, having their own in house water bore wells.

Due to the failure of the Municipal water sources, the Municipality is purchasing water from surrounding private agricultural bore wells located about 6 to 8km away. The purchased water is supplied through hired tankers. Even then, it is unable to supply an adequate quantity of water to the population.

The Madanapalle Municipality is

- Spending Rs. 120,000/- a day on water supply.
- Unable to meet the total demand requirement of 220,000 gallons.
- Able to supply the water once in 3 to 4 days only.
- Unable to supply water to meet needs satisfactorily.
- Sinking further bore wells and fixing hand pumps and motors for a few wells to make available some additional quantity.

Due to inadequacy in availability of water, the majority of the population is purchasing water from private suppliers.

B7.6 Problems Encountered

Government/Municipality

The Government and Municipality are experiencing the following problems:

- Availability of water even from private bore wells is on the decline.
- Proper accessibility to water sources is not satisfactory.
- Time taken to fill a tanker is increasing due to lessened flow from the source.
- Unscheduled power supply breakdowns.
- Irregularity in availability of hired tankers due to repairs and maintenance of the vehicles.
- Resistance from surrounding villagers for drilling or tapping of water by the Municipality.

Population

- Difficulty in getting an assured and regular supply of water.
- Exorbitant cost charged by private suppliers.
- Irregular timings, resulting in dislocation of daily work schedules.
- Scuffles among people while sharing free supply of water by Municipality.
- People are forced to purchase a pitcher of drinking water at a cost of Rs. 1.00.
- Due to impurity of water supply, the public are facing a variety of health problems.
- Even if one is prepared to spend money there is a lot of inconvenience.

B7.7 Suggestions / Solutions to Tackle the Water Problem

Considering all the available data, information and facts, the following suggestions / solutions are considered worth implementation.

- Construction of water harvesting structures around the base of surrounding hillocks like Basinikoda, Madana Konda, Kappa Konda, Anapa Gutta and Mallaiah Konda.
- Converting the surrounding 16 irrigation tanks as percolation tanks to recharge the aquifer.
- Individual rain water harvesting structures.
- Desiltation and construction of injection bored wells in near by tanks and in local streams.
- Measures to prevent evaporation of water.
    - Plantation to increase in green coverage of catchment areas.
- Construction of summer storage tank
- Arranging water transfer scheme from the Handri – Neeva canal.

The long term plans to augment water supply are as follows:

- Construction of soak pits
- Installation of filtration unit.
- Proper and regular repairs, replacement and maintenance of water pipe lines.
- Enforcement of regulations to prevent more drilling of deep bore wells.
- Regional water supply scheme.

B7.8 Conclusion

Proper planning, coordination and implementation of the suggested measures by all Government Departments is required. Provided that there is a clearly defined time schedule and with adequate funds at disposal, these measures will go a long way in providing sustainable water supply systems, that could withstand adverse conditions in the future.

Madanapalle town is experiencing an unprecedented shortage of water due to a variety of reasons:

- While the daily demand is for 220,000 gallons of water, only 105,000 gallons are supplied.
- Available municipal water supply sources are unable to supply water as expected.
- Private water sources are not dependable, they are considered to be irregular and exorbitantly priced.
- Levels of awareness and concern in the public about proper and optimum utilisation of available water are found to be lacking.

B8. MADANAPALLE

RELATED DISCUSSIONS ON APPLICATION OF WATER STRATEGY (WORKSHOP 20 NOVEMBER 2005 – AFTERNOON SESSION)

B8.1 Introductory Remarks

The purpose of the afternoon workshop was to present the results of studies of water resources and related socio-economic aspects of Mandanapalle and Rayachoty in Andhra Pradesh and of Pondicherry and then to apply the proposed Strategy Formulation methodology to one of these areas. In the event the Workshop was well represented by those with knowledge of the Madanapalle area and this was used as the test area in second part of the afternoon.

The Consultants presentations were based on the results of the studies undertaken in the period April to August 2005.

Dr. Visveswaran described how the three study areas (two in Andhra Pradesh and at Pondicherry) had been selected after a preliminary scan of areas where groundwater was being over-abstracted, which included aquifers in Rajasthan, Gujarat, Andhra Pradesh, Tamil Nadu and Kerala.

He presented the demographic and water resources aspects of the study areas.

Kandaswamy Barathan then presented the socio-economic aspects of the areas selected including the assessment of groups which were vulnerable to shortages of water, using the criteria identified by the Consultants from earlier studies. He presented a comparative assessment of the related water issues in these study areas.

Presentations were then made by Mr E.J. Manohar Lal, Municipal Water Supply Engineer, Madanapalle, Andhra Pradesh and Dr S Siddiraju, Environmental Promotion & Community Awareness Society, Madanapalle, Andhra Pradesh. Mr Manohar Lal described the status of water supply in Madanapalle. Dr Siddiraju presented some of the historical context and socio-economic conditions in the town. An shortened and edited version of these presentations is give in Section B7 above.

B8.2 Policy and Strategy Formulation – Application to Madanapalle:

In the second session it was decided to use Madanapalle to test the strategy framework developed by the Consultants. It was fully understood that in a real situation the process adopted would take many months and involve a wide range of stakeholders. However it proved to be useful exercise as Mr. Visweswaran, Mr. Manohar Lal and Dr. Siddharaju's extensive knowledge of the area provide sufficient background information for the pupose of the Workshop.

The following figures and tables:

- Policy Review and Strategy Development (Figure 5.1, Strategy Formulation Report)
- Water Demand Management Measures (Table 4.1, Strategy Formulation Report)
- Supporting and Enabling Measures (Table 4.2, Strategy Formulation Main Report)

- Water Supply and Augmentation Options (Table C1, Annex C, Strategy Formulation Report)
- Water Quality Improvement Options (Table C2, Annex C, Strategy Formulation Report)
- Water demand management measures – Evaluation process (Annex C, Strategy Formulation Report)

Although policy and strategy formulation is a lengthy process involving many stakeholders, the workshop participants examined the steps needed to develop policy objectives and formulate a strategy. The first step was to identify the development context and water policy objectives.

B8.3 Water Resources Policy Review

Legal and Institutional Context:

The main legal framework governing natural resources extraction in the state was the Andhra Pradesh Water, Land and Trees Act (WALTA) 2002. The various areas under the jurisdiction of the Act were listed.

The Rules for this Act have been formulated as recently as January 2005. So the Act is in the early stages of implementation. Although Government Agencies have been briefed regarding the rules, there is very little awareness in the general population. According to the Act, the Revenue Department headed by the District Collector is responsible for implementing the Act.

The institutional framework for the specific area viz. “Registration of Wells” covered by WALTA was discussed. The rules governing registration of wells specify the following procedures.

- No-objection certification needs to be obtained from Revenue Dept.
- Approval of electrical connection
- Insurance
- Geologists Feasibility Certificate (A geologist’s certificate certifying that the well will not harm the aquifer, after considering the hydrogeological conditions in the area, has to be obtained.

A consumer wishing to drill a well must apply to the Revenue Department with payment of a fee and insurance. The Act requires the Department to verify that well spacing norms have been adhered to. The norms are 160 m between private wells and 220 m between a Government borewell to private borewell.

Community and Stakeholders

Total population 100,000 (2001 Census) of which 27% are poor. The poor are spread over several villages and constitute landless labour, daily wage earners etc.

The rest of the 73,000 people typically work in small and medium industries (cotton weaving, sericulture, farmers, etc.) and pensioners.

There appears to be a significant retirement community in Madanapalle attributable to the pleasant climate.

The main Institutional Stakeholders are the Municipality and the Revenue Department.

Water Balance

Madanapalle is a highly drought prone area. Droughts are the norm. Surplus rainfall (floods) occurs only one in 8 years.

Although a piped water distribution system exists, it has been abandoned for many years because of poor rains. Tanker supply is the primary source of supply. 30- 40 l/c/d has been supplied to all income groups.

This year, because of the good rains, piped supply has been resumed. Currently, piped supply is being given every third day. The piped supply system is very leaky. The problem of lack of supply at the tail-end of the distribution system remains. The problem is compounded by the fact that the tail-end of the system comprises of hill slopes, populated by poor migrant labour. Two percent of households have their own borewells.

In the last years, there has been no supply to commercial businesses through the public supply system. Businesses have had to arrange private means of meeting their needs, typically borewells or private tankers purchasing water from agricultural wells. The cost of a tanker has been about Rs 350. Many farmers gave up cultivation and exclusively sold water during the drought. The aquifer used by farmers remains over-utilised.

Although the government has tried to curb growing of water intensive crops in this drought prone region, this has met with stiff resistance. Any such action by the government is likely to have a major impact as paddy however is a very labour intensive crop.

To augment supply to Madanapalle, the Government of Andhra Pradesh proposed a summer storage tank. However, this met with resistance as cultivable land would be submerged. Detailed land acquisition proposals have been made. Almost 80 percent of farmers have agreed to sell; the remaining 20 percent are still bargaining about the price.

There are a number of old tanks that could be used but these are no longer connected because of siltation. The main reason for these broken links is lack of maintenance.

Critical Issues identified

The following critical issues were identified

- Unsustainable Water Use Practices
- Attitudes of farmers (refusal to change crops)
- Lack of technical capacity

Policy Objectives

The next step was to identify key policy objectives faced by the population of Madanapalle. Mr. Manohar Lal and Dr. Siddharaju were asked to identify the key objectives. They identified these to be:

- Ensuring equal distribution of water
- Getting access to a more reliable (all-season) source of supply
- Stabilizing the groundwater table
- Improving the quality of water supply
- Regulating the quantity of supply
- Keeping agricultural livelihoods stable

B8.4 Water Strategy Development

The next step was to identify the appropriate measures for each policy objective from the matrix developed by the Consultants.

- Water Demand Management Measures
- Water Supply and Augmentation Options
- Water Quality Improvement Options
- Supporting and Enabling Measures

In the time available, it was possible to identify some of the supply, demand management and water quality improvement measures which would meet the policy objectives and to get an indication of costs for some of the proposed measures.

Policy Objective	Measure	Cost
Ensuring equal distribution of water	SD5: Improve/Extend the Distribution System (Infrastructure) SD6: Improve/Extend the Distribution System (Tankers) DT1: Reduce water losses	\$0.1/ m^3 \$0.5/ m^3
Getting access to a more reliable water source	SD 10: Rainwater harvesting SD 11: Interbasin transfers (e.g. HNSS canal from Krishna Basin)	
Stabilizing the groundwater table	A1:Inter-sectoral water quotas and allocations SD7: Retention dams and reservoirs SD8: Aquifer recharge SD 10: Rainwater harvesting	
Improving quality of water supply	QA1: Pollution control in agriculture QD2: Construction of sewage treatment plants QD5: Control landfills	
Regulating the quantity of supply	SD5: Improve/extend the water distribution system (metering) DA4:Water Tariffs	
Keeping agricultural production stable	AT1: Reduce losses from surface water irrigation systems AS1: Water User Associations AS3*: Migration *: Not necessarily desirable	

This exercise provided a trial of the first steps in the development of water strategy and in a "real life" situation could have led to use of the evaluation and comparison of alternative measures and their impact on poor and vulnerable sections of the community.

Substantial progress was achieved within a limited time frame substantiating the utility of the framework as a strategy tool. The exercise proved useful in identifying a range of options which could be considered for the area which included supply, water demand management and water quality improvement options and have helped the Consultants in refining the step-by-step process outlined in the Strategy Document.

WATER DEMAND MANAGEMENT
STRATEGY FORMULATION
FINAL REPORT
ANNEX C
WATER DEMAND MANAGEMENT AND WATER SUPPLY OPTIONS

FEBRUARY 2006

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ANNEX C - WATER DEMAND MANAGEMENT AND WATER SUPPLY OPTIONS

C1. INTRODUCTION

This Annex comprises two sections.

The first comprises: (i) a description of the methodology which allows a comparison to be made of alternative water demand management measures and the likelihood of their success and (ii) data sheets which can be used in evaluating water demand management options.

The second describes water supply and augmentation, and water quality improvement options, which should be considered alongside water demand management measures, when a water resources development strategy is being developed.

C2. WATER DEMAND MANAGEMENT MEASURES

C2.1 Introduction

Descriptions of a range of water demand management measures are given in this section. They are grouped together under the categories shown in the table below.

	Water demand management measure	
	Domestic/municipal water	**Agricultural water**
Developmental and technical measures	**DT** Physical changes to the infrastructure which reduce losses in the supply system, improved water use by consumers and re-cycling of water in industrial systems.	**AT** Physical changes to the irrigation infrastructure or introduction of more water efficient systems (drip or sprinkler systems) and improved water management which reduce water consumption.
Allocative, financial and market based measures	**DA** Re-allocation through inter-sectoral and intra-sectoral water quotas and allocations and through water tariffs	**AA** Re-allocation through inter-sectoral and intra-sectoral water quotas and allocations, land use and cropping pattern changes, water tariffs and water markets
Other socio-economic measures	**DS** Community level management of water and measures relating to population	**AS** Establishment of water users' associations to improve water management and measures relating to population
Supporting or enabling measures	**SD** Measures required in support of the implementation of those above (e.g. legislation, regulation, public awareness campaigns, mobilisation and institutional changes)	**SA** Measures required in support of the implementation of those above (e.g. legislation, regulation, improved extension services and institutional changes)

The measures are described in Data Sheets under a number of headings which may be used to define and compare the quality and impact of each measure:

- Description of measure
- Implementing agency or agencies
- Supporting measures which may be required
- Example of potential amount and unit cost of water saved or made available
- Subsidy and tax issues
- Potential impact (groups affected and impact on poor and vulnerable)
- Pre-conditions to implementation
- Likelihood of success

The Data Sheets provide a guide to typical measures that might be employed and are useful when a comparison of alternative water demand management measures is contemplated.

C2.2 Value and impact of water demand management measures

C2.2.1 General

Understanding the value and impact of alternative measures and the likelihood of their success is an important consideration when developing a water demand management strategy. There is no simple quantitative method to compare measures but an outline of a practical method for evaluating and comparing measures is given below.

In practice, both quantitative and qualitative evaluations of different aspects of a water demand management measure will be required. These will include an estimate of the economic, social and financial impacts of a measure but will inevitably rely, in part, on some subjective assessments of the potential effectiveness of the measure and its political efficacy.

The following are useful indicators which can be used to assess a measure. They have been selected as they are useful in evaluating any single measure proposed and can also be used to provide comparative quantitative data for alternative measures. The key indicators are:

- Potential amount of water per year saved or made available;
- Unit cost of water saved or made available (including subsidy and tax issues);
- Groups and number of persons affected;
- Impact of measure on groups and sub-groups (including the poor and vulnerable).

Examples of the first two of these indicators above are given in each of the attached Data Sheets and the calculation of these indicators are part of the basic data required before any measure can be considered.

Details of the different socio-economic groups or sub-groups affected, including those assessed as poor or vulnerable, are also essential data and these can usefully be recorded in a simple table. An example for doing this is given below.

This is an important determination as it defines the target populations and the groups on which the impact of the measure is to be evaluated.

Table C1 Groups affected by measure (example)

Type of group affected	Population in group	Number ranked poor in group	Group as % of total population	Poor as % of total population
Population of project area (including those affected and those unaffected by the proposed measure)	460,000			
Urban domestic water consumers	240,000	75,000	43	16
Rural domestic water consumers	42,000	35,000	9	8
Farmers and farm labour	8,300	6,500	2	1
Industry and industrial workers	20,000	3,500	4	<1
Government and commercial	45,000	2,500	10	<1
Other (to be described)				

Clear definition of the groups affected is an essential preliminary to the evaluation of the impact. With any water demand management measure there are likely to be "winners" and "losers" and these groups should be clearly identified. Where the measure is intended to redress an imbalance in water consumption between one group and another (e.g. improving access of the vulnerable), a detailed understanding of these groups or sub-groups is required so that the impacts may be assessed.

C2.2.2 Potential impact of measure on groups affected

The potential social and financial impacts of a water demand management measure on the groups or persons affected, however, can be difficult to assess and a suitable and practical methodology for doing this is required.

Social impact assessment - general

Six indicators of the social impact of a measure have found to be sufficient and complementary (see Annex A) and through which a water demand management measure can be shown to have a positive or negative impact, or to produce little or no change on the group concerned. The indicators are listed below:

- Access to water
- Quality of water

- Affecting livelihood
- Affordability
- Sense of empowerment
- Health

There may be a number of groups and sub-groups within each group, as outlined above, to be considered. A simple tabular assessment for a group or sub-group (as shown below and under Item 6.2 on the Data Sheet) is normally sufficient as a summary indication of the social impact. One of these summary tables is required for each group or sub-group affected by the proposed water demand management measure. However, assessing these indicators will normally require the views of the group affected and an understanding of its current status, as well as a supporting analysis from which to derive the Impact summary table for the group under assessment.

Impact summary (example)

Water demand management measure: DT4 Use of "grey water"

Group: Urban domestic water consumer (Population 20,000);

Sub-group: Poor/vulnerable; (Population 4,000)

Location: Ref. J 5

Indicator	**Potential impact on group**				
	Very positive	**Slightly positive**	**No change**	**Slightly negative**	**Very negative**
Access to water		**X**			
Quality of water				**X**	
Effect on livelihood	**X**				
Affordability			**X**		
Sense of empowerment	**X**				
Health			**X**		

Social Impact assessment - Supporting analysis

The supporting social analysis, on which the summary table above can be based, can be provided through assessment of the social indicators described below. Two sample tables are shown below, one which can be used for application to groups or sub-groups of domestic water consumers and the other to those in the agricultural sector.

Table applicable to domestic water consumers (Example)

Proposed water demand management measure: DT1 - Reduce water losses.

Group: Domestic water consumer (Population 240,000);

Sub-group: Poor/vulnerable; (Population 75,000)

Location: Ref. C12

SOCIAL INDICATOR	ASSESSMENT OF IMPACT ON SUB-GROUP	IMPACT			
		ALL	PARTIAL	NONE	N/A[+]
Access	Will the number of households with immediate and easy-to-reach access to domestic water supply increase? (% increase?)		✓ (45%)		
	Will the number of households with 24 hour access to domestic water supply increase? (% increase?)		✓ (5%)		
	Will there be an increased number of households with sufficient quantity of water (e.g. 60 lpcd) for daily domestic needs? (% increase?)		✓ (25%)		
	Number of households with increased availability of potable domestic water supply (% increase?)	✓			
	Number of households without any consequential reduction in water supply (%)	✓			
Quality	Number of households with overall improvement in quality of water made available (%)		✓ (20%)		
	Number of households with previous water quality constraints relieved completely of these (%)			✓	
Livelihoods	Number of households spending more than 30 minutes per day in domestic water collection(% decrease?)		✓ (50%)		
	Reduced amount of household budget spent on domestic water costs(% decrease?)	✓			
Affordability	Cost to households is within their capacity to pay	✓			
Empowerment	Community can manage the measure (%)			✓	
	Community self-reliant, not dependent on power-brokers for water		✓		
Health	Reduction in water-related diseases in households previously affected (% reduction)		✓ (50%)		
	Reduced expenditure on treating water-related diseases as a result of improved water quality (as % of budget previously allocated to water-related health treatment)		✓ (30%)		
	Improved nutrition, particularly of women, as more money available to spend on balanced diet		✓ (20%)		

Note: [+] **N/A** = Not applicable

Example of Table applicable to farmers and farm labour

Proposed water demand management measure: Change land use (by well buy-out and transfer of water rights)

Group: Farmers and farm labour (Population 8,300);

Sub-group: All (Population 8,300)

Location: Ref. A3

SOCIAL INDICATOR	ASSESSMENT OF IMPACT ON SUB-GROUP	IMPACT			
		ALL	PARTIAL	NONE	N/A
Access	Will the number of households with immediate and easy-to-reach access to domestic water supply increase/decrease? (+% increase/-% decrease)		✓ (-20%)		
	Will there be an increased number of households with sufficient quantity of water (e.g. 60 lpcd) for daily domestic needs? (% increase?)		✓ (-25%)		
	Increase of farming households with easy access to irrigated water source (% increase?)			✓	
Quality	Number of farming-dependent households with adequate quality irrigated water supply(% increase)		✓ (-10%)		
	Number of households with previous water quality constraints relieved completely of these (%)		✓ (5%)		
Livelihoods	Average increase in income (% increase)		✓ (10%)		
	Amount of household budget spent on irrigation water costs(% decrease?)		✓ (3%)		
Affordability	Cost to households is within their capacity to pay	✓			
Empowerment	Community can manage the measure (%)				✓
	Loss of land-dependent ocupational opportunities (%)		✓ (-60%)		
Health	Reduction in water-related diseases in households previously affected (% reduction)			✓	
	Reduced expenditure on treating water-related diseases as a result of improved water quality (as % of budget previously allocated to water-related health treatment)			✓	
	Improved nutrition, particularly of women, as more money available to spend on balanced diet		✓ (3%)	✓	

Financial impact assessment – general

Although the economic analysis is undertaken to evaluate the "Unit cost of water saved" (Item 4 on the Data Sheet), the financial impact for the individual domestic consumer or farmer is also an important consideration when comparing options.

This financial impact is covered broadly in the "livelihoods" and "affordability" classifications given in the social impact tables above. However, it is valuable to examine in more detail, for a number of water demand management measures, the change in the actual farm or domestic budgets as they are affected by any measure that is proposed.

Farm budgets

Farm budgets can be derived from an examination of the inputs and outputs for the crops grown. Typically, the output will be the farmer's income from the produce sold calculated at the farm-gate price. The inputs will comprise the costs of such items as: seed; fertilisers and pesticides; labour and machinery costs for land and

seedbed preparation, transplanting, weeding, application of fertilisers and pesticides, harvesting and any post harvest treatments. They will include the cost of operating and maintaining the irrigation and drainage networks and equipment, which may include the cost of pumping and associated equipment. The farm budget will provide a balance sheet from which the farmer's annual net benefit can be derived.

The possible future situation may then be calculated, taking into account any proposed changes in circumstance which might occur. These should take any benefits into account (e.g. equivalent annuity for capital payments made for well buy-out, relinquishing water rights or land) if these apply.

The financial impact of a water demand management measure may be derived by comparing the current situation with that which would apply after its introduction. A firm financial figure can be calculated which will demonstrate the size of the positive or negative outcome of the introduction of a measure.

A similar process (using appropriate elements of the budget) may be applied to derive the financial impact on industry or other businesses where this is required.

Domestic budgets

Domestic budgets may be calculated in a similar way but here the budget refers to the family or individual. For farm labour, the loss of livelihood may be a consideration where water from irrigated agriculture is diverted to other uses.

In the domestic budget, allowance should be made for any change in the productive time lost in walking or travelling to collect water, queuing or waiting for water to arrive, changes in expenditure over water-related health issues, and any increase or reduction in payments that have to be made to others for the supply of water.

There will be a net benefit or loss in obtaining the same amount of water and a further cost or benefit for obtaining an increased amount of water and both these should be calculated.

C2.2.3 Pre-conditions to implementation and likelihood of success

Apart from evaluation of the water saved, the cost, the associated supporting measures and the social and financial impact of the measure, there are a number of other issues to be considered when introducing a water demand management measure. These can broadly be described under the headings of "Pre-conditions to implementation" and "Likelihood of success".

Preconditions

"Pre-conditions to implementation" may include items such as: the will of the implementing agency or agencies; the availability of funding; or the availability of appropriate technology. In the Data Sheets, some indications of typical "Preconditions" are shown but it is likely that other preconditions will apply in specific instances and these should be noted so that any barriers to implementation can be identified and evaluated.

Likelihood of success

The assessment of the "Likelihood of success" of a water demand management measure is an important consideration. Qualitative and subjective assessments may be required but these will generally address two key indicators:

(i) the viability of the water demand management measure; and

(ii) the ease of its implementation.

The assessment of viability may include, for instance, consideration of:

- Stakeholders and consumers likely future compliance with legislation and regulations
- Maintenance of new infrastructure and equipment (e.g. water meters)

The ease of implementation may include, for instance, an assessment of the:

- Likely resistance of consumers to implementation of the measure
- Institutional changes required and the introduction of new financial systems
- Effectiveness of participatory approaches

In the Data Sheets, a score (between 1 and 5) for the viability and ease of implementation is entered, based on subjective assessments. The choice of these scores must be done after consultation with stakeholders and drawing upon the experience of as wide a range of disciplines as possible. The evaluation of these should allow consideration of the "drivers" and "barriers to change" and should yield some valuable views on the measures proposed.

C2.2.4 Evaluation flow diagram

A useful assessment of individual measures and comparisons of a range of water demand management measures can be made on the basis of the Data Sheets attached and the notes above, which may be used to contribute to a water resources development strategy.

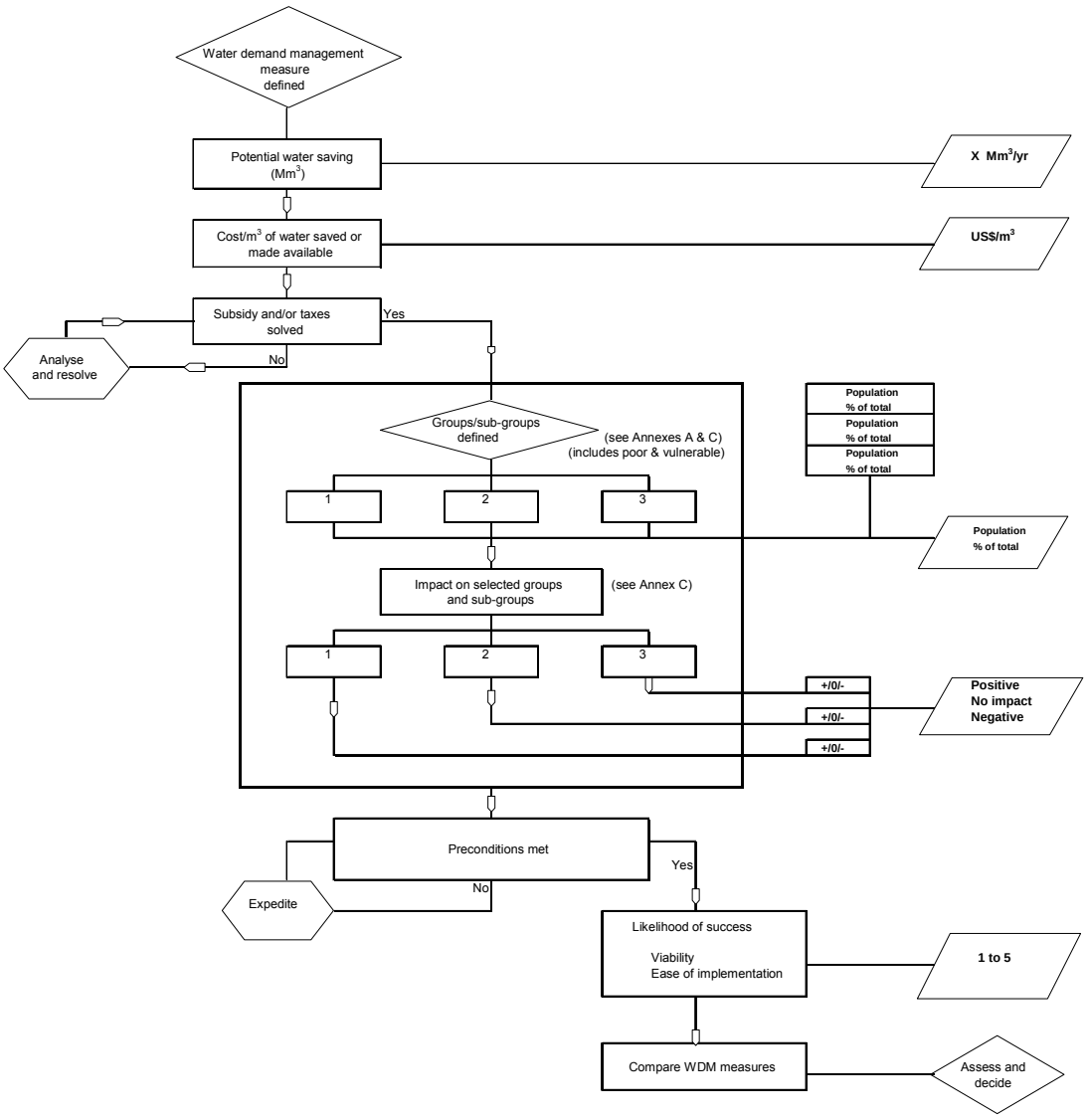
The process has some complex features to evaluate and it is useful to adopt a step-by-step approach which is summarised in the diagram below.

The principal steps are:

- selection of water demand management measure for evaluation
- calculate potential water saving brought about by measure (Mm^3)
- calculate cost per m^3 of water saved or made available for others
- analyse and resolve any subsidy or tax issues related to the measure
- Define groups and subgroups affected by measure (including the poor and vulnerable)
- Evaluate potential impact of measure on groups or sub-groups
    - *Social impact (using social indicator table)*
    - *Financial impact*
- Examine preconditions to implementation and take into account "drivers" and "barriers"

- Evaluate the “Likelihood of success” of the measure (its viability and ease of implementation)
- Compare measures where options exist.

Water demand management measures
Evaluation process



WATER DEMAND MANAGEMENT MEASURES

DATA SHEETS - DOMESTIC/MUNICIPAL/INDUSTRIAL

Ref No.	Measure
DT1	Reduce Water Loss (leakage control)
DT2	Water Saving Devices
DT3	Recycling of Industrial Water
DT4	Use of “grey” water
DA1	Inter-sectoral water quotas and allocations
DA2	Intra-sectoral water quotas and allocations
DA3	Land development control
DA4(a)	Water tariff (Progressive or stepped)
DA4(b)	Water tariff (Differential)
DS1	Community level management
DS2	Population distribution
DS3	Migration

DATA SHEET

Ref No. DT1 Reduce Water Loss (Leakage control)

1. Description of measure

The measure comprises control of leakage from the piped system to reduce water losses or "unaccounted for water" (UFW). UFW in municipal systems is the difference between the total amount of water produced and amount of water delivered to the users. It consists of (i) transmission losses; (ii) meter under-registration; (iii) public uses; (iv) leakage and illegal use. The measure is implemented through repairing leaks, pressure control, pipe replacement and rehabilitation. Leak detection surveys are required to locate the sites of leakage.

2. The measure is normally implemented by one or more of the following agencies:

Government	National	
	Regional or State	
	Municipal	**X**
	Local	**X**
Water supplier	Public utility	**X**
	Private	**X**
	Public-private-partnership	**X**
	Public-private-community partnership	**X**
	Community	**X**
Water consumer	Municipal	
	Community	
	Family/individual	
	Agricultural	
	Industrial	

3. Supporting measures may be required through:

Domestic/municipal/industrial		**Agriculture**	
Public awareness campaign	**X**	Public awareness campaign	
Legislation and regulation		Legislation and regulation	
Advice to industry		Agricultural extension services	
Metered water supplies	**X**	Metered agricultural wells or supply	
Public-private-community participation	**X**	Water rights/licensing/registration	
Community mobilization	**X**	Monitoring and enforcement	
		Subsidy introduction	

4. Example of the amount and unit cost of water saved or made available

Jordan

The overall Unaccounted for Water (UFW) in Jordan is high, about 54% in the Ma'an Governorate. The large proportion of UFW is reported to be leakage and illegal use (38%). The potential water saving is large, of the order of 30%, by improving and rehabilitating the existing distribution network and household connections.

Water supplied in Ma'an Governorate was 15.8 MCM/year and the potential for saving water through leakage control would be 4.7 MCM/year. Preliminary estimates of the cost of projects and potential water saving in different Governorates showed that projects implemented during 1993-1997 at a total cost of 51.7 JD Million could save a total water of 20.1 MCM/year and proposed projects implemented during 2005-2010 at a total cost of 23.1 JD Million could save 10.3 MCM/year. The cost of water saved by these measures would be 0.216 – 0.248 JD/m^3 (0.31-0.35 US$/$m^3$)

Oman

In Muscat and Salalah, transmission and distribution pipelines are relatively new and in good condition. It is estimated that further savings could be made of 5% of current supplies.

Items	India (USD/m^3)	Ma'an, Jordan (USD/m^3)	Muscat, Oman (USD/m^3)
Cost of water saved or made available	NA	0.31-0.35	0.98

5. Subsidy and tax issues

Not applicable

6. Potential impact on community

6.1 Groups directly affected

Population of project area (including those affected and those not affected by the measure): ……

Type of group affected	Population in group	Number ranked poor in group	Group as % of total population	Poor as % of total population
Urban domestic water consumers				
Rural domestic water consumers				
Farmers and farm labour				
Industry and industrial workers				
Government and commercial				
Other (to be described)				

6.2 Impact of measure (Social)

Group: …… (Population ……); *Sub-group:* (e.g. Poor/vulnerable)….. (Population…..); *Location:* Ref. ……

Social Indicator	Potential impact on group				
	Very positive	Slightly positive	No change	Slightly negative	Very negative
Access to water					
Quality of water					
Effect on livelihood					
Affordability					
Sense of empowerment					
Health					

6.3 Impact of measure (Financial)

- Net financial benefit (or loss) arising from implementation of measure per individual, family or enterprise

7. Implementation

7.1 Preconditions to implementation

- Will of and financial resources for water supplier to undertake measures required.
- Leak detection studies undertaken

7.2 Likelihood of success

Viability	**1 - 5**	**Mean score**
Ease of implementation	**1 - 5**	

DATA SHEET

Ref No. DT2 Water Saving Devices

1. Description of measure

The measure would provide better plumbing at household level and encourage the installation of water saving devices to reduce water consumption. The measure includes lower water consuming and higher technology taps (faucets), showers and toilet flushing systems. Introduction of these measures provides the potential for reducing water consumption. (Water saving spray faucets require high pressure in the supply pipe which limits its scope of application).

2. The measure is normally implemented by one or more of the following agencies:

Government	National	
	Regional or State	
	Municipal	
	Local	
Water supplier	Public utility	
	Private	
	Public-private-partnership	
	Public-private-community partnership	
	Community	
Water consumer	Municipal	**X**
	Community	**X**
	Family/individual	**X**
	Agricultural	
	Industrial	**X**

3. Supporting measures may be required through:

Domestic/municipal/industrial		Agriculture	
Public awareness or information campaign	**X**	Public awareness campaign	
Legislation and regulation	**X**	Legislation and regulation	
Advice to industry		Agricultural extension services	
Metered water supplies		Metered agricultural wells or supply	
Public-private-community participation		Water rights/licensing/registration	
Community mobilization	**X**	Monitoring and enforcement	
		Subsidy introduction	

4. Example of the unit cost of water saved or made available through the measure

Jordan and India

No information was readily available on (i) cost of water saving devices for household; (ii) application percentage (number of HH applying saving devices) to estimate the unit cost of water saved by this measure in the two case studies areas in India and Jordan. Currently in Jordan there are several types of (i) toilets with 6-10 litres flush comparing to "traditional one" of 15 litres; (ii) Faucets of 6 litres/minute compared to that of 20 litres/minute; (iii) washing machine using 60-70 litres/load compared to 100-120 litres/load. Potential water saving could be in an order of 30% of domestic water uses.

Oman

The water savings have been evaluated by Oman Ministry of Water Resources[47] for Muscat at 22% of current domestic use. Assuming that the average domestic property has an occupancy rate of 7 persons with individual water demands of 150 lcd, the cost of devices was estimated at RO 41.3/family (US$ 99 per household) with a ten year replacement. Unit cost of water saved would be 0.086 RO/m^3 (US$ 0.20 per m^3).

Items	India (USD/m^3)	Jordan (USD/m^3)	Oman (USD/m^3)
Cost of water	NA	NA	0.20

5. Subsidy or tax issues

Subsidy on water saving devices and/or zero rated sales tax (VAT) could be considered.

[47] Oman Water Resources Master Plan, 2002

6. Potential impact on community

6.1 Groups directly affected

Population of project area (including those affected and those not affected by the measure): ……

Type of group affected	Population in group	Number ranked poor in group	Group as % of total population	Poor as % of total population
Urban domestic water consumers				
Rural domestic water consumers				
Farmers and farm labour				
Industry and industrial workers				
Government and commercial				
Other (to be described)				

6.2 Impact of measure (Social)

Group: …… (Population ……); *Sub-group:* (e.g. Poor/vulnerable)….. (Population…..); *Location:* Ref. ……

Social Indicator	Potential impact on group				
	Very positive	Slightly positive	No change	Slightly negative	Very negative
Access to water					
Quality of water					
Effect on livelihood					
Affordability					
Sense of empowerment					
Health					

6.3 Impact of measure (Financial)

- Net financial benefit (or loss) arising from implementation of measure per individual, family or enterprise

7. Implementation

7.1 Preconditions to implementation

- Availability of water saving devices on market.
- Information campaign

7.2 Likelihood of success

Viability	**1 - 5**	**Mean score**
Ease of implementation	**1 - 5**	

DATA SHEET

Ref No. DT3 Recycling of Industrial Water (use of waste water in industrial plant)

1. Description

Industrial water users are required to treat and recycle wastewater thereby reducing the amount of make-up water required and improving the quality of wastewater effluent.

2. The measure is normally implemented by one of the following agencies:

Government	National	
	Regional or State	
	Municipal	
	Local	
Water supplier	Public utility	
	Private	
	Public-private-partnership	
	Public-private-community partnership	
	Community	
Water consumer	Municipal	
	Community	
	Family/individual	
	Agricultural	
	Industrial	**X**

3. Supporting measures may be required through:

An information campaign targeted at water consuming industries, which demonstrates the need to make savings and the advantages of doing so, will be required. Technical advice to specific industries may also be required.

Domestic/municipal/industrial		**Agriculture**	
Public awareness or information campaign	**X**	Public awareness campaign	
Legislation and regulation	**X**	Legislation and regulation	
Advice to industry	**X**	Agricultural extension services	
Metered water supplies		Metered agricultural wells or supply	
Public-private-community participation		Water rights/licensing/registration	
Community mobilization		Monitoring and enforcement	
		Subsidy introduction	

4. Example of the unit cost of water saved or made available through the measure

India

CMWSSB is encouraging recycling of wastewater by providing secondary treated wastewater to the Chennai Petroleum Corporation Ltd. and Madras Fertilizer Ltd. at Manali and untreated wastewater to a private power corporation at Basin Bridge. The CMWSSB is programmed to construct an RO Desalination Plant of 50 MLD capacity to supply secondary treated wastewater to industries in lieu of the clear water. The cost is estimated at Rs 200 Crores. It is assumed that: (i) the life of RO plant is 30 years; (ii) replacements will be made at 10 year-intervals at a cost of 20% of the total capital cost; (iii) O&M cost (power consumption) is of 5 kWh/m^3 and the cost of secondary treated wastewater[48] is Rs 2.88 per m^3; (iv) discount rate is 12% per year. Cost[49] of water from RO plant for industry uses would be Rs 36 per m^3.

Oman

The Oman study[50] showed that (i) unit cost of water from sewage treatment system for domestic uses of 0.113-0.182 RO/m^3 (0.27-0.44 US$/$m^3$). However, in a town where sewage collection system not yet in place, unit cost of waste-water in sewage collection system would be in an order of 0.775-1.164 RO/m^3 (1.76-2.79 US$/$m^3$) to make waste water available at treatment plant.

Items	India (USD/m3)	Jordan (USD/m3)	Oman (USD/m3)
Cost of water	0.80	0.52	0.27 – 0.44

[48] Costing Department, CMWSSB

[49] Net present value of costs is Rs 5,223 million to produce 147 million m^3

[50] Oman Water Resources Master Plan, 2002

5. Subsidy or tax issues

Government subsidy may be considered to encourage this measure

6. Potential impact on community

6.2 Groups directly affected

Population of project area (including those affected and those not affected by the measure): …….

Type of group affected	Population in group	Number ranked poor in group	Group as % of total population	Poor as % of total population
Urban domestic water consumers				
Rural domestic water consumers				
Farmers and farm labour				
Industry and industrial workers				
Government and commercial				
Other (to be described)				

6.2 Impact of measure (Social)

Group: …… (Population ……); *Sub-group:* (e.g. Poor/vulnerable)….. (Population…..); *Location:* Ref. ……

Social Indicator	Potential impact on group				
	Very positive	Slightly positive	No change	Slightly negative	Very negative
Access to water					
Quality of water					
Effect on livelihood					
Affordability					
Sense of empowerment					
Health					

6.3 Impact of measure (Financial)

- Net financial benefit (or loss) arising from implementation of measure per individual, family or enterprise

7. Implementation

7.1 Preconditions to implementation

- Availability of technology
- Advice to industrial water users and information campaign
- Subsidy considerations.

7.2 Likelihood of success

Viability	**1 - 5**	**Mean score**
Ease of implementation	**1 - 5**	

DATA SHEET

DT4 Use of "grey water"

1. Description of measure

Domestic wastewater that is non-toxic and of suitable quality is used without treatment for garden watering or urban environmental use.

2. This measure is normally implemented by the following agencies:

Government	National	
	Regional or State	
	Municipal	
	Local	
Water supplier	Public utility	
	Private	
	Public-private-partnership	
	Public-private-community partnership	
	Community	
Water consumer	Municipal	**X**
	Community	**X**
	Family/individual	**X**
	Agricultural	
	Industrial	

3. Supporting measures may be required through:

Domestic/municipal/industrial		Agriculture	
Public awareness or information campaign	**X**	Public awareness campaign	
Legislation and regulation		Legislation and regulation	
Advice to industry		Agricultural extension services	
Metered water supplies		Metered agricultural wells or supply	
Public-private-community participation		Water rights/licensing/registration	
Community mobilization	**X**	Monitoring and enforcement	
		Subsidy introduction	

4. Example of the unit cost of water saved or made available through the measure

India and Jordan
There was no information available in the two case studies in Chennai (india) and in Jordan.

Oman
The Oman water resources master plan 2002 showed that using "grey water" with primary treatment by natural process in ponds for irrigation of garden/park in Muscat would cost 0.073 RO/m^3 (0.18 US$/$m^3$).

Items	India (USD/m3)	Jordan (USD/m3)	Oman (USD/m3)
Cost of water			0.18

5. Subsidy or tax issues

Not applicable

6. Potential impact on community

6.1 Groups directly affected

Population of project area (including those affected and those not affected by the measure): ……

Type of group affected	Population in group	Number ranked poor in group	Group as % of total population	Poor as % of total population
Urban domestic water consumers				
Rural domestic water consumers				
Farmers and farm labour				
Industry and industrial workers				
Government and commercial				
Other (to be described)				

6.2 Impact of measure (Social)

Group: …… (Population ……); *Sub-group:* (e.g. Poor/vulnerable)….. (Population…..); *Location:* Ref. ……

Social Indicator	Potential impact on group				
	Very positive	Slightly positive	No change	Slightly negative	Very negative
Access to water					
Quality of water					
Effect on livelihood					
Affordability					
Sense of empowerment					
Health					

6.3 Impact of measure (Financial)

- Net financial benefit (or loss) arising from implementation of measure per individual, family or enterprise

7. Implementation

7.1 Preconditions to implementation

- Evaluation of benefits of measure
- Preparation of advice to water users on quality and appropriate use of “grey water”.

7.2 Likelihood of success

Viability	**1 - 5**	**Mean score**
Ease of implementation	**1 - 5**	

DATA SHEET

Ref No. DA1 - Inter-sectoral water quotas and allocations; and Ref No. DA2 - Intra-sectoral water quotas and allocations

1. Description

When renewable resources are being over-exploited, defining inter-sectoral and intra-sectoral water allocations and quotas for the water consuming sectors (e.g. domestic, municipal, industrial and agricultural users), becomes a priority.

DA1 There are a number of basic steps in determining these.

(i) Definition of priority demands (e.g. domestic water quotas per capita, population and demographic trends, industrial and environmental demands);

(ii) Calculation of an appropriate allocation for the priority demands;

(iii) Determination of the supply options and sustainable yields;

(iv) Calculation of the water availability for other uses (i.e. principally agriculture);

(v) Definition of the allocations for the different water using sectors.

Sectoral allocations can then be applied.

DA2 Once sectoral allocations and quotas for the water consuming sectors have been defined (see measure DA1 above), it may be necessary to define the quotas within any water using sector. For example, quotas may be defined for different farming communities, for different domestic priorities or communities.

2. This measure is normally implemented by one or more of the following agencies:

Government	National	**X**
	Regional or State	**X**
	Municipal	**X**
	Local	**X**
Water supplier	Public utility	
	Private	
	Public-private-partnership	
	Public-private-community partnership	
	Community	
Water consumer	Community	
	Family/individual	
	Agricultural	
	Industrial	

3. Supporting measures may be required

A number of supporting measures may be required to ensure that the allocations and quotas are observed.

Stakeholder involvement and participatory approaches in defining and agreeing allocations and quotas are recommended. Other supporting measures required may include:

- the introduction of meters for domestic, industrial and agricultural consumers;
- the introduction of legislation and regulations on water use and abstraction;
- registration, licensing and the definition of water rights.

An information campaign targeted at water consumers, to demonstrate the need to make savings and the advantages of doing so, will be required.

Domestic/municipal/industrial		Agriculture	
Public awareness or information campaign	**X**	Public awareness or information campaign	**X**
Legislation and regulation	**X**	Legislation and regulation	**X**
Advice to industry	**X**	Agricultural extension services	**X**
Metered water supplies	**X**	Metered agricultural wells or supply	**X**
Public-private-community participation	**X**	Water rights/licensing/registration	**X**
Community mobilization		Monitoring and enforcement	**X**
		Subsidy introduction to be considered	

4. Example of the unit cost of water saved or made available through the measure

Not applicable

5. Subsidy or tax issues

Not applicable.

6. Potential impact on community

6.1 Groups directly affected

Population of project area (including those affected and those not affected by the measure): ……

Type of group affected	Population in group	Number ranked poor in group	Group as % of total population	Poor as % of total population
Urban domestic water consumers				
Rural domestic water consumers				
Farmers and farm labour				
Industry and industrial workers				
Government and commercial				
Other (to be described)				

6.2 Impact of measure (Social)

Group: …… (Population ……); *Sub-group:* (e.g. Poor/vulnerable)….. (Population…..); *Location:* Ref. ……

Social Indicator	Potential impact on group				
	Very positive	Slightly positive	No change	Slightly negative	Very negative
Access to water					
Quality of water					
Effect on livelihood					
Affordability					
Sense of empowerment					
Health					

6.3 Impact of measure (Financial)

- Net financial benefit (or loss) arising from implementation of measure per individual, family or enterprise

7. Implementation

7.1 Preconditions to implementation

- Evaluation of demands and rationalization of appropriate allocations
- Agreement with stakeholders and community

7.2 Likelihood of success

Viability **1 - 5**

Ease of implementation **1 - 5**

Mean score

DATA SHEET

Ref No. DA3 Land development control

1. Description

Planning permission for land development (e.g. for housing, commercial and industrial development or for irrigated agriculture) is controlled with regard to the potential water consumption of the development area.

2. This measure is normally implemented by:

Government	National	**X**
	Regional or State	**X**
	Municipal	**X**
	Local	**X**
Water supplier	Public utility	
	Private	
	Public-private-partnership	
	Public-private-community partnership	
	Community	
Water consumer	Community	
	Family/individual	
	Agricultural	
	Industrial	

3. Supporting measures which may be required

Domestic/municipal/industrial		Agriculture	
Public awareness or information campaign	**X**	Public awareness or information campaign	**X**
Legislation and regulation	**X**	Legislation and regulation	**X**
Advice to industry	**X**	Agricultural extension services	
Metered water supplies		Metered agricultural wells or supply	
Water rights/licensing/registration	**X**	Water rights/licensing/registration	**X**
Public-private-community participation		Monitoring and enforcement	
Community mobilization		Subsidy introduction to be considered	

4. Example of the unit cost of water saved or made available through the measure

There is no value of water saved if the land is currently used for non-agricultural purposes (not taking water for irrigation). If the land is being used as agricultural production, controlling land development may include (i) changing land use or (ii) changing cropping pattern to save the water and for this the unit cost of water saved would refer to measures AA3 to AA5

5. Subsidy or tax issues

Not applicable.

6. Potential impact on community

6.1 Groups directly affected

Population of project area (including those affected and those not affected by the measure): ……

Type of group affected	Population in group	Number ranked poor in group	Group as % of total population	Poor as % of total population
Urban domestic water consumers				
Rural domestic water consumers				
Farmers and farm labour				
Industry and industrial workers				
Government and commercial				
Other (to be described)				

6.2 Impact of measure (Social)

Group: …… (Population ……); *Sub-group:* (e.g. Poor/vulnerable)….. (Population…..); *Location:* Ref. ……

Social Indicator	**Potential impact on group**				
	Very positive	**Slightly positive**	**No change**	**Slightly negative**	**Very negative**
Access to water					
Quality of water					
Effect on livelihood					
Affordability					
Sense of empowerment					
Health					

6.3 Impact of measure (Financial)

- Net financial benefit (or loss) arising from implementation of measure per individual, family or enterprise

7. Implementation

7.1 Preconditions to implementation

- Urban and rural planning strategy
- Preparation of legislation.

7.2 Likelihood of success

Viability	**1 - 5**	**Mean score**
Ease of implementation	**1 - 5**	

DATA SHEET

Ref No. DA4(a) Domestic Water Tariff (Progressive or stepped)

1. Description

By charging a higher tariff to those who consume high amounts of water, this measure aims to reduce the amount of water consumed. A progressive or stepped water tariff can provide a means of ensuring all consumers can afford a basic quantity of water (charged at a low tariff) but those who consume more have to pay for additional amounts at higher tariffs. Although the tariff may primarily be used by the provider as a cost recovery mechanism, it may also be used as a demand management measure. Through this measure, water may be re-allocated among consumers and/or may induce a saving of water which could be used to serve new connections.

2. This measure is normally implemented by:

Government	National	**X**
	Regional or State	**X**
	Municipal	**X**
	Local	**X**
Water supplier	Public utility	**X**
	Private	**X**
	Public-private-partnership	**X**
	Public-private-community partnership	**X**
	Community	
Water consumer	Community	
	Family/individual	
	Agricultural	
	Industrial	

3. Supporting measures which may be required

Domestic/municipal/industrial		Agriculture	
Public awareness or information campaign	**X**	Public awareness campaign	
Legislation and regulation	**X**	Legislation and regulation	
Advice to industry		Agricultural extension services	
Metered water supplies	**X**	Metered agricultural wells or supply	
Public-private-community participation		Water rights/licensing/registration	
Community mobilization		Monitoring and enforcement	
		Subsidy introduction to be considered	

4. Example of the unit cost of water saved or made available through the measure

The main cost is that of the supporting measures which may include the introduction of water meters.

Oman

The implementation of a variable tariff may initially be targeted at areas where high cost desalinated water is currently used. With price elasticity of the demand estimated at -16%, if the water tariff increases by 50% to 0.66 RO/m^3 (1.58 US$/$m^3$) then demand would be reduced by 10% (20 l/c/d). The economic cost of the measure would be 0.110 RO/m^3 (0.26 US$/$m^3$) of water saved.

Jordan

The Government of Jordan has assigned a stepped domestic tariff to consumers . This is reviewed from time to time, taking into account cost recovery, customer willingness and ability to pay, social and health effects. The price for the lowest step (0-20 m^3) is 0.10 JD per m^3 (0.14 US$/$m^3$). About 38% of subscribers were within this step consuming about 10% of the municipal water[51] but information not available for research team to evaluate unit cost of water saved.

Location / Items	India USD/m3	Jordan USD/m3	Oman USD/m3
Cost of water saved or made available			0.26

5. Subsidy or tax issues

Not applicable.

[51] PRIDE August, 1992: A Water Management Study for Jordan

6. Potential impact on community

6.1 Groups directly affected

Population of project area (including those affected and those not affected by the measure): ……

Type of group affected	Population in group	Number ranked poor in group	Group as % of total population	Poor as % of total population
Urban domestic water consumers				
Rural domestic water consumers				
Farmers and farm labour				
Industry and industrial workers				
Government and commercial				
Other (to be described)				

6.2 Impact of measure (Social)

Group: …… (Population ……); *Sub-group:* (e.g. Poor/vulnerable)….. (Population…..); *Location:* Ref. ……

Social Indicator	Potential impact on group				
	Very positive	Slightly positive	No change	Slightly negative	Very negative
Access to water					
Quality of water					
Effect on livelihood					
Affordability					
Sense of empowerment					
Health					

6.3 Impact of measure (Financial)

- Net financial benefit (or loss) arising from implementation of measure per individual, family or enterprise

7. Implementation

7.1 Preconditions to implementation

- Evaluation of potential impact of measure
- Preparation of legislation

7.2 Likelihood of success

Viability	1 - 5	Mean score
Ease of implementation	1 - 5	

DATA SHEET

DA4(b) Domestic Water Tariff (Differential)

1. Description

By charging a different tariff to different types of users or different socio-economic groups, this measure aims to reduce the amount of water consumed. This is an alternative to a progressive or stepped water tariff. Although the tariff may be used by the provider as a cost recovery mechanism, it may also be used as a demand management measure. Through this measure, water may be re-allocated among the users and/or induce a saving of water which may be used to serve new connections.

2. This measure is normally implemented by:

Government	National	**X**
	Regional or State	**X**
	Municipal	**X**
	Local	**X**
Water supplier	Public utility	**X**
	Private	**X**
	Public-private-partnership	**X**
	Public-private-community partnership	**X**
	Community	
Water consumer	Community	
	Family/individual	
	Agricultural	
	Industrial	

3. Supporting measures which may be required

Domestic/municipal/industrial		**Agriculture**	
Public awareness or information campaign		Public awareness campaign	
Legislation and regulation	**X**	Legislation and regulation	
Advice to industry		Agricultural extension services	
Metered water supplies	**X**	Metered agricultural wells or supply	
Public-private-community participation		Water rights/licensing/registration	
Community mobilization		Monitoring and enforcement	
		Subsidy introduction to be considered	

4. Example of the unit cost of water saved or made available through the measure

The main cost is that of the supporting measures which may include the introduction of water meters, preparation of tariff plan, social impact study. There is no information available for estimating unit cost of water saved.

5. Subsidy or tax issues

Not applicable.

6. Potential impact on community

6.1 Groups directly affected

Population of project area (including those affected and those not affected by the measure): ……

Type of group affected	**Population in group**	**Number ranked poor in group**	**Group as % of total population**	**Poor as % of total population**
Urban domestic water consumers				
Rural domestic water consumers				
Farmers and farm labour				
Industry and industrial workers				
Government and commercial				
Other (to be described)				

6.2 Impact of measure (Social)

Group: …… (Population ……); *Sub-group:* (e.g. Poor/vulnerable)….. (Population…..); *Location:* Ref. ……

Social Indicator	**Potential impact on group**				
	Very positive	**Slightly positive**	**No change**	**Slightly negative**	**Very negative**
Access to water					
Quality of water					
Effect on livelihood					
Affordability					
Sense of empowerment					
Health					

6.3 Impact of measure (Financial)

- Net financial benefit (or loss) arising from implementation of measure per individual, family or enterprise

7. Implementation

7.1 Preconditions to implementation

- Evaluation of potential impact of measure
- Preparation of legislation

7.2 Likelihood of success

Viability	**1 - 5**	**Mean score**
Ease of implementation	**1 - 5**	

DATA SHEET

Ref No. DS1 Community level management

1. Description

Where the supply of water is restricted or unreliable, the community manages the demand for water through lobbying, consents and agreement to make the most appropriate and best use of the available water.

2. This measure is normally implemented by:

Government	National	
	Regional or State	
	Municipal	
	Local	
Water supplier	Public utility	
	Private	
	Public-private-partnership	
	Public-private-community partnership	**X**
	Community	**X**
Water consumer	Community	**X**
	Family/individual	**X**
	Agricultural	
	Industrial	

3. Supporting measures which may be required

Community mobilisation.

Domestic/municipal/industrial		**Agriculture**	
Public awareness campaign		Public awareness campaign	
Legislation and regulation		Legislation and regulation	
Advice to industry		Agricultural extension services	
Metered water supplies		Metered agricultural wells or supply	
Public-private-community participation	**X**	Water rights/licensing/registration	
Community mobilization	**X**	Monitoring and enforcement	
		Subsidy introduction to be considered	

4. Example of the unit cost of water saved or made available through the measure

Community management time and costs. Savings in time traveling, waiting for and accessing water. There is no information available for estimating unit cost of water saved

5. Subsidy or tax issues

Not applicable.

6. Potential impact on community

6.1 Groups directly affected

Population of project area (including those affected and those not affected by the measure): ……

Type of group affected	**Population in group**	**Number ranked poor in group**	**Group as % of total population**	**Poor as % of total population**
Urban domestic water consumers				
Rural domestic water consumers				
Farmers and farm labour				
Industry and industrial workers				
Government and commercial				
Other (to be described)				

6.2 Impact of measure (Social)

Group: …… (Population ……); *Sub-group:* (e.g. Poor/vulnerable)….. (Population…..); *Location:* Ref. ……

Social Indicator	**Potential impact on group**				
	Very positive	**Slightly positive**	**No change**	**Slightly negative**	**Very negative**
Access to water					
Quality of water					
Effect on livelihood					
Affordability					
Sense of empowerment					
Health					

6.3 Impact of measure (Financial)

- Net financial benefit (or loss) arising from implementation of measure per individual, family or enterprise

7. Implementation

7.1 Preconditions to implementation

- Community will and acceptance by water providers.

7.2 Likelihood of success

Viability	**1 - 5**	**Mean score**
Ease of implementation	**1 - 5**	

DATA SHEET

Ref No. DS2 Population distribution

1. Description

Regional planning and controls on population and its distribution and the associated domestic and industrial infrastructure. Applicable to areas with insurmountable water shortages.

2. This measure is normally implemented by:

Government	National	**X**
	Regional or State	**X**
	Municipal	**X**
	Local	**X**
Water supplier	Public utility	
	Private	
	Public-private-partnership	
	Public-private-community partnership	
	Community	
Water consumer	Community	
	Family/individual	
	Agricultural	
	Industrial	

3. Supporting measures which may be required

Domestic/municipal/industrial		**Agriculture**	
Public awareness campaign		Public awareness campaign	
Legislation and regulation	**X**	Legislation and regulation	**X**
Advice to industry		Agricultural extension services	
Metered water supplies		Metered agricultural wells or supply	
Public-private-community participation		Water rights/licensing/registration	
Community mobilization		Monitoring and enforcement	
		Subsidy introduction to be considered	

4. Example of the unit cost of water saved or made available through the measure

Not applicable

5. Subsidy or tax issues

Not applicable.

6. Potential impact on community

6.1 Groups directly affected

Population of project area (including those affected and those not affected by the measure): ……

Type of group affected	**Population in group**	**Number ranked poor in group**	**Group as % of total population**	**Poor as % of total population**
Urban domestic water consumers				
Rural domestic water consumers				
Farmers and farm labour				
Industry and industrial workers				
Government and commercial				
Other (to be described)				

6.2 Impact of measure (Social)

Group: …… (Population ……); *Sub-group:* (e.g. Poor/vulnerable)….. (Population…..); *Location:* Ref. ……

Social Indicator	**Potential impact on group**				
	Very positive	**Slightly positive**	**No change**	**Slightly negative**	**Very negative**
Access to water					
Quality of water					
Effect on livelihood					
Affordability					
Sense of empowerment					
Health					

6.3 Impact of measure (Financial)

- Net financial benefit (or loss) arising from implementation of measure per individual, family or enterprise

7. Implementation

7.1 Preconditions to implementation

- Evaluation of potential impact of measure
- Preparation of legislation

7.2 Likelihood of success

Viability	**1 - 5**	**Mean score**
Ease of implementation	**1 - 5**	

DATA SHEET

Ref No. DS3 Migration

1. Description

Migration may be spontaneous or induced. Where water shortages are extreme, communities may migrate to areas where water is less scarce or Government may encourage migration to less water short areas.

2. This measure is normally implemented by:

Government	National	**X**
	Regional or State	**X**
	Municipal	**X**
	Local	**X**
Water supplier	Public utility	
	Private	
	Public-private-partnership	
	Public-private-community partnership	
	Community	
Water consumer	Community	**X**
	Family/individual	**X**
	Agricultural	**X**
	Industrial	**X**

3. Supporting measures which may be required

Domestic/municipal/industrial		Agriculture	
Public awareness campaign		Public awareness campaign	
Legislation and regulation	**X**	Legislation and regulation	**X**
Advice to industry		Agricultural extension services	
Metered water supplies		Metered agricultural wells or supply	
Public-private-community participation		Water rights/licensing/registration	
Community mobilization	**X**	Monitoring and enforcement	
		Subsidy introduction to be considered	

4. Example of the unit cost of water saved or made available through the measure

Not applicable

5. Subsidy or tax issues

Not applicable.

6. Potential impact on community

6.1 Groups directly affected

Population of project area (including those affected and those not affected by the measure): …….

Type of group affected	Population in group	Number ranked poor in group	Group as % of total population	Poor as % of total population
Urban domestic water consumers				
Rural domestic water consumers				
Farmers and farm labour				
Industry and industrial workers				
Government and commercial				
Other (to be described)				

6.2 Impact of measure (Social)

Group: …… (Population ……); *Sub-group:* (e.g. Poor/vulnerable)….. (Population…..); *Location:* Ref. ……

Social Indicator	**Potential impact on group**				
	Very positive	**Slightly positive**	**No change**	**Slightly negative**	**Very negative**
Access to water					
Quality of water					
Effect on livelihood					
Affordability					
Sense of empowerment					
Health					

6.3 Impact of measure (Financial)

- Net financial benefit (or loss) arising from implementation of measure per individual, family or enterprise

7. Implementation

7.1 Preconditions to implementation

- Evaluation of potential impact of measure
- Preparation of legislation

7.2 Likelihood of success

Viability **1 - 5**

Ease of implementation **1 - 5**

Mean score

WATER DEMAND MANAGEMENT MEASURES

DATA SHEETS - AGRICULTURE

Ref No.	Measure
AT1	Improve efficiency of surface irrigation systems
AT2(a)	Introduce sprinkler drip systems (with subsidy)
AT2(b)	Introduce sprinkler drip systems (without subsidy)
AA1	Inter-sectoral water quotas and allocations
AA2	Intra-sectoral water quotas and allocations
AA3(a)	Change land use (through land purchase)
AA3(b)	Change land use (through land purchase)
AA3(c)	Change land use (by well buy-out and transfer of water rights)
AA4	Crop area prohibition
AA5(a)	Change cropping patterns (through extension services advice)
AA5(b)	Change cropping patterns (through applying tax)
AA5(c)	Change cropping pattern (through market support)
AA6	Introduce water markets
AA7(a)	Introduce water tariffs (based on volume pumped)
AA7(b)	Introduce water tariffs (based on power supplied to pumps)
AA7(c)	Introduce water tariffs (based on area irrigated)
AS1	Formation of water users associations
AS2	Population distribution
AS3	Migration

DATA SHEET

Ref No. AT1 Reduce losses from surface irrigation system

1. Description of measure

In many surface irrigation schemes the overall irrigation efficiency (consumptive use as a percentage of water supplied from the source) is low due to (i) poorly maintained earth irrigation water supply canals; (ii) low operation efficiency; and (iii) low field application efficiency due to poor on-farm development. Through this measure, the losses to evaporation and the water lost to seepage which can not be re-used may be reduced by (i) improving or lining the irrigation canal system, (ii) improving operation of the system; and (iii) improving field irrigation to reduce on-farm losses. The losses from surface irrigation may partly recharge the underlying aquifer and are partly lost through evaporation and evapo-transpiration. This measure considers that water loss from the irrigation system to ground water is not a loss to the water resources available.

2. The measure is normally implemented by one of the following agencies:

Government	National	
	Regional or State	**X**
	Municipal	
	Local	
Water supplier	Public utility	
	Private	
	Public-private-partnership	
	Public-private-community partnership	
	Community	
Water consumer	Community	
	Family/individual	
	Agricultural	**X**
	Industrial	

3. Supporting measures may be required through:

Domestic/municipal/industrial		Agriculture	
Public awareness or information campaign		Public awareness or information campaign	**X**
Legislation and regulation		Legislation and regulation	
Advice to industry		Agricultural extension services	**X**
Metered water supplies		Metered agricultural wells or supply	**X**
Public-private-community participation		Water rights/licensing/registration	
Community mobilization		Monitoring and enforcement	**X**
		Subsidy introduction	

4. Example of the unit cost of water saved or made available through the measure

Tamil Nadu, India

Rice and groundnut are the two main crops in the A-K basin, Chennai. Improvement of water use, which is applied through surface irrigation systems, could generate water savings of 3,470 m^3/ha for double paddy, 5,273 m^3/ha for triple paddy and 2,170 m^3/ha for paddy-groundnut. The average water savings from the water demand management measure could be as much as 3,600 m^3/ha per year. The average cost of investment would be Rs 15,660 (US$ 356) per ha. The annuity cost (30 years life; discount rate 12%/year) would be Rs 1,944 (US$ 44) per ha. Cost of water saving from improvement of irrigation efficiency would be Rs 0.54 per m^3 (0.01 US$/$m^3$).

Oman

The study in Oman showed that (i) to improve surface irrigation systems through small investments estimated at RO 100/ha in irrigation infrastructure and training of farmers through extension at a cost of RO 50/ha. Using a discount rate of 6% per year in 20 years, the annualised cost of the action would be RO 13.08/ha/year.

The anticipated water savings are calculated based on the prevalent cropping patterns for the different types of farms and the crop-specific consumptive water use, irrigation efficiency and the total evaporation losses in sub-regions. The weighted average of water saved varies from 1,145 m^3/ha/yr to 1,925 m^3/ha/yr. Unit cost of water saved from the measure would be varied from 0.007 to 0.011 RO/m^3 (0.008-0.013 US$/$m^3$).

Items	India USD/m3	Jordan USD/m3	Oman USD/m3
Cost of water saved or made available	0.012	NA	0.008-0.013

5. Subsidy or tax issues

Not applicable

6. Potential impact on community

6.1 Groups directly affected

Population of project area (including those affected and those not affected by the measure): ……

Type of group affected	Population in group	Number ranked poor in group	Group as % of total population	Poor as % of total population
Urban domestic water consumers				
Rural domestic water consumers				
Farmers and farm labour				
Industry and industrial workers				
Government and commercial				
Other (to be described)				

6.2 Impact of measure (Social)

Group: …… (Population ……); *Sub-group:* (e.g. Poor/vulnerable)….. (Population…..); *Location:* Ref. ……

Social Indicator	Potential impact on group				
	Very positive	Slightly positive	No change	Slightly negative	Very negative
Access to water					
Quality of water					
Effect on livelihood					
Affordability					
Sense of empowerment					
Health					

6.3 Impact of measure (Financial)

- Net financial benefit (or loss) arising from implementation of measure per individual, family or enterprise

7. Implementation

7.1 Preconditions to implementation

- Farmers have the will to implement;
- Farmers have sufficient funds.

7.2 Likelihood of success

Viability	**1 - 5**	**Mean score**
Ease of implementation	**1 - 5**	

DATA SHEET

Ref No. AT2 Introduction of Sprinkler and Drip Irrigation System (a) with subsidy; (b) without subsidy

1. Description of measure

The measure would encourage the use of sprinkler and drip irrigation systems so that evaporative losses are reduced.

2. The measure is normally implemented by one of the following agencies:

Government	National	
	Regional or State	
	Municipal	
	Local	
Water supplier	Public utility	
	Private	
	Public-private-partnership	
	Public-private-community partnership	
	Community	
Water consumer	Community	
	Family/individual	**X**
	Agricultural	**X**
	Industrial	

3. Supporting measures may be required through:

Domestic/municipal/industrial		Agriculture	
Public awareness campaign		Public awareness or information campaign	**X**
Legislation and regulation		Legislation and regulation	
Advice to industry		Agricultural extension services	**X**
Metered water supplies		Metered agricultural wells or supply	**X**
Public-private-community participation		Water rights/licensing/registration	**X**
Community mobilization		Monitoring and enforcement	
		Subsidy introduction to be considered	**X**

4. Example of the unit cost of water saved or made available thr4ough the measure

India The case study in India showed that water saving from the application of sprinkler/drip irrigation would be 269m^3/ha for vegetables-groundnut and 676 m^3/ha for sugarcane. The cost of installation of sprinkler irrigation depends upon a number of factors such as the type of crop, the distance of the water source, sprinkler spacing, and nature of terrain. The approximate capital cost (excluding pump cost) ranges from Rs 16,000 to Rs 20,000 per ha. The annuity cost (15 years life; discount rate 12%/yr) would be Rs 2,350 - 2,940 (US$ 53-67) per ha. The cost of water saving from sprinkler irrigation would be between Rs 3.50-10.9 (US$ 0.08-0.24) per m^3. The average cost of drip irrigation development ranges from Rs 30,000 - 40,000 per ha, but a farmer can receive a subsidy up to Rs 15,000. Assuming the average life of a drip irrigation system is 7 years (10 years for main pipe and 5 year for drip lines), with a discount rate of 12% per year, an annuity of the capital cost is Rs 6,674-8,765 (US$ 150-200) per ha. The cost of water saving from drip irrigation would be Rs 9.7-12.9 (US$ 0.22-0.29) per m^3.

Oman The cost of sprinkler irrigation is RO 2,024/ha (annualised cost of RO 275 at discount rate 6% over 10 years of irrigation equipment) and drip is RO 1,667 (annualised cost of RO 226 at discount rate 6% over 10 years of irrigation equipment). The introduction of measure requires extension services to support farmers in advising on the purchase and operation of irrigation equipment with a cost of RO 100/ha.

The anticipated water savings calculated are based on the prevalent cropping patterns for the different types of farms and the crop-specific consumptive water use, irrigation efficiency and the total evaporation losses in sub-regions. The weighted average of water saved varies from 2,200 m^3/ha/yr in Mahdah to 4,350 m^3/ha/yr in Muscat. Apart from water savings, the introduction of sprinkler or drip irrigation influences the pumping costs (less water has to be pumped, but a larger dynamic pumping head is required), and reduces the labour requirement. The unit cost of water saved would be 0.003-0.049 RO/m^3 (0.01-0.12 US$/$m^3$)

Items	India (USD/m3)	Jordan (USD/m3)	Oman (USD/m3)
Cost of water (Sprinkler)	0.08-0.24		0.01-0.12
Cost of water (Drip)	0.22-0.29		

5. Subsidy or tax issues

Subsidy or credit for equipment may be considered

6. Potential impact on community

6.1 Groups directly affected

Population of project area (including those affected and those not affected by the measure): ……

Type of group affected	Population in group	Number ranked poor in group	Group as % of total population	Poor as % of total population
Urban domestic water consumers				
Rural domestic water consumers				
Farmers and farm labour				
Industry and industrial workers				
Government and commercial				
Other (to be described)				

6.2 Impact of measure (Social)

Group: …… (Population ……); *Sub-group:* (e.g. Poor/vulnerable)….. (Population…..); *Location:* Ref. ……

Social Indicator	Potential impact on group				
	Very positive	Slightly positive	No change	Slightly negative	Very negative
Access to water					
Quality of water					
Effect on livelihood					
Affordability					
Sense of empowerment					
Health					

6.3 Impact of measure (Financial)

- Net financial benefit (or loss) arising from implementation of measure per individual, family or enterprise

7. Implementation

7.1 Preconditions to implementation

- Farmers have the will to implement;
- Farmers have sufficient funds.

7.2 Likelihood of success

Viability **1 - 5**

Ease of implementation **1 - 5**

Mean score

DATA SHEET

Ref No. AA1 - Inter-sectoral water quotas and allocations
Ref No. AA2 - Intra-sectoral water quotas and allocations

1. Description

When renewable resources are being over-exploited, defining inter-sectoral and intra-sectoral water allocations and quotas for the water consuming sectors (e.g. domestic, municipal, industrial and agricultural users), limiting the demand from each sector or sub-sector – becomes a priority.

AA1 There are a number of basic steps in determining inter-sectoral water quotas and allocations

(i) Definition of priority demands (e.g. domestic water quotas per capita, population and demographic trends, industrial and environmental demands);

(ii) Calculation of an appropriate allocation for the priority demands;

(iii) Determination of the supply options and sustainable yields;

(iv) Calculation of the water availability for other uses (i.e. principally agriculture);

(v) Definition of the allocations for the different water using sectors.

Sectoral allocations can then be applied.

AA2 Once sectoral allocations and quotas for the water consuming sectors have been defined (see measure **AA1** above), it may be necessary to define the quotas within any water using sector. For example, quotas may be defined for different farming communities and for different domestic priorities or communities.

2. This measure is normally implemented by:

Government	National	**X**
	Regional or State	**X**
	Municipal	**X**
	Local	**X**
Water supplier	Public utility	
	Private	
	Public-private-partnership	
	Public-private-community partnership	
	Community	
Water consumer	Community	
	Family/individual	
	Agricultural	
	Industrial	

3. Supporting measures may be required

To ensure that the allocations and quotas are observed, a number of supporting measures may be required. Stakeholder involvement, in defining and agreeing allocations and quotas, is recommended. Other supporting measures required may include:

- the introduction of meters for domestic, industrial and agricultural consumers;
- the introduction of legislation and regulations on water use and abstraction;
- registration, licensing and the definition of water rights.

An information campaign targeted at water consumers will be required to demonstrate the need to make savings and the advantages of doing so.

Domestic/municipal/industrial		Agriculture	
Public awareness or information campaign	**X**	Public awareness or information campaign	**X**
Legislation and regulation	**X**	Legislation and regulation	**X**
Advice to industry	**X**	Agricultural extension services	**X**
Metered water supplies	**X**	Metered agricultural wells or supply	**X**
Public-private-community participation	**X**	Water rights/licensing/registration	**X**
Community mobilization		Monitoring and enforcement	**X**
		Subsidy introduction to be considered	

4. Example of the unit cost of water saved or made available through the measure

Not applicable.

5. Subsidy or tax issues

Not applicable.

6. Potential impact on community

6.1 Groups directly affected

Population of project area (including those affected and those not affected by the measure): ……

Type of group affected	Population in group	Number ranked poor in group	Group as % of total population	Poor as % of total population
Urban domestic water consumers				
Rural domestic water consumers				
Farmers and farm labour				
Industry and industrial workers				
Government and commercial				
Other (to be described)				

6.2 Impact of measure (Social)

Group: …… (Population ……); *Sub-group:* (e.g. Poor/vulnerable)….. (Population…..); *Location:* Ref. ……

Social Indicator	Potential impact on group				
	Very positive	Slightly positive	No change	Slightly negative	Very negative
Access to water					
Quality of water					
Effect on livelihood					
Affordability					
Sense of empowerment					
Health					

6.3 Impact of measure (Financial)

- Net financial benefit (or loss) arising from implementation of measure per individual, family or enterprise

7. Implementation

7.1 Preconditions to implementation

- Evaluation of demands and rationalization of appropriate allocations.
- Agreement with stakeholders and community.

7.2 Likelihood of success

Viability **1 - 5**

Ease of implementation **1 - 5**

Mean score

DATA SHEET

AA3 Change Land-use
(a) land purchase; (b) re-zoning/re-classification; (c) well buy-out and transfer of water rights

1. Description

This measure will bring about a change in land use from agricultural to non-agricultural use, thereby eliminating the use of water for agriculture in the selected area. This may be done by a number of methods: for example (a) land purchase; (b) re-zoning/re-classification; (c) well buy-out and transfer of water rights, and may release water for other uses.

2. The measure is normally implemented by one of the following agencies:

Government	National	**X**
	Regional or State	**X**
	Municipal	**X**
	Local	**X**
Water supplier	Public utility	**X**
	Private	
	Public-private-partnership	
	Public-private-community partnership	
	Community	
Water consumer	Community	
	Family/individual	
	Agricultural	
	Industrial	

3. Supporting measures may be required through:

Domestic/municipal/industrial		Agriculture	
Public awareness campaign		Public awareness campaign	
Legislation and regulation	**X**	Legislation and regulation	**X**
Advice to industry		Agricultural extension services	
Metered water supplies	**X**	Metered agricultural wells or supply	**X**
Public-private-community participation		Water rights/licensing/registration	**X**
Community mobilization		Monitoring and enforcement	
		Subsidy introduction to be considered	

4. Example of the unit cost of water saved or made available through the measure

India In India where there is a large area of double paddy, changing land use from paddy-paddy to non-cropped land would save by amount of water of 22,000 m^3/ha per year. In northern Tamil Nadu, the market prices of land per acre are respectively, Rs 100,000, Rs 150,000 and Rs 1,000,000 for “wet” land having no access road, “wet” land with some access and land next to a road respectively. This is equivalent to Rs 247,100; Rs 370,700; and Rs 2.471 million per ha of agricultural land. With a financial annual net return of Rs 5,343 per acre, the financial price of land would be Rs 44,370 per acre, which is lower than the market price of land. This has an implication for the progress of urbanization in the suburban area putting the price of agricultural land higher than its real value from agriculture. The economic value of agricultural land is the present value of the economic net benefit stream generated from crop cultivation for 50 years at the discounted rate of 12% per year. The average economic net benefit in northern Tamil Nadu would be about Rs 4,200 per ha per year. The economic value of agricultural land would then be Rs 34,880 per ha. Changing land use from paddy-paddy to non-cropped land would cause a loss to the national economy of Rs 2,029 per ha per year. The economic cost of water in changing land use would be Rs 0.091 per m^3 saved.

Jordan In the Jordan Case Study Area, the measure related to changing agricultural land into non-cropped land to allow the aquifer to restore. In this area, there are four main groups of tree/crops: (i) fruit trees which consume about 6,000 m^3/ha; (ii) berseem and alfalfa which consume about 8,000 m^3/ha; (iii) vegetables which consume about 5,000 m^3/ha; and (iv) wheat and barley which consume about 3,500 m^3/ha. Changing land use to non-agriculture would result in an economic loss to society. An analysis of unit cost of water saved by changing land use shows that to minimize the loss to society, priority of changing land use would start from wheat and barley which have a relatively low economic value of irrigation water, followed by fodder crops and fruit trees. The unit cost of water saved would be JD 0.02-0.66 per m^3 (0.03-0.94 US$/$m^3$)

Oman The economic value of land (or opportunity cost) was calculated as the present value of the net return forgone in 50 years at a discount rate of 6% per year. Presently there is some agricultural land whose economic value is zero (e.g. the traditional farms in Barka and Al Massarat). A high economic value of land has been found in Salalah for all farm types (8,000-12,000 RO/ha) and in Barka for mixed and new farms (6,000-7,000 RO/ha). High economic value of land in Salalah resulted from better net return from bananas and coconut. The amount of water saved would be about 18,500-27,400 m^3/ha/yr if land is put out of service. The economic unit cost of water is the economic net benefit from cultivation divided by the total net water used by these crops on one hectare of land. This varies with farm type and region due to differences in cropping system, irrigation techniques and labour requirement. The weighted average of the economic cost of water lies in a range of 1-33 Baisa/m^3 (0.002-0.08 US$/$m^3$)

Location Items	India (USD/m3)	Jordan (USD/m3)	Oman (USD/m3)
Cost of water	0.002	0.03-0.94	0.002-0.08

5. Subsidy or tax issues

Generally not applicable. Subsidy or compensation may be required if re-zoning or re-classification is introduced

6. Potential impact on community

6.1 Groups directly affected

Population of project area (including those affected and those not affected by the measure): …….

Type of group affected	**Population in group**	**Number ranked poor in group**	**Group as % of total population**	**Poor as % of total population**
Urban domestic water consumers				
Rural domestic water consumers				
Farmers and farm labour				
Industry and industrial workers				
Government and commercial				
Other (to be described)				

6.2 Impact of measure (Social)

Group: …… (Population ……); *Sub-group:* (e.g. Poor/vulnerable)….. (Population…..); *Location:* Ref. ……

Social Indicator	**Potential impact on group**				
	Very positive	**Slightly positive**	**No change**	**Slightly negative**	**Very negative**
Access to water					
Quality of water					
Effect on livelihood					
Affordability					
Sense of empowerment					
Health					

6.3 Impact of measure (Financial)

- Net financial benefit (or loss) arising from implementation of measure per individual, family or enterprise

7. Implementation

7.1 Preconditions to implementation

- Strategic plan and review of planning legislation and regulations

7.2 Likelihood of success

Viability	**1 - 5**	**Mean score**
Ease of implementation	**1 - 5**	

DATA SHEET

Ref No. AA4 Crop Area Prohibition

1. Description

This measure will bring about change by banning the use of water for irrigation of selected areas and/or selected high water using crops. This measure has an equivalent impact to AA3 – Change land use.

2. The measure is normally implemented by one of the following agencies:

Government	National	**X**
	Regional or State	**X**
	Municipal	
	Local	**X**
Water supplier	Public utility	
	Private	
	Public-private-partnership	
	Public-private-community partnership	
	Community	
Water consumer	Community	
	Family/individual	
	Agricultural	
	Industrial	

3. Supporting measures may be required through:

Domestic/municipal/industrial		**Agriculture**	
Public awareness campaign		Public awareness or information campaign	**X**
Legislation and regulation		Legislation and regulation	**X**
Advice to industry		Agricultural extension services	**X**
Metered water supplies		Metered agricultural wells or supply	
Public-private-community participation		Water rights/licensing/registration	
Community mobilization		Monitoring and enforcement	**X**
		Subsidy introduction to be considered	

4. Example of the unit cost of water saved or made available through the measure

Examples are as measure AA3

Location Items	India (USD/m3)	Jordan (USD/m3)	Oman (USD/m3)
Cost of water	0.002	0.03-0.94	0.002-0.08

5. Subsidy or tax issues

Compensation may be required if farming is already in place.

6. Potential impact on community

6.1 Groups directly affected

Population of project area (including those affected and those not affected by the measure): …….

Type of group affected	**Population in group**	**Number ranked poor in group**	**Group as % of total population**	**Poor as % of total population**
Urban domestic water consumers				
Rural domestic water consumers				
Farmers and farm labour				
Industry and industrial workers				
Government and commercial				
Other (to be described)				

6.2 Impact of measure (Social)

Group: …… (Population ……); *Sub-group:* (e.g. Poor/vulnerable)….. (Population…..); *Location:* Ref. ……

Social Indicator	**Potential impact on group**				
	Very positive	**Slightly positive**	**No change**	**Slightly negative**	**Very negative**
Access to water					
Quality of water					
Effect on livelihood					
Affordability					
Sense of empowerment					
Health					

6.3 Impact of measure (Financial)

- Net financial benefit (or loss) arising from implementation of measure per individual, family or enterprise

7. Implementation

7.1 Preconditions to implementation

- Evaluation of demands and rationalization of appropriate allocations.
- Agreement with stakeholders and community.

7.2 Likelihood of success

Viability	**1 - 5**	**Mean score**
Ease of implementation	**1 - 5**	

DATA SHEET

AA5 Change Cropping Patterns

(a) through extension services; (b) through applying tax; (c) through market support

1. Description

This measure relates to a change of cropping pattern from high irrigation water requirement (e.g. paddy and sugarcane) to lower irrigation water requirement (upland crops). Different supporting measures could be employed to bring about the changes, including services to classify land suitability and markets for new products.

2. The measure is normally implemented by one of the following agencies:

Government	National	**X**
	Regional or State	**X**
	Municipal	
	Local	**X**
Water supplier	Public utility	
	Private	
	Public-private-partnership	
	Public-private-community partnership	
	Community	
Water consumer	Community	
	Family/individual	
	Agricultural	
	Industrial	

3. Supporting measures may be required through

Domestic/municipal/industrial		**Agriculture**	
Public awareness campaign		Public awareness or information campaign	**X**
Legislation and regulation		Legislation and regulation	**X**
Advice to industry		Agricultural extension services	**X**
Metered water supplies		Metered agricultural wells or supply	
Public-private-community participation		Water rights/licensing/registration	
Community mobilization		Monitoring and enforcement	**X**
		Subsidy introduction to be considered	

4. Example of the unit cost of water saved or made available through the measures

India In Tamil Nadu, India, the potential for water saving in replacing two paddy crops (22,208 m^3/ha) by paddy-groundnut (13,888 m^3/ha) would be 8,320 m^3/ha/year.

For the purpose of reducing water requirement for irrigation, groundnut would be a promising crop for extension. Other crops such as vegetables and chillies could be in a list of crop diversification program for saving water. Agricultural extension work and associated demonstration farms may be required to convince farmers to change and to establish new market channels for new products.

Oman High water using crops, currently grown in Oman are alfalfa, Rhodes grass and dates. Analysis shows that by changing from these crops to annual crops, which can be grown in the winter season, there are benefits not only to the nation in saving water but also better financial returns would accrue to the farmer. Proposed changes of cropping system should take into account soil suitability analyses and farm types and should be supported by extension. The estimated cost is RO 500/ha equivalent to an annualised cost of 43.59 RO/ha/yr. Besides extension services, changing the cropping system from perennial to annual crops requires (i) a stable market; and (ii) suitable post-harvesting technology (dates and grass can be easily stored when the market is not favourable).

The anticipated water savings calculated are based on the prevalent and assumed changed cropping patterns for the different types of farms and the crop-specific consumptive water use, irrigation efficiency and the total evaporation losses in the sub-regions. The weighted average of water saving varies from 1,150m^3/ha/yr in Sohar to 5,440m^3/ha/yr in Umayri. Unit cost of water saved would be 0.008-0.038 RO/m^3 (0.02-0.09 US$/$m^3$).

Unit cost of water saved or made available

Location / Items	India (USD/m3)	Jordan (USD/m3)	Oman (USD/m3)
Cost of water	NA	-	0.02-0.09

5. Subsidy and tax issues

For AA5(b) crop specific tax may be considered on cultivation of high water using crops and AA5(c) market support may be considered for low water consuming crops.

6. Potential impact on community

6.1 Groups directly affected

Population of project area (including those affected and those not affected by the measure): ……

Type of group affected	Population in group	Number ranked poor in group	Group as % of total population	Poor as % of total population
Urban domestic water consumers				
Rural domestic water consumers				
Farmers and farm labour				
Industry and industrial workers				
Government and commercial				
Other (to be described)				

6.2 Impact of measure (Social)

Group: …… (Population ……); *Sub-group:* (e.g. Poor/vulnerable)….. (Population…..); *Location:* Ref. ……

Social Indicator	Potential impact on group				
	Very positive	Slightly positive	No change	Slightly negative	Very negative
Access to water					
Quality of water					
Effect on livelihood					
Affordability					
Sense of empowerment					
Health					

6.3 Impact of measure (Financial)

- Net financial benefit (or loss) arising from implementation of measure per individual, family or enterprise

7. Implementation

7.1 Preconditions to implementation

- Evaluation of impact on farmers and need for compensation

7.2 Likelihood of success

Viability	**1 - 5**	**Mean score**
Ease of implementation	**1 - 5**	

DATA SHEET

Ref No. AA6 - Introduce Water Markets

1. Description

Water markets are markets in which water utilisation rights are traded. Inter-sectoral rights would allow water to be traded between water using sectors (e.g. agricultural use and domestic water use). Markets can in some instances help to redress the imbalance that has arisen in the value of water for different uses thereby alleviating shortages. Markets are not commonplace in the world and the introduction requires detailed study before they are introduced to evaluate the potential impact of doing so, particularly on the poor. Pre-cursors to water markets are the establishment of fully specified property rights and water abstraction licenses.

2. The measure is normally implemented by one of the following agencies:

Government	National	**X**
	Regional or State	**X**
	Municipal	**X**
	Local	**X**
Water supplier	Public utility	
	Private	
	Public-private-partnership	
	Public-private-community partnership	
	Community	
Water consumer	Community	
	Family/individual	
	Agricultural	
	Industrial	

3. Supporting measures may be required through:

Study, specification of existing property and water rights. Definition and issue of water licences/registration and agreements on water rights. Legislation. Public awareness campaign to precede the introduction of water markets.

Domestic/municipal/industrial		**Agriculture**	
Public awareness campaign		Public awareness campaign	**X**
Legislation and regulation	**X**	Legislation and regulation	**X**
Advice to industry		Agricultural extension services	
Metered water supplies	**X**	Metered agricultural wells or supply	**X**
Public-private-community participation		Water rights/licensing/registration	**X**
Community mobilization		Monitoring and enforcement	
		Subsidy introduction to be considered	

4. Unit cost of water saved or made available

The potential amount of water saved or made available is nil. Water abstraction may increase rather than decrease. The cost of this water demand management and supporting measures will be site specific.

5. Subsidy or tax issues

Not applicable

6. Potential impact on community

6.1 Groups directly affected

Population of project area (including those affected and those not affected by the measure): ……

Type of group affected	**Population in group**	**Number ranked poor in group**	**Group as % of total population**	**Poor as % of total population**
Urban domestic water consumers				
Rural domestic water consumers				
Farmers and farm labour				
Industry and industrial workers				
Government and commercial				
Other (to be described)				

6.2 Impact of measure (Social)

Group: …… (Population ……); *Sub-group:* (e.g. Poor/vulnerable)….. (Population…..); *Location:* Ref. ……

Social Indicator	**Potential impact on group**				
	Very positive	**Slightly positive**	**No change**	**Slightly negative**	**Very negative**
Access to water					
Quality of water					
Effect on livelihood					
Affordability					
Sense of empowerment					
Health					

6.3 Impact of measure (Financial)

- Net financial benefit (or loss) arising from implementation of measure per individual, family or enterprise

7. Implementation

7.1 Preconditions to implementation

- Study, specification of existing property and water rights.

7.2 Likelihood of success

Viability	**1 - 5**	**Mean score**
Ease of implementation	**1 - 5**	

DATA SHEET

Ref No. AA7 Introduce Water Tariffs
(a) based on volume pumped
(b) based on power supplied to pumps
(c) based on area irrigated

1. Description

The measure would have to be introduced at a regional or national level with the aim of reducing agricultural water consumption. The choice of tariff levels requires considerable extra study and piloting. Tariffs may only lead to higher costs of produce or to farmers changing to higher value crops. The impact of the measure is unpredictable and may be to increase rather than reduce agricultural water use.

2. The measure is normally implemented by one of the following agencies:

Government	National	**X**
	Regional or State	**X**
	Municipal	**X**
	Local	
Water supplier	Public utility	
	Private	
	Public-private-partnership	
	Public-private-community partnership	
	Community	
Water consumer	Community	
	Family/individual	
	Agricultural	
	Industrial	

3. Supporting measures may be required through

Study, evaluation of tariff structure and potential impact. Public awareness campaign. Metering of wells, monitoring and enforcement. Introduction of billing and payment system. Licensing and registration and agreements on water rights.

Domestic/municipal/industrial		**Agriculture**	
Public awareness campaign		Public awareness campaign	**X**
Legislation and regulation	**X**	Legislation and regulation	**X**
Advice to industry		Agricultural extension services	
Metered water supplies	**X**	Metered agricultural wells or supply	**X**
Public-private-community participation		Water rights/licensing/registration	**X**
Community mobilization		Monitoring and enforcement	
		Subsidy introduction to be considered	

4. Unit cost of water saved or made available

Nil. Water abstraction may increase rather than decrease. Cost of water demand management measure and supporting measures will be site specific

5. Subsidy or tax issues

Not applicable

6. Potential impact on community

6.1 Groups directly affected

Population of project area (including those affected and those not affected by the measure): ……

Type of group affected	**Population in group**	**Number ranked poor in group**	**Group as % of total population**	**Poor as % of total population**
Urban domestic water consumers				
Rural domestic water consumers				
Farmers and farm labour				
Industry and industrial workers				
Government and commercial				
Other (to be described)				

6.2 Impact of measure (Social)

Group: …… (Population ……); *Sub-group:* (e.g. Poor/vulnerable)….. (Population…..); *Location:* Ref. ……

Social Indicator	**Potential impact on group**				
	Very positive	**Slightly positive**	**No change**	**Slightly negative**	**Very negative**
Access to water					
Quality of water					
Effect on livelihood					
Affordability					
Sense of empowerment					
Health					

6.3 Impact of measure (Financial)

- Net financial benefit (or loss) arising from implementation of measure per individual, family or enterprise

7. Implementation

7.1 Preconditions to implementation

- Study, specification of existing property and water rights.

7.2 Likelihood of success

Viability	**1 - 5**	**Mean score**
Ease of implementation	**1 - 5**	

DATA SHEET

Ref No. AS1 Formation of Water Users Associations

1. Description
Where the supply of water is restricted or unreliable, the formation of water Users Associations manages the demand for water through consents and agreement to make the most appropriate and best use of the available water.

2. The measure is normally implemented by one of the following agencies:

Government	National	
	Regional or State	
	Municipal	
	Local	
Water supplier	Public utility	
	Private	
	Public-private-partnership	
	Public-private-community partnership	
	Community	
Water consumer	Community	
	Family/individual	
	Agricultural	**X**
	Industrial	

3. Supporting measures may be required through

Domestic/municipal/industrial		Agriculture	
Public awareness campaign		Public awareness campaign	
Legislation and regulation		Legislation and regulation	
Advice to industry		Agricultural extension services	**X**
Metered water supplies		Metered agricultural wells or supply	
Public-private-community participation		Water rights/licensing/registration	**X**
Community mobilization		Monitoring and enforcement	
		Subsidy introduction to be considered	

4. Unit cost of water saved or made available
Community management time and costs. Savings in time traveling, waiting for and accessing water. Water saved through improved management of resource at farm level.

5. Subsidy or tax issues
Not applicable

6. Potential impact on community

6.1 Groups directly affected

Population of project area (including those affected and those not affected by the measure): ……

Type of group affected	Population in group	Number ranked poor in group	Group as % of total population	Poor as % of total population
Urban domestic water consumers				
Rural domestic water consumers				
Farmers and farm labour				
Industry and industrial workers				
Government and commercial				
Other (to be described)				

6.2 Impact of measure (Social)

Group: ……. (Population ……); *Sub-group:* (e.g. Poor/vulnerable)….. (Population…..); *Location:* Ref. ……

Social Indicator	**Potential impact on group**				
	Very positive	**Slightly positive**	**No change**	**Slightly negative**	**Very negative**
Access to water					
Quality of water					
Effect on livelihood					
Affordability					
Sense of empowerment					
Health					

6.3 Impact of measure (Financial)

- Net financial benefit (or loss) arising from implementation of measure per individual, family or enterprise

7. Implementation

7.1 Preconditions to implementation

- Study, specification of existing property and water rights.

7.2 Likelihood of success

Viability **1 - 5**

Ease of implementation **1 - 5**

Mean score

DATA SHEET

Ref No. AS2 Population distribution

1. Description

Regional planning and controls on population and its distribution and the associated domestic and industrial infrastructure. Applicable to areas with insurmountable water shortages.

2. This measure is normally implemented by:

Government	National	**X**
	Regional or State	**X**
	Municipal	**X**
	Local	**X**
Water supplier	Public utility	
	Private	
	Public-private-partnership	
	Public-private-community partnership	
	Community	
Water consumer	Community	
	Family/individual	
	Agricultural	
	Industrial	

3. Supporting measures which may be required

Domestic/municipal/industrial		**Agriculture**	
Public awareness campaign		Public awareness campaign	
Legislation and regulation	**X**	Legislation and regulation	**X**
Advice to industry		Agricultural extension services	
Metered water supplies		Metered agricultural wells or supply	
Public-private-community participation		Water rights/licensing/registration	
Community mobilization		Monitoring and enforcement	
		Subsidy introduction to be considered	

4. Example of the unit cost of water saved or made available through the measure

Not applicable

5. Subsidy or tax issues

Not applicable.

6. Potential impact on community

6.1 Groups directly affected

Population of project area (including those affected and those not affected by the measure): ……

Type of group affected	**Population in group**	**Number ranked poor in group**	**Group as % of total population**	**Poor as % of total population**
Urban domestic water consumers				
Rural domestic water consumers				
Farmers and farm labour				
Industry and industrial workers				
Government and commercial				
Other (to be described)				

6.2 Impact of measure (Social)

Group: …… (Population ……); *Sub-group:* (e.g. Poor/vulnerable)….. (Population…..); *Location:* Ref. ……

Social Indicator	**Potential impact on group**				
	Very positive	**Slightly positive**	**No change**	**Slightly negative**	**Very negative**
Access to water					
Quality of water					
Effect on livelihood					
Affordability					
Sense of empowerment					
Health					

6.3 Impact of measure (Financial)

- Net financial benefit (or loss) arising from implementation of measure per individual, family or enterprise

7. Implementation

7.1 Preconditions to implementation

- Evaluation of potential impact of measure
- Preparation of legislation

7.2 Likelihood of success

Viability **1 - 5**

Ease of implementation **1 - 5**

Mean score

DATA SHEET

Ref No. AS3 Migration

1. Description

Migration may be spontaneous or induced. Where water shortages are extreme, communities may migrate to areas where water is less scarce or Government may encourage migration to less water short areas.

2. This measure is normally implemented by:

Government	National	**X**
	Regional or State	**X**
	Municipal	**X**
	Local	**X**
Water supplier	Public utility	
	Private	
	Public-private-partnership	
	Public-private-community partnership	
	Community	
Water consumer	Community	**X**
	Family/individual	**X**
	Agricultural	**X**
	Industrial	**X**

3. Supporting measures which may be required

Domestic/municipal/industrial		Agriculture	
Public awareness campaign		Public awareness campaign	
Legislation and regulation	**X**	Legislation and regulation	**X**
Advice to industry		Agricultural extension services	
Metered water supplies		Metered agricultural wells or supply	
Public-private-community participation		Water rights/licensing/registration	
Community mobilization	**X**	Monitoring and enforcement	
		Subsidy introduction to be considered	

4. Example of the unit cost of water saved or made available through the measure

Not applicable

5. Subsidy or tax issues

Not applicable.

6. Potential impact on community

6.1 Groups directly affected

Population of project area (including those affected and those not affected by the measure): …….

Type of group affected	Population in group	Number ranked poor in group	Group as % of total population	Poor as % of total population
Urban domestic water consumers				
Rural domestic water consumers				
Farmers and farm labour				
Industry and industrial workers				
Government and commercial				
Other (to be described)				

6.2 Impact of measure (Social)

Group: …… (Population ……); *Sub-group:* (e.g. Poor/vulnerable)….. (Population…..); *Location:* Ref. ……

Social Indicator	**Potential impact on group**				
	Very positive	**Slightly positive**	**No change**	**Slightly negative**	**Very negative**
Access to water					
Quality of water					
Effect on livelihood					
Affordability					
Sense of empowerment					
Health					

6.3 Impact of measure (Financial)

- Net financial benefit (or loss) arising from implementation of measure per individual, family or enterprise

7. Implementation

7.1 Preconditions to implementation

- Evaluation of potential impact of measure
- Preparation of legislation

7.2 Likelihood of success

Viability	**1 - 5**	**Mean score**
Ease of implementation	**1 - 5**	

C3. WATER SUPPLY & WATER QUALITY IMPROVEMENT OPTIONS

The management of water demand becomes of key importance once the available water supply can no longer meet the demand for water and when the supply or augmentation options become either technically difficult or economically unviable. It is important, therefore, to have a clear idea of supply options and their costs before considering significant water demand management measures. A list of elements of potential supply measures for increasing supplies for domestic/municipal use and for agriculture is given in the Table C1 below. Potential measures for improving water quality are given in Table C2. Not all these measures will necessarily apply or be relevant to any one area or region. Many of them will, however, have been considered or adopted before demand management measures become an over-riding necessity.

Table C1 Water supply and resource augmentation options

	WATER SUPPLY / AUGMENTATION			
		Domestic/municipal		**Agriculture**
Developmental and technical measures	D1	Develop additional groundwater (wellfield)	A1	Develop additional groundwater (wellfield)
	D2	Desalination (a) seawater (b) brackish water		
	D3	Blending of water supplies		
	D4	New water treatment facilities	A2	Treat/use wastewater
	D5	Improve/extend water distribution system (fixed infrastructure)	A3	Improve/extend water distribution system
	D6	Improve/extend water distribution system (water tankers)		
	D7	Retention dams & reservoirs	A4	Retention dams & reservoirs
	D8	Aquifer recharge: a) dam/tank b) well	A5	Aquifer recharge: a) dam/tank b) well
	D9	Increased abstraction from surface water sources	A6	Increased abstraction from surface water sources
	D10	Rainwater harvesting	A7	Rainwater harvesting
	D11	Trans basin water transfer (import)	A8	Trans basin water transfer (import)
			A9	Cloud seeding

The supply of water may be restricted on account of its quality or susceptibility to pollution. In Table C2 below, a number of elements of measures that could be taken to secure a improved quality of water are listed and these measures may prove of higher priority than searching for new supplies of water.

Table C2 Water quality improvement options

		WATER QUALITY IMPROVEMENT			
		Domestic/municipal		**Agriculture**	
	Developmental and technical measures				
		QD1	Sewage collection/reticulation system	QA2	Pollution control (reduction in use of pesticides/fertilisers, control on pollutant disposal)
		QD2	Construct sewage treatment plant		
		QD3	Wellfield protection zones (a) Community source protection (b) Government implemeted		
			Industrial/commercial		
		QD4	Pollution control by: a) providing collection stations		
		QD5	Control landfill and tipping		
		QD6	Pollution control by: a) disincentives for polluters b) incentives for clean technology		

The relative costs of water supply and water quality improvement measures and the contributions that they can make to increase the water availability must also be borne in mind, of course, when considering them or comparing them with demand management options. Some examples of cost estimates of components of a number of water supply options, based on data from Chennai, Tamil Nadu, India are given in Table C3.

Table C3 Cost of components of water produced (US$/m^3)

Option	Description	Cost of Water (US$/m^3)	Water made available at
D1/A1	Develop additional groundwater (wellfield)	0.14	at head of distribution system
	Develop additional g.w. and supply to city (Veeranam)	0.39	at head of distribution system
D2	Desalination	1.01	at plant
D4	New water treatment facilities	0.06	at treatment plant (cost of facility only)
D5	Extend water distribution system	0.16	average for city supply system
D6	Extend tanker distribution		
D7/A3	Retention dams and reservoirs	0.24	at aquifer
D8/A4	Aquifer recharge (dam)		
D9/A5	Increased surface water diversion		
D11/A7	Trans basin water transfer		
A2	Treat/use wastewater	0.06	at treatment plant (cost of facility only)

Examples of cost estimates of components of a number of water supply options, based on data made available in Jordan, are given in Table C4. These costs are based on schemes that have been studied or implemented in Jordan.

Table C4 Cost of components of water produced (US$/m^3)

Option	Description	Cost of Water (US$/m^3)	Water made available at
D1/A1	Develop additional GW	0.09-0.12	at wellhead
	Develop additional surface	3.67	at dam outlet
D2	Desalination	1.00-1.97	at plant
D4	New water treatment facilities		
D5	Extend water distribution system	0.92	at consumer (transfer to Ma'an and distribution)
D7/A3	Retention dams and reservoirs	3.66	at dam outlet
D8/A4	Aquifer recharge (dam)	0.12	In aquifer
D11/A7	Trans basin water transfer	0.67-1.63	Amman from Jordan river, from Lebanon
A2	Treat/use wastewater	0.51	at treatment plant