

MOST WORTHWHILE USE OF WATER

**Efficiency, Equity and Ecologically Sound Use;
Pre-requisites for 21st Century Management**

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SWEDISH INTERNATIONAL DEVELOPMENT
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Publications on Water Resources

This series covers issues on water resources from a development cooperation perspective. Sida's Department for Natural Resources and the Environment believes that the publications will be of interest to those involved in this field of work.

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FOREWORD

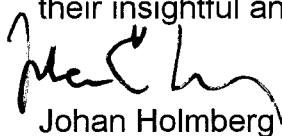
During the 20th century the rate of water withdrawals in the world has increased 2,5 times faster than population, and with accelerating economic growth in developing countries it is increasing yet faster. The signs of an oncoming crisis are ominous in large parts of the world. As much as one-third of the world population lives in countries suffering from moderate to severe water resources stress in terms of water use relative to availability. Current estimates are that by 2025 two-thirds of the world population could be thus affected.

Despite a number of international conferences on this subject ever since Mar del Plata in 1977 the water crisis has not really caught on in international discourse. The issue of freshwater resources was largely forgotten in the report of the Brundtland Commission that paved the way for the UN conference on environment and development (UNCED) in Rio in 1992. Perhaps as a result, it was also neglected by the environmental movement which in the run-up to UNCED focused more on pollution and biodiversity issues. Agenda 21 does have a lengthy chapter on freshwater resources. However, with a multitude of UN agencies claiming a role the water sector remains characterized by fragmentation and lack of international leadership.

It is against this background that the Swedish Government in collaboration with other donors funded a comprehensive review of the world's fresh water resources. The report, the *Comprehensive Assessment of the Freshwater Resources of the World*, was completed in late 1996. That report provides a broad assessment of the water sector complete with projections of future water withdrawals and recommendations for action by governments.

The present paper has been prepared at the request of the Swedish Ministry for Foreign Affairs and Sida to focus on the policy agenda consistent with sustainable water resources management. The point of departure is the set of four principles for sustainable water resources management agreed in Dublin in early 1992 and later incorporated in chapter 18 of Agenda 21. The paper draws on the *Comprehensive Assessment* and enhances its reasoning in respect of policy prescriptions.

The paper has been written by Professor Jan Lundqvist, Department of Water and Environmental Studies at the University of Linköping, and Dr. Klas Sandström, Network Officer at the Secretariat of the Global Water Partnership at Sida. I am indebted to them both for their insightful and thorough analysis of this important subject.



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SUMMARY

Water is an indispensable resource. It is vital for life and human well-being. It is necessary for almost any kind of activity and its role in the landscape and in ecosystems is of an integral character. The recognition of water as a life giving and basic resource is widespread.

Rapid population growth, poverty and changes in life-style contribute to growing scarcity and threats of water and environmental degradation. In areas where overall availability is small and where additional withdrawals are difficult and expensive, scrutiny of water use and sectoral allocation assume prime significance. The heydays of solving water scarcity with concrete and steel, i.e. to build dams and pipelines, are over even if additional supply will have to be contemplated.

Educational measures, feminization of approaches and demand management are components of strategies that have to be developed in order to stimulate the most worthwhile overall use. Social, economic and environmental considerations form a common basis for management.

Considerable subsidies have been geared to the water sector. Unfortunately, they have only to a certain degree reached the poor. Subsidies are motivated from a social point of view. An alternative to subsidising water is to provide economic or other support directly to the poor and to such activities that are deemed important.

The notion of water as an economic good is important in the review of management approach. It must be combined with social and environmental objectives. The implementation of this concept needs further clarification and guidance. Identification of 'life-line tariff' of water is one attempt in this regard. In any case, there is a need of models that can be used for the proper allocation of water between competing and incompatible water requirements.

POLICY IMPLICATIONS TO STIMULATE THE MOST WORTHWHILE USE OF WATER

1. COMBINE EFFICIENCY CRITERIA WITH SOCIAL AND ENVIRONMENTAL OBJECTIVES

Since water is a finite and vulnerable resource, unevenly distributed in time and space and progressively expensive and problematic to develop, a prerequisite to meet social objectives and ecological needs is that water is used as efficiently as appropriate in all sectors. *Therefore, wherever the natural availability or the arranged supply is inadequate to satisfy all demands, an analysis must be made of the various costs and benefits associated with alternative and competing demands for water.* Costs include investments in water development, distribution and treatment, maintenance & operation, and detrimental effects on the environment. Indirect costs, emanating from the allocation to activities generating low value per unit of water, i. e. opportunity costs, are becoming increasingly important and should be considered. Benefits include the potential for increased employment, production, alleviation of poverty and improved human satisfaction, e g better health. Implementation of this policy may include private sector engagement, including commercialised government owned utilities. This has been shown in many countries, for example in South Africa, where small firms have become involved in water supply and sanitation projects. *Without making this kind of analysis it is impossible to know how to best allocate a limited resource and how to monitor performance of use.*

2. USE SUBSIDIES FOR WHAT THEY ARE AIMED FOR AND NOT TO HELP THE RICH

The water sector is today subsidised by an average of about 80%. Considering that rich and influential people are generally quite well served with piped water and irrigation water, whereas some one billion of the poor and other disadvantaged groups lack access to safe water, it is obvious that the massive subsidies are misdirected. Equally significant, the combination of subsidies and lack of attempts to monitor performance in water use, results in massive water waste. But subsidies are not inherently "bad". On the contrary, they can provide clear social benefits to poor segments of society and they could promote a desirable pattern of use. Subsidies must be openly debated and analysed in terms of costs and benefits. The principle should be: *Subsidise the poor, not the water.* The poor could be catered for by extending infrastructure, improving utilities and service level or through retirement schemes. Cross-subsidies in terms of block and so-called life-line tariffs are important. *"Free services" should not be allowed as a hidden approach to subsidise the rich. Every service must have a reciprocal and reasonable responsibility on the part of the individual consumer or the community.*

3. STRENGTHEN WOMEN BY EDUCATING THE WATER MANAGERS OF THE 21ST CENTURY

The crucial and multiple roles of women in water management have been repeatedly recognised. An argument for paving the way for women in water management is their concern and special obligation for children. However, strategies to involve women have primarily been based on gender considerations. Their prominent role in inter-generation care is largely left out or taken for granted.

It is often stated that since tomorrow's mothers are already born, an unavoidable population growth is imminent. In a similar fashion, since tomorrow's water managers are already born, we have to educate them properly today. Women possess the kind of water awareness that is needed, and in many countries the proportion of women who could be enrolled as teachers and educators is high and growing. *Children and proper education are fundamental pillars for sustainable water use in the 21st century. In many water scarce countries "water" is already part of the school curriculum, but this has to be extended. Depending on the local water conditions, school curriculum, literature and concepts must be appropriate at all levels of training, including university.*

4. DEFINE THE ROLES OF POLLUTERS AND THE PUBLIC SECTOR IN THE IMPLEMENTATION OF PPP

The Polluter Pays Principle (PPP) is a sound concept which is widely endorsed. While the polluters must take responsibility and pay for environmental degradation, the public sector must set standards, provide monitoring and enforcement mechanisms, and initiate major infrastructure investments, e.g. in effluent treatment plants. *Hence, a partnership between environment protection agencies (governments, authorities) and polluters (industries, farms, urban councils) is needed, where the roles and the responsibilities of both parties are clarified and made transparent.* Furthermore, environmental improvements could be speeded up if *compartmentalised efforts are suspended and joint strategies worked out.* It seems particularly important that authorities are not only confined to end-of-pipe monitoring and policing tasks. Instead, more effort should be geared towards measures which advocate technological improvements in production, consumer awareness and similar aspects. *Associated with the PPP concept is the dual role of authorities: the implementor and the monitor. Both roles cannot be combined in the same office or under the same leadership. The roles are different and have to be kept apart for successful and efficient water quality management.*

5. CHANGE GOVERNMENT INTERFERENCE, ALLOW FARM FAMILIES TO MAKE DECENT EARNINGS FROM THEIR FIELDS, AND STIMULATE RAINFED AGRICULTURE PRODUCTIVITY

Rural farm-families, relying on rainfed agriculture for their survival, are not subject to demand management principles. However, they are responding to the incentives of good farm-gate prices, which encourage land investments and sustainable land husbandry practices. This in turn favours high crop yields - which reduce evaporation losses and surface runoff, and increase productive transpiration "losses" of water. Hence, through favourable farm-gate prices, rainfed agriculture is given an opportunity to increase its productivity. *National government policies and international trade conditions should therefore favour good farm-gate prices. Market distortions and barriers to trade are effective hindrances to proper resource utilization. Since a vast majority of the Third World are farmers, it is in their interest to promote any crop use, production system or trade condition that increase their income. Whether this implies international export, urban-rural trade or local sale, it should not be hindered by national or international regulation systems, quotas, subsidies or unfair pricing mechanisms.* The policy must be to focus on the typical, rural, family farmer - can he or she increase water use efficiency by increasing production, then a major step forward has been taken. Considering that most food in the world today is produced under rainfed conditions, a small increase in that sector produces more food than a similar increase in the comparatively smaller irrigation sector.

6. ESTABLISH RIVER BASIN COMMISSIONS AND PROMOTE INTEGRATED WATER RESOURCES MANAGEMENT

The ultimate policy in regard to sustainable and efficient water use, is the adoption of integrated water resources management (IWRM). The approach implies an emphasis on a decentralised, transparent and productive water use. It implies that all competing uses are recognised, evaluated (according to a definition on most worthwhile water use with regard to society's overall need) and prioritised, with consideration to egalitarian and ecological objectives. The approach must be flexible; in different places will different water uses be favoured. *Donors and governments alike should support and adopt comprehensive IWRM approaches. Although difficult to develop and implement, it represents a long-term solution to coping with water scarcity and the development of a fair society.*

1. WATER MARKS A TURN IN THE ENVIRONMENTAL CONCERN

Water issues have become prominent on the international agenda in recent years. At the national and regional level, they constitute prime political challenges with significant implications for economic development, food security, social welfare, political stability and environmental sustainability in large parts of the world. For individuals and communities, access to water, and notably safe water, could mean the difference between life and death or decent livelihood and dire destitution.

The increasing concern for water may be seen as a recent expression for an awareness of the opportunities but also profound constraints and problems that are associated with natural resources utilisation and environmental degradation. Historical analyses illuminate though, that the concern for natural resources and environmental degradation is not only a contemporary phenomenon. History is replete with examples of how vagaries of nature have hit people and civilisations, of squandering of essential and vulnerable resources and of massive pollution that have accumulated in the environment and become serious hazards for health, etc. But it is relevant to note a difference in the current concern. The debate since, say the 1960's, first focused on signs of serious ecological and societal implications from the poisoning of the living environment (cf. R. Carson's *Silent Spring*). Somewhat later, the threat of exhaustion of non-renewable resources, e.g. minerals and fossil energy sources in combination with massive pollution, came into focus (cf. message of the Club of Rome and other reports).

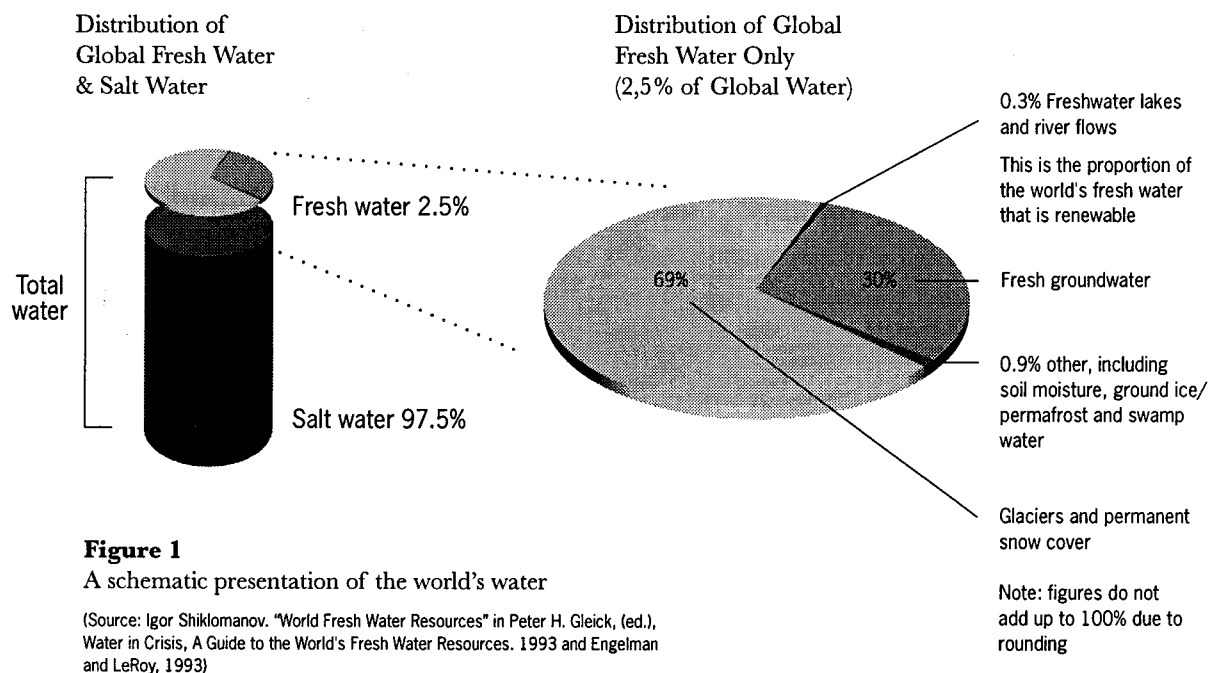
The current concern for water marks a difference in important respects. Now, it refers to a renewable resource, continuously regenerated through the hydrological cycle. Contrary to the previous worries about natural resources, which built on fairly scanty information and poor estimates, the knowledge about the size, the dynamics and the demand for water resources is much better. Even rather recent assumptions about the stock of mineral resources have gradually had to be upgraded. Today there are few, if any, colleagues who would claim that essential mineral resources are on the verge of exhaustion. An opposite view is noticeable with regard to water. The amount that is available has been reasonably well known for some time. We also know that requirements exceed supply in certain areas and during certain periods, with drastic consequences.

Water can not be substituted for in fundamental respects. This is the case with physiological needs. Water is also a sine qua non in biological and ecological systems. It can be used more or less efficiently, but in most cases water can not be replaced.

Contrary to most other natural resources, water can not be substituted for in fundamental respects. This is the case with the physiological needs for drinking water. Water is also a sine qua non in biological and ecological systems. It can be used more or less efficiently but in most cases, water can not be replaced. It can partly be substituted for in the sense that investments in, for example, drip irrigation technologies, will reduce the requirement for water. An important question is not only what amount of freshwater that can be extracted from rivers, lakes, ground and sea to cater for the demands in society, but also what amounts that should be extracted. So-called in-stream functions of water in rivers, lakes etc. are of great importance for society, directly and indirectly. When relatively more water is withdrawn from natural sources, these functions are threatened.

The amount of water on earth is certainly huge. But most of the water on the 'blue planet' is salt or brackish (about 98%). And out of the freshwater, most is fixed in permanent icecaps and as permafrost (over 70% of the freshwater) and a large fraction constitutes ground water (about 30%). A surprisingly tiny fraction of all water, constitutes the annually renewable source in terms of run-off

through streams and water courses (**Figure 1**). Moreover, the correlation between habitations and water availability is poor and trends are showing a worsening scenario. While about 300 million people in 1990 lived in areas labelled as water stressed/water scarce, defined as number of people per flow unit, estimates suggest that by 2025, this figure will have to be multiplied by 10 (Falkenmark and Rockström 1993, based on calculations by M. Arnestrand).



In the period of a generation, about three billion people, corresponding to about a third of the world population, may be found in countries characterised as water stressed, whereas the corresponding current proportion is less than 10%. The absolute and relative number of people residing in water short areas in relation to people living in areas where water is comparatively more abundant, is inevitably growing. This scenario suggests a challenging future in view of the fact that today, poverty and human destitution is highly correlated with water scarcity. In those parts of the world where water is already scarce, and where most of the easily available water resources have been developed, the rate of population growth has a corresponding and direct negative effect on the per capita amount of water availability.

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In chapter 2, some main points in the current discussion about what constitute challenging water issues are summarised. Chapter 3 addresses the rapidly growing problem of pollution and its relation to environmental degradation and human sufferings. In chapter 4, the links between efficiency, equity and ecologically sound use are seen in a common context. Finally, in chapter 5 an attempt is made pinpoint some of the implications for the 21st century management.

2. CHALLENGING ISSUES

2.1 The complexity of water scarcity

As indicated above, water is a finite but renewable resource, and inherently different from other natural resources. The hydro-climatological context sets the limits to water availability and influences its functions in the environment and its use in society. The increase in population and changes in human activities mean that the demand for water is increasing. Since the amount of freshwater is more or less constant on earth, although with considerable inter-annual and inter-seasonal variations, a logical consequence is that water is becoming relatively more scarce in relation to the growing demand for water. Although such a conclusion is correct at a general level, it is quite a narrow interpretation of the problem. Simple interpretations of the problem, which tend to flourish, are misleading and tend to block the advancement of proper policies.

Scarcity is partly a result of hydro-climatological and other physical circumstances, but it is also related to human capacity to capture rainwater and water flowing in stream, and to store it in reservoirs, above or below ground. Water in a river, even if it is nearby, or water in the ground is something quite different from water in a reservoir and, of course, water in a pipe. Scarcity, or rather shortage or lack of water in this connection, is both experienced in terms of poor access to the water that is developed and distributed through physical infrastructure and institutional arrangements, and in terms of poor availability in wells, springs and streams in rural areas. An important distinction must be made between the water which is available directly through the rains and in streams, lakes and in the ground, on the one hand, and water that is provided through societal arrangements, on the other. In some countries, the amount of water accessible through societal arrangements is comparatively limited and/or the distribution system may be poorly adjusted to settlement dynamics.

Water in a river or in the ground is something quite different from water in a pipe. An important distinction must be made between water available in streams, lakes and in the ground, and water that is provided through societal arrangements.

Shortage of water may be experienced by some groups, even in countries where rainfall is abundant or where streamflow (periodically) may be high. The fact that scarcity is experienced by certain groups in a society is not only due to low capacity of the supply arrangements but is often related to permissive use and abuse on the part of some groups in a society. If some people are lavish in their water use and if they pollute water, others will be deprived of certain quantities and they may suffer due to degrading water quality. Demand for water is dynamic and could be seen as a composite of several social and economic circumstances. If income changes and if people adopt 'new lifestyles', for instance, the demand for water is likely to change. Consequently, the demand for water and the actual per capita use varies considerably between different countries and between various social groups in a country.

Scarcity may therefore be regarded as to some extent relative, that is, over and above minimum provisions for basic human and ecosystems needs. If there is less water than what is physiologically and biologically required and if there is not enough to cater for hygienic practices and decent human well-being, it is justified to talk about acute scarcity and to meet these needs as a matter of priority. But when the basic needs have been met, the supply of additional amounts of water will gradually have to be scrutinised. Instead of ever more expensive and problematic interventions in the landscape in terms of dams, canals and ground water abstractions, most of which mean major environmental changes and movement of people, it is relevant to first have a critical look into the actual use of water above basic needs requirements. If demand and expectations for water is higher than what can be considered reasonable, and what can be accomplished within given financial and other resources, it is appropriate to scrutinise the composition of the demand instead of perpetuating the conventional policy to augment supply.

Instead of ever more expensive and problematic interventions in the landscape in terms of dams, canals and ground water abstractions, it is relevant to have a critical look into the actual use of water above basic needs requirements.

In **Figure 2**, an attempt is made to illustrate the relations between overall water availability in terms of rainwater and how technical and societal arrangements are applied in order to withdraw water from natural sources and supply it to various use(r)s. As indicated in the Figure, the logical step after water development is to decide how to allocate it to sectors and users and to monitor how water is used. Performance should be seen in relation to the accomplishment of various objectives such as health, employment, food output, income, etc. The figure also illustrates that disposal is an integral part of water use and that re-use of waste water should be considered.

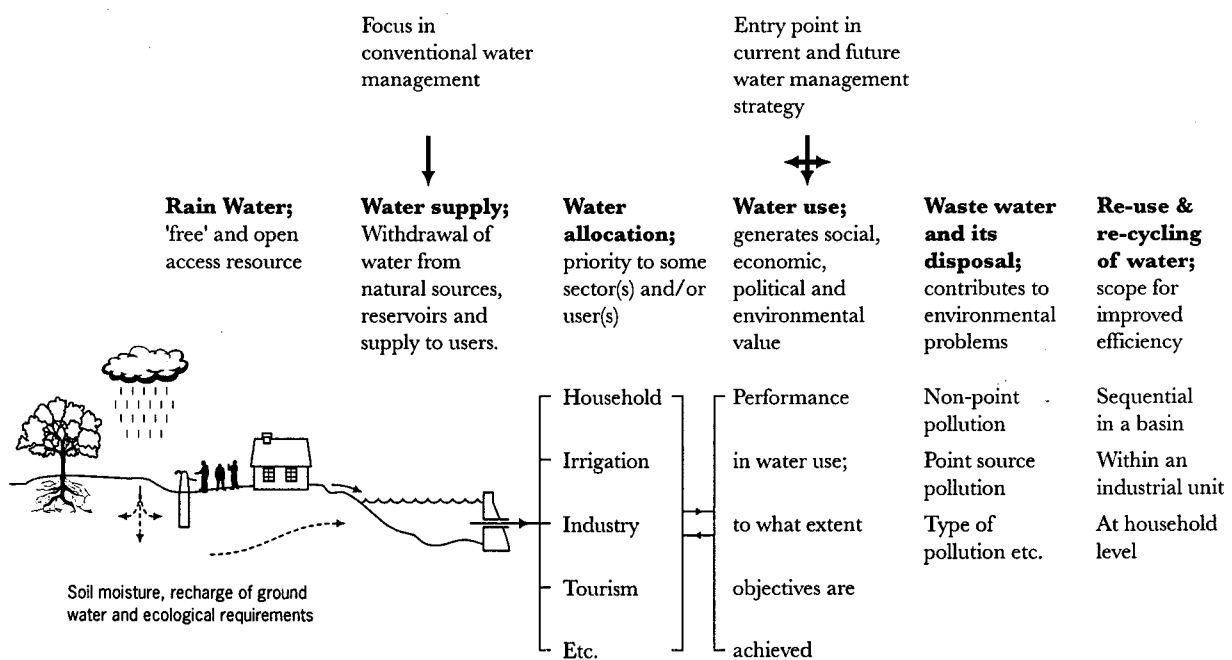


Figure 2

A schematic presentation of main stages in the availability and use of water in the landscape and in society. The upper part illustrates important changes in water management while the lower part indicates the principle difference between rain water and supplied water.

While attention conventionally has been focused on efforts to develop and supply water, surprisingly little concern has been paid to how limited amounts of water should be allocated to competing use(s) and how it is actually used. Today and for the future, the perspective is much wider. The entry point in water management strategies should be a consideration of how water is used, i.e. what social, economic and environmental value that is generated from water and how national, regional and local development objectives can be achieved. Closely linked with the 'new entry point' in management strategies, is the need to consider allocation. Needless to say, the efforts to develop and supply water, will continue to be important. In addition, the concern about re-use of waste water must be part of water management strategies, especially in urban areas (see further under point 4.2 below).

2.2 A BENCHMARK FOR WATER SCARCITY?

A basic problem in discussion about scarcity is to define what should comprise the essential requirements for water and thus at what level water may be considered scarce. Various attempts have been made to define the amount of water which may be considered as a basic or minimum requirement and below which scarcity or water stress may be said to prevail. A widely used figure is 1,000 m³/person, year to denote water scarcity and 1667 m³/person, year to denote water stress (Falkenmark, 1986; World Bank, 1993; Engelman & LeRoy, 1993). The figure of 1,000 m³/person and year is supposed to be a benchmark for the minimum amount required to meet the various requirements for water in a society. This amount would allow the development of the main sectors of society, including, food production, industries, social amenities etc. A major fraction, or some 75 - 90%, of the 1,000 or 1,667 m³ would be needed to make national food self-sufficiency possible in semi-arid regions, that is, to produce the national requirements of food domestically. As will be further commented below, the water requirement for food production is a crucial issue in considerations about water allocation and management.

The figure of 1,000 m³/person and year is supposed to be a benchmark for the minimum amount required to meet the various requirements for water in a society.

But many countries in the world have already today less water than this benchmark. This is especially noticeable in Middle East. Water availability below the benchmark is also found in regions and localities in many other parts of the world. Several countries in the Middle East have an overall availability of renewable freshwater which is currently only a fraction of the above mentioned benchmark. Libya, for instance, has about 110 (surface water is 'supplemented' by lifting large volumes of fossil ground water). Israel, Saudi Arabia and Jordan have about 300. With rapid population growth and with possible re-allocations between countries in the region, the per capita availability will be further reduced in the region. For Israel, for instance, it is calculated that the per capita availability till 2030 may be reduced to some 190 m³/person, year which include some 65 m³ of recycled waste water (Shuval, 1997).

2.3 SIGNIFICANT VARIATION IN RATE OF WITHDRAWAL

In arid and semi-arid areas, the natural availability is by definition very limited. This is the case in the countries mentioned above. In spite of very high relative rates of withdrawal, they are still unable to supply more than a very limited amount of water. The fraction of water that is withdrawn from the overall annual renewable flow in streams, ground, etc., varies considerably between countries. The amount of water that annually falls over land is estimated to be about 100,000 km³

(Figures vary between about 90,000 to 110,000; see UNCSD, 1997; Postel 1996; Engelman & LeRoy, 1993).

Most of it evaporates and transpires back to atmosphere from the landscape, or about 60,000 to 65,000 km³. Rainfed agriculture and many other functions in the landscape as well as in society are nourished through this flow. About 40 % or 40, 000 km³ flow through streams, and aquifers to the sea. It is primarily from rivers, lakes and ground that withdrawals can be made, but only a fraction of the 40,000 km³ can be withdrawn. Estimates suggest that with given technology, the amount that may be possible to withdraw is in the range of 12,000 to 14,000 km³. The global rate of withdrawal today is estimated to be between 4,000 to 5,000 km³, representing some 40% of what is considered possible to withdraw (further information is provided in documentation prepared for the Comprehensive Assessment of the Freshwater Resources of the World, see UNCSD, 1997).

The global rate of withdrawal today is about 4,000 to 5,000 km³ representing some 40% of what is considered possible to withdraw.

The variation in rates of withdrawal between countries is significant. Twelve countries in various part of the world have a withdrawal ratio of 40% or more. The most extreme cases are in the North Africa and the Middle East. Libya has a ratio of about 760 (i.e. they withdraw more than seven times the water that is yearly replenished), Qatar 102, Israel 84, Egypt 77 and Jordan 41. At the other end of the spectrum we find countries with a very low ratio: Brazil (0.6), Argentina (3.4) and Sweden (1.6). A large number of countries have a low ratio or a ratio up to about 20. USA has (18.9), Mexico (21.7), and Poland (21.9). (Figures compiled by Steering Committee for the Comprehensive Assessment of Freshwater Resources of the World, see UNCSD, 1997; Personal communication Pierre Najlis 1996).

The relative amount of water that can be withdrawn is determined by topographical and other physical factors in combination with investment and technological capacity. The amount that should be withdrawn is something quite different and must be seen in relation to environmental and social objectives. Excessive withdrawal of water from natural water bodies has an environmental cost as discussed by Postel (1996) apart from the heavy financial outlays. Moreover, big reservoirs are often causing inundation of settled areas and movement of people.

The relative amount of water that can be withdrawn is determined by topographical and other physical factors in combination with investment and technological capacity. The amount that should be withdrawn is something quite different and must be seen in relation to environmental and social objectives.

For countries faced with a quite limited availability, the development of all sectors of the economy is severely constrained. Food production, in particular, is hampered. Priorities in terms of what sectors, activities, regions, etc. that should be given water on a priority basis, and how much, will have to be made (see further under section 4.2 below). As a result of limited water resources, the water starved countries are increasingly dependent on the imports of food to feed a large and rapidly growing population. Tony Allan has estimated that the imports of food to the Middle East, comprising a population of some 300 million people today, requires a volume of water for its production which is roughly equivalent to 1.5 times the annual flow of the Euphrates (Allan 1994) or about the total

quota that Egypt has been allocated from the Nile, i.e. about 50 billion cu metres. This figure may be seen as an expression of the water deficit in the region, that is, if food self-sufficiency would be attempted. In any case, it is an expression of the fact that water is a quite limited resource which necessitates proper management and judicious utilisation.

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2.4 RELEVANCE OF RAIN WATER MANAGEMENT

In the discussion above, reference is mainly to the water supplied through various societal arrangements (cf. 'Focus in conventional water management' in Figure 2). However, in large parts of the world, and particularly in rural areas, people have to rely on whatever amounts of water that is given from the sky in form of rainfall. Some of this infiltrates into the ground and results in the growth of crops and other biomass, some recharges ground water, and some leaves the area as surface runoff or returns back to atmosphere as unproductive evaporation. Although it is often stated that irrigated agriculture is the main avenue open to increase future global food production, it should be remembered that about 60 % of all food is today produced under rainfed conditions. Hence, the proper utilisation of rain water is an imperative contribution to serve population now and in the future.

Although it is often stated that irrigated agriculture is the main avenue open to increase future global food production, it should be remembered that about 60 % of all food is today produced under rainfed conditions.

The question then arises: How can rain water handling and use be improved? And what are the factors involved? The key issue concerns the possibility to reduce the unproductive losses of water from the landscape in terms of evaporation and to transform rainwater to soil moisture and to recharge ground water aquifers. In a hot climate, the thirst of the atmosphere, i.e. the potential evapotranspiration, is quite high, often in the range of 2,000 to 2,500 mm/year. The amount of precipitation, which is generally below the potential evapotranspiration, is thus subject to rapid return flow to atmosphere. We can not stop the hydrological cycle and the return flow is an integral part of that cycle. The important task is to facilitate that as large a fraction as possible of the rains may infiltrate into the ground and thereby be accessible for the root systems of crops and other biomass. Rain water returning as transpiration through crops or other biomass instead of unproductive evaporation from open surfaces, makes a significant difference for the community who depend on the land and the water. In **Figure 3**, an illuminating illustration of the various fractions of water flows in the landscape indicates the challenge but also the potential to improve the utilisation of local rains in hot climates.

Sandström (1995) has shown that the ratio between productive use of water and unproductive losses of water is closely related to land use. When land is under forest or thick grass cover, little water is lost by evaporation and surface runoff, as compared to open, degraded and low-producing farmland, where much water is evaporated and lost by surface runoff, thus reducing the amount of water available for productive biomass growth. Furthermore, land use also has a decisive effect to the

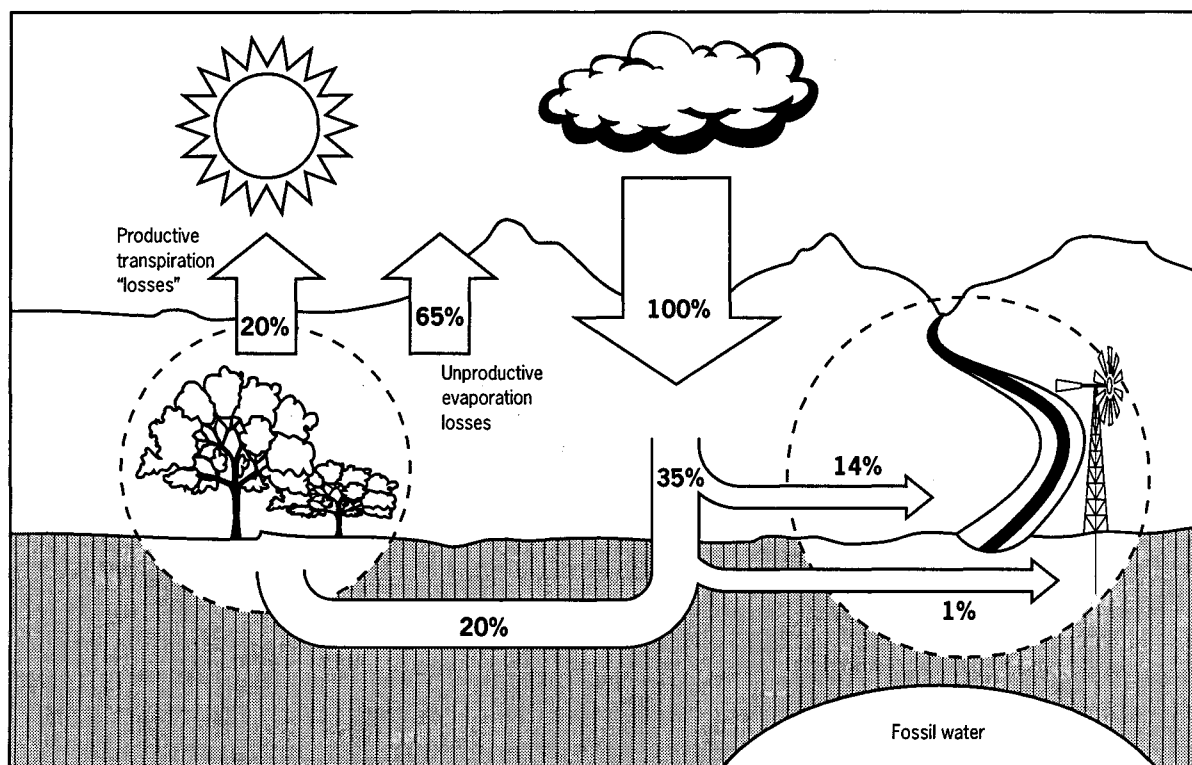


Figure 3

A schematic water balance for southern Africa. The productive and unproductive fractions of the return flows of water back to atmosphere have been marked. The figure also indicates that the fractions for surface run-off and recharge of ground water may be only one or two percent of precipitation in hot climates.

(Source: Piet Heyns: Water management in Namibia. Proceedings of the workshop on water resources management in southern Africa, Victoria Falls 5-9 July 1993)

extent that tropical drylands can be populated. As land use has a direct control on the rate of ground water recharge, which typically is the only source of water available during tropical dry seasons, it must favour and allow an adequate amount of ground water recharge to occur, or the land cannot sustain sedentary populations.

The important task is to facilitate that as large a fraction as possible of the rains may infiltrate into the ground to be accessible for the root systems of crops.

The discussion above indicates that scarcity of water is linked with land use practices and, generally, with landscape engineering and management. In order to improve possibilities to increase the amount of food or biomass grown per volume of locally received rainfall, the reduction of evaporation is of paramount importance. The concept is evaporation management, i.e. management practices that encourage land use activities that minimise evaporation losses, and correspondingly increase the beneficial return flow of water through transpiration associated with food and biomass growth. Factors that reduce evaporation are overall good land husbandry, terracing, where appropriate, to cover the ground from the sun and hard-hitting raindrops by a growing crop or crop residues, and improving soil structure. Fortunately, all of these measures can be practised parallel with efforts to increase food production. Through proper cropping pattern and land husbandry practices, the land is well managed and less water is lost through evaporation and rapid surface flows, while more water could be made accessible for productive transpiration.

2.5 ISSUES FOR FURTHER SCRUTINY

The discussion above illustrates that the water scarcity equation consists of three major components: water provided by the hydrological cycle, the number of users, and the way that water, and land, is used. The first cannot be changed; the other two can. At least two issues require further scrutiny. One is that the conventional approach to mitigate scarcity by increasing supply needs to be given a second thought. Increase of supply is still a standard solution, but progressively difficult to pursue for reasons mentioned above. This is not to deny the fact that additional supply of water is an important component in overall water management and will continue to be so. But when the gap between actual accomplishments and political promises widens and when performance is deteriorating, crisis management will replace a sound and efficient management of water supply.

A supply oriented water management approach can only be perused if the progressive investments that are required for each additional unit of water supply, can be assured. The staggering financial outlays to reduce scarcity by augmenting supply, together with the environmental and social costs, are making an indiscriminate promulgation of the conventional supply management approach unsustainable. Moreover, the very possibility to find water within a reasonable distance from where it is required, is literally remote in large part of the world. Population growth and concentration, generally, are not related to resource endowment. Globally, it is quite the opposite. Unlike most other natural resources, the bulkiness, the comparatively low value per unit of water and logistical problems, make long-distance transfers unfeasible. This is especially the case for the huge volumes that would be required for food production. Under such circumstances, it is appropriate to discuss what is the most worthwhile overall use of water and to allocate it to such activities that are likely to generate the most desirable outcome in relation to social, economic and environmental objectives. It then becomes relevant to manage the demand instead of augmenting supply, or perhaps rather to combine the two approaches.

Increase of water supply is a standard solution, but progressively difficult to pursue. The possibility to develop water within a reasonable distance from where it is required, is literally remote in large part of the world.

A second issue is that development is certainly difficult in areas with little water, but it is not blocked. With increasing relative scarcity of water, the sectoral composition of an economy and the associated allocation of water, must inevitably be reviewed. The value that water use generates in alternative allocations must be considered in water resources management. However, the value of water is not limited to returns in monetary terms. Social value includes, for instance, health and jobs. Although difficult to quantify, water is also associated with aesthetic value, it is irreplaceable in scenic beauty, etc.

3. WATER POLLUTION - A SIGNIFICANT FACTOR IN ENVIRONMENTAL DEGRADATION

When a growing proportion of the overall availability is withdrawn from natural sources and when use intensifies, the amount of pollutants increases while, at the same time, the dilution of waste water in natural water bodies decreases. Water quantity and water quality are two sides of the same coin: if effluents degrade the quality, a certain quantity of freshwater is lost (or degraded), and if the quantity increases, dilution improves quality. Degradation of water quality through various kinds of pollution, by definition, reduce the amount of freshwater, i.e. it is counter productive to water quantity management. When ground water is polluted, it is ruined for very long periods, often generations. Gradually, the self-purification capacity in natural systems will be outstripped and degradation

of water and environmental quality is growing worse. Compared to the efforts to develop and supply water, little attention has, so far, been devoted to degradation of water quality through pollution resulting from (ab-)use and from careless disposal after use. The toll in terms of high rates of morbidity and mortality and also threats to ecosystems' functioning and productivity is, however, substantial.

Two kinds of pollution may be distinguished. One refers to bacterial contamination as a consequence of lack of sanitary arrangements and improper disposal of human and animal excreta. Problems in this connection are naturally aggravated in relation to growing agglomerations of people and, generally, in densely populated areas. Another kind of pollution is related to development of industrial activities, transport systems, and is also a result of growing amounts of waste, residues and wear and tear of goods and equipment. Untreated or insufficiently treated water from industrial units has been let out in recipients and resulted in very high concentrations of harmful substances in surface as well as in ground water. Persistent substances are accumulated in soils and to the extent that they are taken up in biological material, the quality of food and fodder is affected. Pollution in connection with production is probably the most rapidly increasing problem in the contemporary setting in most countries in the South, but pollution associated with consumption pattern and life-styles is rapidly becoming important.

Huge quantities of organic and inorganic compounds from a large number of sources are let out into the air and water recipients, some of which are persistent and toxic and which accumulate in soils and in biological material, unfortunately with little control and hardly any attempts of treatment. According to UNCSD (1997, p.18) there are estimates suggesting that about 90% of the waste water in developing world is left without treatment. Environmental degradation is also a problem in Europe (Stanners & Bourdeau, 1995). Evidence of massive pollution in and around industrial sites and urban centres in different parts of the world is available. Besides statistical evidence, it is easy for anybody who has visited or who lives in rapidly growing urban centres in the South to note, with all senses, the hazards and the quite disgraceful changes associated with the environment in and around the habitations.

Estimates suggest that about 90% of the waste water in developing world is left without treatment.

The impact from pollution on ecosystem productivity and functionings is noticeable, for instance, in terms of salinisation, eutrophication with accelerated growth of algae, with deleterious effects on food and agricultural production, aquatic productivity, etc. (Meybeck et al. 1989). But detailed statistical evidence of the human plight mainly refers to the first category of pollution. The World Health Organisation reports, for instance, that every eight second a child dies of a water-related disease and that more than five million human beings die annually from illnesses linked to unsafe drinking water, unclean domestic environments and improper excreta disposal. Absence of sanitation measures in combination with limited amounts of water means that the concentration of substances causing health hazards and other disturbances is high in the areas where people live and work. The geographical nexus between sites of population growth, poor private and environmental sanitation and inadequate water supply, is a significant feature associated with urbanisation and widespread poverty. People living in rural areas are exposed to other water and environmental hazards. With rising billions of people in third world mega-cities, old solutions based on water-borne sewage are inadequate and partly counter productive in an environmental context. Dry systems, financially viable, with local management and re-use of nutrients need to be developed and implemented.

At any given time, perhaps half of all the people in the developing world are suffering from one or more of the six main diseases associated with water supply and sanitation (diarrhoea, ascariis, dracunculiasis, hookworm, schistosomiasis, and trachoma). The health burden of poor water includes

the annual expenditure of over 10 million person-years of time and effort by women and children carrying water from distant, often polluted, sources (Warner, 1995; Enderlein, 1996. Personal communication: Dennis Warner and Ute Enderlein, WHO).

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The links between water use, which unfortunately also includes abuse, environmental degradation and health impacts are a growing challenge, particularly in densely populated areas. Water and environmental quality degradation is partly related to poverty and poor governance structures, but it is often related to industrial development, economic growth and, notably, improvements in material aspects of standard of living. A common denominator is its relation to the actual handling and use of water and lack of proper routines and strategies for disposal and treatment after use. The implication is that relatively more attention should be paid to use pattern. Augmenting water services is not an adequate strategy to remedy the problem.

4. EFFICIENCY, EQUITY AND ECOLOGICALLY SOUND USE

4.1 VARIOUS KINDS OF EFFICIENCY

The two problems discussed in previous sections, i.e. water scarcity and water quality degradation, are partly related to each other. Scarcity of water is also clearly related to socio-economic differentiation. As mentioned above, permissive and irresponsible use is often aggravating the problem of water shortage and quality degradation for society as a whole.

Numerous studies indicate that water tends to be taken for granted and looked upon as something which can be used with little concern about overall water requirement in society. Such perceptions are noticeable even in areas where the natural availability is quite limited. (See for instance reports from Namibia and other parts of Southern Africa in Pallet, 1997). As a consequence, more water is expected or 'demanded' as compared to what can be considered 'reasonable' and what would be necessary for a given level of production, for personal needs and, for 'non-essential' uses such as watering of lawns in arid zones, etc. A logical result is that per capita consumption can be quite high also in places where natural circumstances would suggest a more modest pattern of use. In terms of overall quantity used, the attention is often directed towards water use in irrigated agriculture and to the prevailing low efficiency and poor performance in that sector.

The kind of observations just indicated, together with the escalating costs to supply water, have contributed to a growing awareness about the inevitable need to promote efficient use of water. If those who today use water lavishly could be persuaded/stimulated/etc. to use less water per unit of production (similar) or for personal satisfaction, a certain amount of water will be 'freed'. This amount of 'freed water' could be supplied to those who today are deprived of water, without developing new sources of water. Remedies for the poor and disadvantaged segments may thus be created through the improvement of efficiency in water use. Efficiency in water use on the part of some users could thus create an opportunity for meeting social objectives, e.g. supporting the poor.

The poor who are supposed, and often promised, to get water through the public system are to a very large extent still outside the reach of these services. About 1 billion people or almost 20% of the world population are estimated to be without access to safe water. These people often have to struggle hard to get it, either by drawing it from faraway sources or by purchasing it from private vendors. Either way, they have to pay dearly in cash, health, effort etc. to obtain the required water. Large segments of the better-off sections, on the other hand, have generally better access to public water and they enjoy it at rates which are quite modest in every respect. Permissive use and abuse in terms of degradation of water quality, both of which often occur in contexts where heavy subsidies are levied and where laxity in the enforcement of PPP (Polluters' Pay Principle; see section 5.4) is the rule are, of course, highly undesirable and negative in itself. Such malpractices are also a considerable hindrance for efforts to achieve equity and ecologically sound practices.

Water tends to be taken for granted and more water is demanded as compared to what can be considered 'reasonable'. If those who today use water lavishly used less water, a certain amount of water will be 'freed'. The 'freed water' could be supplied to those who today are deprived of water, without developing new sources of water.

An important implication from the discussion above is that problems of scarcity, quality degradation and socio-economic differentiation could be seen in a common context. Rather than trying to deal with the problems individually, it makes sense to develop water policies where the interlocking features of the problems are tackled. It is reasonable to argue that improved efficiency could be a means through which it could be possible to achieve a more equitable access to water services as well as a pre-condition for an ecologically sound use. It is no panacea to tackle poverty or environmental degradation but it appears as a rational and reasonable measure. Efficiency could therefore be seen as an entry point for the other two main challenges, i.e. equity and environmental sustainability. In **Figure 4**, some features of the three "E's"; Efficiency, Equity and Ecologically sound use, have been listed.

Some colleagues rightly stress that efficiency refers to a most complex issue and that it is quite tricky to say what efficiency at one level, for instance a project, means in a broader context. It also appears that the very notion of efficiency tends to provoke the idea that purely economic aspects are of interest and thus that social and environmental considerations are left out. While it may be true that discussions about efficiency often highlight comparatively narrow economic aspects, it is worth stressing that there are negative social and environmental implications from certain patterns of water use which best can be characterised as inefficient.

One broad interpretation of water use efficiency refers to the relative amount of water that reaches the intended use out of the total amount that is available, for instance, in a reservoir. But the water source is often far away from the site where a particular use occurs and water may be used several times before, and also after, it reaches a particular activity. Depending on temperature, wind and other climatological circumstances, considerable fractions will return to atmosphere as evaporation along its course through the landscape. Another fraction of the water in streams, canals, reservoirs, etc. is seeping and percolating through the land surface and will add to the soil moisture and ground water in the vicinity of water sources and courses. The water that is replenishing aquifers may be used again, but will require wells and lifting devices. The most important part of the water flow is the fraction that reaches crops and other intended uses. Part of the water is thus consumed (transpired) and is not available for use downstream. Water returning as direct evaporation is lost for all practical purposes, while the excessive flow above and below ground, may be utilised for various purposes downstream.

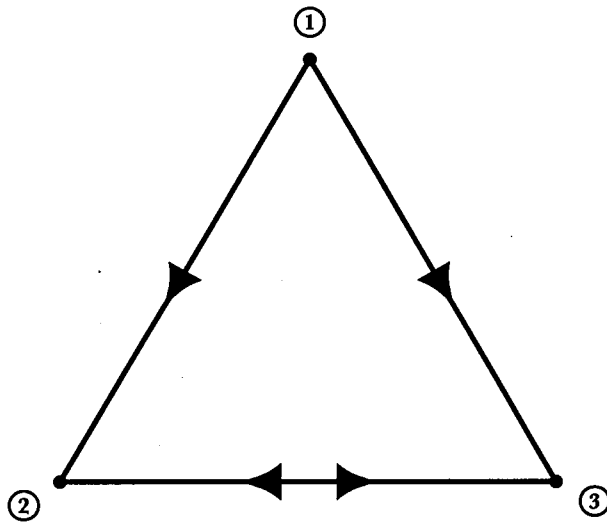


Figure 4

Three interrelated challenges to reach a sustainable water development and utilization. Under each of the three challenges, some remarks are made about contents and possible benefits.

1 Efficiency:

- Optimum output per unit of water
- 'free' excessively used water for social and environmental objectives
- postpone period for exploitation of additional sources
- reduce pressure on scarce budgetary resources

2 Ecologically sound use:

- Define environmental water requirements
- Recognize in-stream water functions as part of sustainable water resources management
- Water quality crucial to avoid environmental degradation
- conservation of natural capital
- safeguards livelihood for large segment of population
- aesthetic and scenic beauty

3 Equity:

- Define Basic Human Need for water
- Recognize that Basic Human Need is a prime social objective
- health benefits
- social justice & stability
- pre-condition for development and care for next generation

One should therefore distinguish between water use efficiency in a particular area or project and overall water use efficiency which may be measured for an entire basin. It is often argued that the efficiency in the Egyptian irrigated agriculture is quite low when measured at local level, while the efficiency for water use in the Nile Valley as a whole is quite high, or about 80 - 90%. The logic of this calculation is that the water that is not consumed in Upper Egypt can be used while flowing to Lower Egypt. In principle, the same situation is supposed to be found in other river basins.

Estimates which suggest large differences between project and basin efficiencies are based on the assumption that people in downstream locations are able to anticipate when they will get the excessive water from permissive users in upstream positions. If they will get it, is not questioned. In many countries and basins, farmers and other people living in downstream locations do, however, experience large fluctuations in terms of period when water is available and the amounts which are reaching them do also vary. In these kind of calculations, it is also taken for granted that water quality remains fit for use. Moreover, by this interpretation, one easily overlooks the fact that low efficiency in particular sites is often caused by excessive application of water which increases the risk of water logging and salinisation. This is, incidentally, one of the noticeable problems in large parts of the Nile Valley.

With these remarks in mind, it is important to define efficiency with regard to project or local area. High efficiency at that level also implies high efficiency at the aggregate level, while the opposite may not be the case, as discussed above. From a similar perspective, high efficiency should primarily refer to a situation where the amount of water used in an activity can not be reduced without reducing output or creating problems. A certain amount of water is, for instance, needed as drainage to control salinity and to avoid the accumulation of pollutants in irrigated fields. With a similar reasoning, low efficiency implies that more water is used as compared to what would be necessary or that more water is abstracted from the source, i.e. a reservoir, than would be necessary to guarantee that the required quantum reaches the intended use(r)s.

4.2 DISTINCTION BETWEEN WATER USE EFFICIENCY AND ALLOCATION EFFICIENCY

Water use efficiency in an activity or in a project refers to performance in resource utilisation and provides an indication on how to accomplish a specific goal without using more water than is necessary. But there is an other kind of efficiency that is becoming more and more important. When water is increasingly scarce in a society, decisions are required with respect to its allocation. What sectors, activities, or regions should be provided with water on a priority basis? The issue of "allocation efficiency" addresses how water should be allocated among social strata, sectors, activities, and regions in order to achieve the most worthwhile overall use across sectors in society (Lundqvist & Gleick 1997).

The two kinds of efficiency are to some extent interlinked, as shown in Figure 5. But they pose completely different types of management challenges. It is quite conceivable to improve efficiency within a single sector or activity, such as agriculture, without achieving a high overall efficiency. If large volumes of water are allocated to a sector producing low value, the total amount of value generated in society will be low. This is the case even if water-use efficiency is high in that sector. An illuminating example is presented by Hillel Shuval from Israel: "While 70% of the nation's water resources are devoted to agriculture, only 3-5% of the GDP is generated by farming" (Shuval, 1997). This ratio is remarkable in view of the very efficient water use in the Israeli agriculture. In other words, it is possible to produce low-valued items very efficiently. "If allocative efficiency is not achieved, it is possible, and even common, to be doing the wrong thing extremely efficiently. It would be much more useful to be doing the right thing, that is with efficiently allocated water, a little badly" (Allan 1995).

Allocation efficiency addresses how water should be allocated among social strata, sectors, activities and regions. If allocative efficiency is not achieved, it is possible, and even common, to be doing the wrong thing extremely efficiently. It would be much more useful to be doing the right thing, that is with efficiently allocated water, a little badly.

The worst situation combines low water-use efficiency within a sector and low allocation efficiency, as characterised in the lower left part of the graph in **Figure 5**. This situation is typically a result of heavy subsidies, privileged treatment of certain sectors, i.e. where allocations are made without any attempt to control performance, and compartmentalised policy and planning, where sectors and activities are not co-ordinated. Many countries who have decided to allocate a large share of their overall water supply to irrigated agriculture now find themselves in that corner. For most countries, it seems comparatively easy to improve efficiency within a sector or activity, i.e. movement along the vertical axis in Figure 5. To go from a low to a high allocation efficiency, i.e. along the horizontal axis in Figure 5, is much more demanding.

In countries or areas with insufficient water to satisfy all potential needs and demands, choices must be made and priorities set. These are hard tasks which could be made through the political and administrative system, through the market or through a combination of these two, main systems. Discussions in this regard, are gradually reflecting a more positive attitude towards the role of the market as a mechanism to deal with use and allocation efficiency issues. But it is important to remember that markets can not function properly in the void of clear rules and regulations, i.e. a strong political and administrative system (Kemper, 1996). Moreover, information and transparency are crucial for a smooth functioning of market transactions. Both of these pre-conditions are not well developed in many countries. A realistic and viable approach should therefore be a dual strategy where both market mechanisms and regulatory measures are promoted.

It is also important to note that political interference and planning now include tasks which conventionally have not been much practised in most countries. Instead of only addressing the conventional top-down issues which tend to be concentrated to technical and administrative tasks, water managers and planners are now obligated to also include other tasks into their agenda, usually associated with efforts to create an enabling environment. According to this, officials should become true civil servants, seeking public participation in public work, stimulating community discussions about allocations and priorities, and, generally, induce more democratic decision making. Governments and also the NGO's, have far better means of communication at their disposal than during earlier times, including simple computer systems and other IT user friendly technologies and applications.

The social and environmental objectives must be incorporated and political guidance and goals must be part of the allocation criteria. If purely market economic returns to water would be allowed to guide allocation, the highest valued uses would primarily be promoted. Some groups, typically farmers and farm workers, would lose allocations which they have become used to get and their economic base of support would be reduced. Generally, re-allocations require that the economy and the political system be able to provide alternative livelihoods for those affected, compensate third parties affected by market transactions, and judge between diverse claims for allocations.

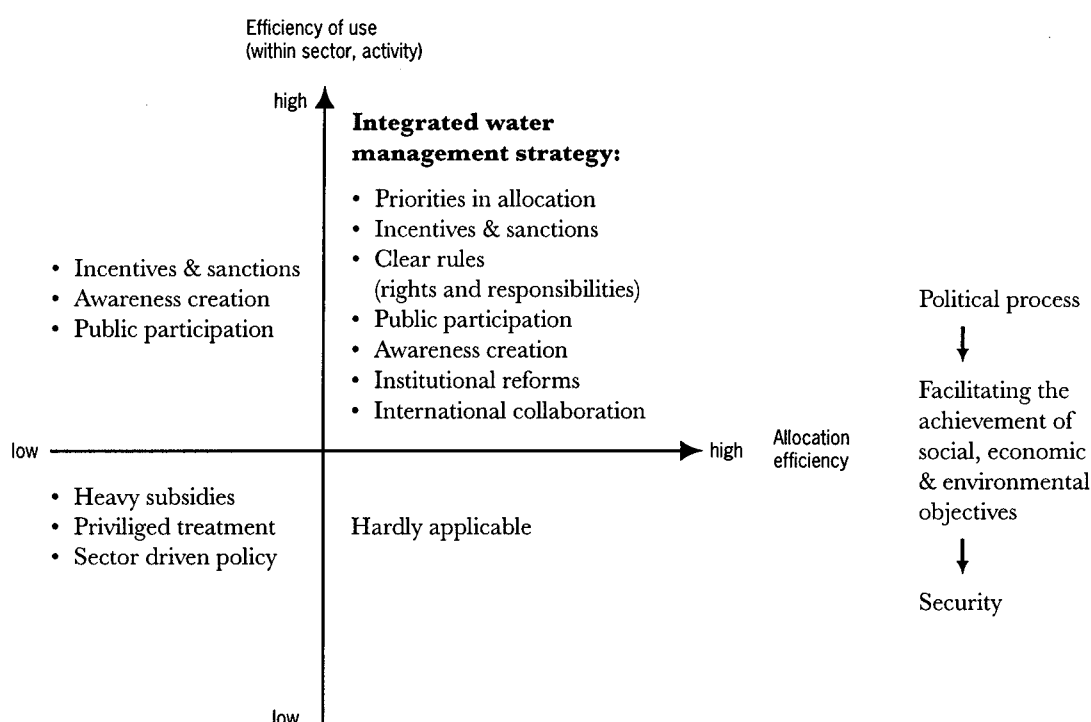


Figure 5

A schematic presentation of within-sector efficiency and allocation efficiency and the policy elements associated with degree of efficiency.

Allocation efficiency is not likely or possible to achieve unless there are strong political and social institutions that may balance various groups of stakeholders. Transparent political discussions and institutions that are conducive to the changes are needed. Based on experiences of current water management reforms in the northeastern part of Brazil, Kemper (1996) illuminates the need for the development of arenas where the various stakeholders could meet and negotiate and also the need for proper institutional arrangements that guarantee and facilitate the representation and say of disadvantaged groups of society.

The new management strategy must be integrative and based on physical, institutional and socio-economic realities. Its implementation requires, among other things, the use of incentives and sanctions, and clearly defined roles and responsibilities. Water policy and management must be open to, and involve, stakeholders at local, national, regional, and international levels and also, an appropriate division of management tasks between the public and private sectors.

5. IMPLICATIONS FOR 21ST CENTURY MANAGEMENT

5.1 SPREAD OF A NEW THINKING

The increasing concern for water has been explicitly expressed in various documents. The most authoritative and comprehensive formulation is found in Agenda 21 (UNCED, 1992). In its chapter 18, a policy framework for sustainable water resources development is presented. More detailed guidelines for appropriate management are formulated in the so called Dublin Statement which was the outcome of a high level International Conference on Water and the Environment held in Dublin in January 1992. Just prior to that meeting, the Nordic Initiative on Freshwaters, prepared some of the ground for the formulation of four key principles that are brought forward in the Dublin Statement (ICWE, 1992).

These principles have become the basis on which national and international efforts are elaborated to improve water management. Currently, at the international level, commitments to meet the pending water crisis include the Global Water Partnership, where the World Bank, UNDP and Sida have jointly launched a programme that is intended to be a co-ordinating mechanism for the prevailing fragmented and compartmentalised efforts which characterise the sector as a whole. World Water Council is another recently established institution which aims to promote increased awareness at the highest level of decision making and to function as a think tank. Still another initiative was made in 1994 by the UN Commission on Sustainable Development. As a follow-up to the Freshwater chapter in Agenda 21, the Commission called for a Comprehensive Assessment of Freshwater Resources, to be reported to the General Assembly in 1997 (see UNCSD 1997).

THE PRINCIPLES FORMULATED IN THE DUBLIN STATEMENT ARE AS FOLLOWS:

- Principle No. 1** - Fresh water is a finite and vulnerable resource, essential to sustain life, development and the environment.
- Principle No. 2** - Water development and management should be based on a participatory approach, involving users, planners and policy-makers at all levels.
- Principle No. 3** - Women play a central part in the provision, management and safe-guarding of water.
- Principle No. 4** - Water has an economic value in all its competing uses and should be recognised as an economic good.

As we approach the turn of the century, a new era is unfolding where the significance of water is started to be recognised, for development and for social and ecological sustainability and where new opportunities to tackle challenges exist. The new thinking is beginning to spread and, as a result, policy reviews are made in a large number of countries, all over the world, for instance, in Southern and Eastern Africa, India, Vietnam, Brazil, Chile, Poland, Israel, etc.

The initiatives just indicated demonstrate an international convergence towards consensus about what constitute the major challenges but also main options in terms of strategy. At the same time, the principles mean a drastic change in the perception of water. Previously, the principle concern in water management can be formulated as follows: "How much water do we/society need and where do we develop it" (cf. 'Focus in conventional water management'; Figure 2). This, in essence, was the supply oriented approach in water management. The current understanding mirrors an understanding that we must make "the best possible use of the finite and vulnerable water resources that are available to society" (cf. 'Entry point in current and future management strategy'; Figure 2). The differences in perception may, of course, be further qualified. But in the main, there is now a recognition that water may no longer be seen as a free good and something which merely represents a technical development and supply problem, but that water is, in fact, a scarce resource of vital significance in all aspects of life and development. The current view does not negate the fact that technical arrangements are a *sine qua non* for water development, storage, conveyance and, indeed, for the treatment of degraded water.

Further elaborations are required with regard to a number of key policy issues. Some are shortly mentioned below:

5.2 FEMINIZATION AND INTER-GENERATION CARE

Approaches to deal with water problems have to a large extent been insufficient and inappropriate, although concerted effort certainly has been shown. A bias towards technical and top-down arrangements has hindered the advancement of alternative and complementary perspectives. Attention has been on standardised and mechanical fixes to acute problems rather than considerate and caring approaches to complex human needs and aspirations.

The struggle with pressing needs must, be combined with a flexible approach where the variety of human experiences and visions are stimulated. Joint effort is required to deal with the acute issues but also to prepare the ground for a viable management for the 21st century. A checklist for life, decent livelihood as well as for development is required. Assessing social value (Burrill, 1997) is an important attempt in this connection, besides quantification of economic return to water use. It is noticeable that the views and experiences of large segments of society are overlooked, notably those of females and the young generation. The value system and the experiences that have accumulated over generations among females, cover basic aspects of livelihood and human well-being.

The value system and experiences that have accumulated over generations among females, cover basic aspects of livelihood and human well-being. Strategies to involve women have been primarily based on gender considerations. Their prominent role in inter-generation care is largely left out or taken for granted.

The crucial and multiple roles of women have been repeatedly recognised. Although quite a large number of examples can be quoted to show that women are becoming more involved in water management, the progress must be characterised as piecemeal and confined to certain tasks. One of the arguments for paving the way for women in water management is their concern and special obligations for children and thereby, the next generation of the 21st century. It is noticeable that strategies to involve women have been primarily based on gender considerations. Their prominent role in inter-generation care is largely left out or taken for granted (Drangert, 1993).

There are opportunities to promote a feminization of approach in water resources management as called for by professor Kadar Asmal, Minister of Water Affairs and Forestry, South Africa at the 1st World Water Forum held in Marrakech in March 1997. One such opportunity is to involve women in educational activities. It is often stated that since tomorrow's mothers are already born, an unavoidable population growth is imminent. In a similar fashion, since tomorrow's water managers are already born, we have to educate them properly today. Women possess the kind of water awareness that is needed, and in many countries the number of women who are formally qualified and who could be enrolled as teachers and educators is high and growing. Children and proper education are fundamental pillars for sustainable water use in the 21st century. In many water scarce countries "water" is already part of the school curriculum, but this has to be extended. Depending on the local water conditions, school curriculum, literature and concepts must be appropriate at all levels of training, including university.

5.3 PUBLIC SECTOR AND OTHER PARTNERS IN MANAGEMENT

Given the magnitude and the complexity of the problem, a new policy must reflect the fact that it can not be handled by professionals and official agencies alone. Such an approach has not been sufficient in the past and it is not better suited to deal with the accelerating problem. There is a need to change, but not necessarily reduce, public sector involvement and incorporate various partners in management. Effort must be made to include contributions from a wide range of parties: suppliers, formal and informal institutions, public, private and NGO units and, most importantly, the users. The changed role of the public sector, i.e. the Government and its affiliated administrative apparatus, does not contradict the fact that it often needs to be strengthened to better ensure efficient inter-sectoral co-ordination, more transparent procedures, enforcement of rules and regulations and similar tasks which can not be performed by other actors.

The crucial issue is not less government, but a revitalised and modified political and administrative system where specific roles and responsibilities are identified and co-ordinated with those of other actors.

With this perspective, the crucial issue is not less government, as sometimes proposed, but a revitalised and modified political and administrative system where specific roles and responsibilities are identified and co-ordinated with those of other actors. The following components have recently been identified with reference to water resources management in Southern Africa. They could be taken as a yardstick for tasks which are generally significant for the public sector at national level:

- I to set policy for water use in a country,
- II to perform regulating, monitoring and control tasks,
- III to decide on standards to control and combat pollution and to ensure environmental sustainability of any development venture,
- IV provide technical, administrative, financial and legal services to deal with infrastructural issues,
- V address the social function of water, guaranteeing that nobody is denied 'life-line' quantity of water irrespective of their socio-economic position, and
- VI to co-ordinate and bring various sectors of the economy together to ensure that national development plans are realistic in terms of their water demand and their consequences for the landscape and the environment (modified from Pallet, 1997, 95).

5.4 DEMAND MANAGEMENT IS AN ADDITIONAL TASK

The tasks outlined above refer to obligations which have been poorly defined and often inadequately executed in water management strategies up till now. In many countries, there are noticeable shifts in perception and awareness, mirrored in policy revisions. It is more difficult to identify to what extent the new awareness has led to changes in terms of concrete activities. Generally speaking, the emergence and the implementation of a new policy is a gradual process where information, awareness, policies etc. must 'mature' before systematic and concrete actions are implemented. The diagram in **Figure 6** tries to summarise stages in this process in a schematic way. The steps which are identified in the diagram, represent logical and rational responses in terms of changes in management components, to growing needs and demands for limited and vulnerable water resource. The steps should be interpreted as higher level of management sophistication. Higher step incorporates the element of lower steps. This means that 'demand management' will include elements of 'supply management' and 'holistic view on water'.

Demand management will include elements of supply management.

An important objective of demand management is to improve performance in water use. Through a combination of incentives and sanctions, the users of water should be stimulated to reduce (unnecessary) wastage of water and to use it in the most worthwhile manner. The purpose is not to reduce water provisions as such, but to foster an awareness of the fact that water is a scarce and vulnerable resources and that no larger quantity should be demanded than what is reasonable for the achievement of social, economic, environmental, etc. objectives.

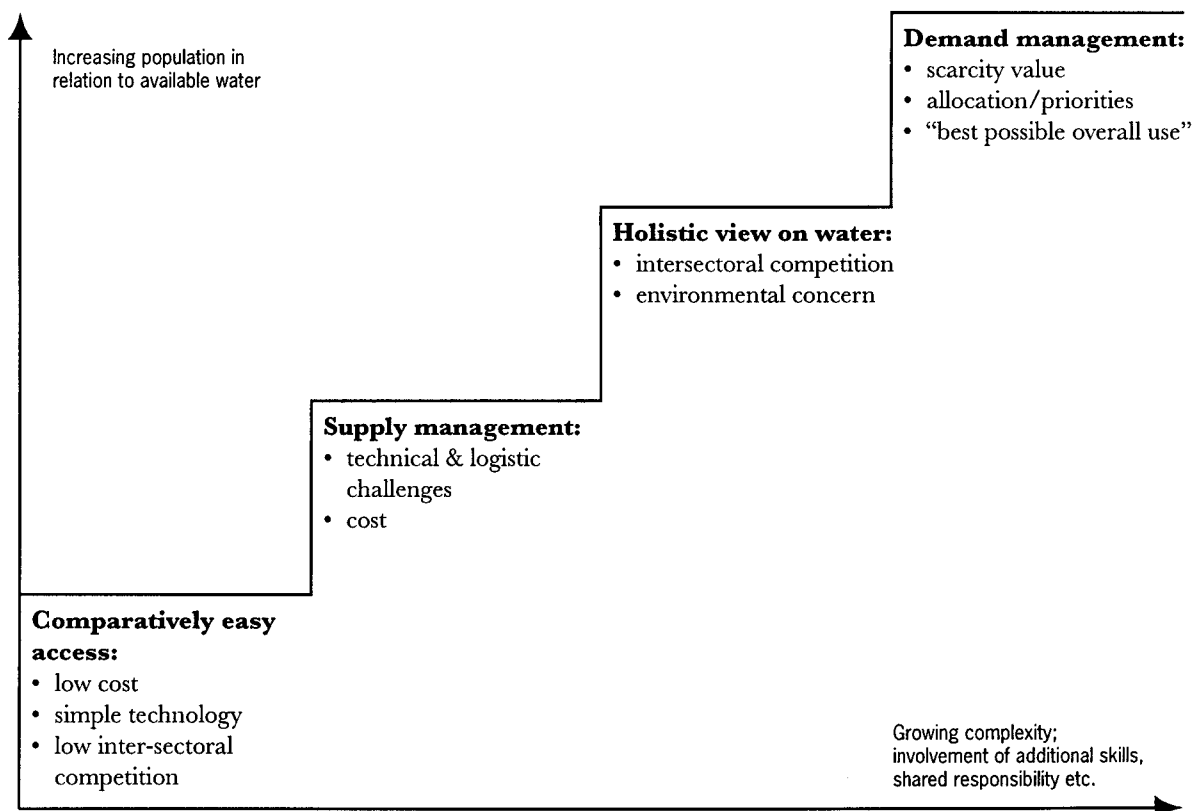


Figure 6
Stages in Water Management Approaches in Response to Growing Demand

Development of additional supply is, however, an option which must be contemplated. In parts of the world, the fraction of developed and supplied water in relation to overall availability is quite small. This is, for instance, the case in parts of Africa, where pressing social and economic problems is a strong plea for further water development projects. Water development and supply will continue to be important. It is important to stress that these efforts not only refer to investments in new structures. Special consideration should be given to maintenance of the infrastructure that is a part of supply systems. It is a regrettable fact that, generally speaking, the budget allocations for operation and maintenance of existing schemes are but a fraction as compared to the investments that have been made and that are contemplated in additional schemes. A shift towards demand management policies does therefore not exclude nor substitute for certain efforts in terms of water supply management.

In many areas there are, however, considerable problems associated with heavy exploitation of surface waters and overdraft of ground water due to financial, environmental and other circumstances.

A suggestion to policy makers/politicians is therefore: You may continue to develop 'your' water resources and even infringe on those that rightfully belong to our children. But there is often a more sensible way to augment supply to those who today are deprived of access, which should first be contemplated; namely to reduce wastage and abuse in some parts of the society and thereby free some of the improperly used water. Policy makers must also decide on the most worthwhile use of the water.

A suggestion to policy makers/politicians: You may continue to develop 'your' water resources and even infringe on those that rightfully belong to our children. But there is often a more sensible way to augment supply which should first be contemplated, namely to reduce wastage and abuse in some parts of the society and thereby free some of the improperly used water.

In short, demand management pre-supposes that each unit of water is utilised so that the most desirable value is being accomplished at the least, acceptable cost. This means that attention has to be given to the chain of steps that were identified in Figure 2 and that particular emphasis should be given to improvements of performance in water use and that proper allocation is strived for.

5.5 WATER QUALITY MANAGEMENT - PPP IN PRINCIPLE AND IN PRACTICE

The magnitude and the composition of pollution today imply quite different management tasks as compared to the 'first generation' of pollution. Water pollution and environmental degradation in connection with industrial development, urbanisation, congestion and intensification of resource utilisation should no longer be left without systematic counter measures. A common situation now seems to be that most countries have formerly recognised the Polluter Pays Principle, usually abbreviated to PPP, but that few countries have neither been able to specify nor to enforce the associated rules. This is partly due to the fact that the dividing line between pollutants and emissions that are acceptable and those types of emissions, or concentrations of polluting substances, that are not accepted, is vaguely defined and thus that legal measures are impossible to impose. But it is also partly due to the ambivalent position as to the degree of responsibility of the authorities versus the degree of responsibility of the polluters. In the current debate, attention is also given to the role of consumers, both as an active force to demand 'clean production', but also as a force in the opposite direction, that is, in the form of 'consumerist behaviour'.

An interpretation of PPP is that i) the polluters cover all expenditures that would be needed to achieve certain water quality or environmental standards, or that they ii) should compensate those groups or interests that are affected by the pollution. The second alternative is hardly applicable more than in special cases. The first approach is usually complicated to practice since remedial activities are not only carried out by the polluters themselves but also through public sector activities, for instance, the building of treatment plants, or through special agencies. It could be private companies that specialise in sanitation, technological improvements etc.

The responsibilities for environmental rehabilitation and preventive measures will, in practice, be shared by the polluters and the public sector and possibly other actors as well. Since a large proportion of the 'new' type of pollution is the result of industrial development, export ventures, job and income creation activities, etc., it goes without saying that polluters may have a fairly strong position to argue that part or the whole cost of pollution abatement and environmental rehabilitation, should be covered by public sector or by consumers. A paradoxical situation may thus develop where a kind of 'Public sector Pay Principle' has developed. That this twist occurs, i.e. who is responsible for what, has been demonstrated by Blomqvist (1996) in a case study from a prosperous and booming textile centre in the south of India. In this case, the Government has agreed to pay for some of the costs incurred from building of common effluent treatment plants. Efforts to implement the PPP (in its original meaning) have failed or at least been seriously delayed.

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There is thus an important distinction between the adherence to the PPP in policy documents and the way that pollution abatement is being organised and practised. In most societies it seems as if the workable approach is one where some kind of joint effort by polluters, the public sector and other stakeholders, including the consumers, is organised. The responsibilities of the polluters must be clearly defined and sanctions against violations promptly enforced. But other parties play a crucial role to stimulate less harmful resource use practises, through technological interventions, through adjustments in life-styles, etc.

It is also well to remember that investments in improving water quality are comparatively much more cost effective if implemented in the early stages of pollution. If pollution has reached ground water sources, remedial actions are extremely difficult, inefficient and expensive.

Water quality management is an interesting and important field for transfer of technology, know-how and environmental management between countries. When water becomes perceived as an economic good, the scope for new technology improves. An important management aspect in this connection is that Pollution Control Boards, or similar organisations, should be given an advisory function apart from the more common control (and 'close down function') which seems to be a first approach in many countries. The scope for technological improvements in production, i.e. where pollution is generated, offers much more opportunities for technological development as compared to end-of-pipe strategies.

5.6 WATER RIGHTS SHOULD BE CLARIFIED AND LINKED TO RECIPROCAL RESPONSIBILITIES

Regulated access to water expressed in terms of proper water rights are important for all members of a community, and not least for the poor. Clarification of water rights is also a precondition for the development of water markets, and for regulation of ground water extraction, which is a big problem in many parts of the world. Clearly defined and monitored water rights are a means to facilitate equity and to improve responsible use of water. The rights and responsibilities of the water (and land) users are closely related to the implementation of the principle: water management at the lowest appropriate levels. If the users are not clear about their rights and responsibilities, a management at that level does not make sense.

Unfortunately, the unclear formulation and execution of 'water rights' and the tendency to take water provisions for granted and for free, have been amplified by a separation of rights from reciprocal responsibilities which is a quite common situation in large parts of the world. Responsibilities could be in terms of paying fees, of accepting the PPP, of refraining from permissive use, etc. It is rare to find any criteria for performance of water supply systems nor any monitoring system for checking reliability, etc. Insecurity of deliveries is a sign of poor system management which also tends to stimulate poor management at the level of the individual user and be detrimental to a responsible and efficient resource management as a whole. A majority of irrigation farmers frequently experience deficiencies in system management. As a result of these structural and contextual weaknesses, a number of paradoxes have become noticeable. Centralised and publicly controlled management systems tend to monopolise the responsibility while their officials tend to blame the users for problems. The users, on the other hand, refer problem to the officials in charge, while at the same time, they expect the officials to deliver services for free or next to it.

Water rights are a means to facilitate equity and improve responsible use of water. If users are not clear about their rights and responsibilities, a management at that level does not make sense. There is a risk that in the absence of proper 'water rights', the rhetoric about 'right to water' will be interpreted as if water services are free and without any reciprocal obligations.

A paradoxical, inefficient, non-equitable and environmentally deleterious system has developed. A large portion of those who benefit from water services get them at substantial subsidies. Obviously a large part of the subsidies are enjoyed by those who belong to the better-off sections of society. More prominently, many of the recipients of water services produce low value per unit of water. Without properly defined water rights and with heavy subsidies and with lax control of use and performance, the burden for people and society at large and the environment is high while the benefits are limited. There is an obvious risk that in the absence of proper 'water rights', the repeated political populist rhetoric about 'right to water' will be interpreted as if water services are free and without any reciprocal obligations. In practice, these conditions are likely to lead to 'water wrongs' in terms of social, economic and environmental inefficiencies and unnecessary cost and burdens. The combined effect is an increased risk of insecurity in livelihood, environmental stress, social tension, political instability and increased risk for open conflict (Lundqvist 1997).

5.7 CONNECT THE NOTION OF WATER AS AN ECONOMIC GOOD TO SOCIAL AND ENVIRONMENTAL OBJECTIVES.

The tendency to perceive water as a kind of ubiquity and to expect that water provision and other services should be free or heavily subsidised is counterproductive to a proper husbandry of a finite and vulnerable resource. Closely related to these kind of attitudes to water, its crucial role in the 'income generation equation' may be overlooked (Pierre Najlis, personal communication). While basic functions of water are related to social and ecological objectives, the growing problems associated with water development, allocation, use and disposal (cf. Figure 2) call for a recognition of water as a crucial but scarce resource, in growing demand for a variety of development purposes. The notion of 'water as an economic good' is frequently used in the context just indicated.

The tendency to perceive water as a ubiquity and to expect that water provision should be free is counterproductive to a proper husbandry of a finite and vulnerable resource. Water's role in the 'income generation equation' may be overlooked.

Treating water as an economic good implies an end to permissive and irresponsible use of the resource wherever it occurs. As discussed above, an important task is to curb lavish use in order to reduce the rate of exploitation of additional sources, create a means to improve services to the poor, etc. Perception of water as an economic good also means an end to the perception that the user is free to pollute and to dispose after use without taking any pre-cautionary measures and without any responsibility as to the likely consequences that this will have for the people living downstream.

The fact that a large proportion of the world population still lack access to safe water, while some are using large volumes of water for activities generating low social and economic value, is a confirmation of the inadequacy of the approach which has prevailed for some time. As a crude illustration of what has not been possible to accomplish, the drinking water supply and sanitation sector could be quoted. Although considerable attention and resources were directed to this sector in connection with the Drinking Water Supply and Sanitation Decade, i.e. the 1980's, about 1 billion people or almost 20% of the world population today lack access to safe water, and roughly 1.7 billion lack sanitary arrangements. The challenge behind these figures is compounded by the fact that they refer only to one sub-sector.

It is important to stress that the notion of water as an economic good must comply with social objectives. One task is to integrate financial, economic and efficiency consideration with obligations towards the poor. The issue of subsidies must be carefully looked into alongside with efforts to improve financial autonomy of the water sector (Serageldin, 1995). A framework for operationalizing the concept of water as a social and economic good has been presented by Rogers et al. (1996). One conclusion is the importance to estimate the full cost of water, including opportunity costs and environmental externalities, and that raising tariffs, levying effluent charges and encouraging water markets play significant roles in improving economic efficiency and environmental sustainability of water use.

Improved access to water from the poor could be achieved through so called life-line tariffs and the development of block tariffs with progressive charges on amount of water requested and with socio-economic position. A complementary approach is to channel subsidies to the poor and not to the water. Subsidies may thus be to families, while water charges can be decided upon through other considerations.

Ecological water requirements is a fairly recent topic on the water agenda. Many countries with quite different opportunities, for instance, countries in Southern Africa (Pallet 1997) and California (Gleick 1995) are trying to define what amounts of water that have to be left in natural water bodies (streams, lakes, etc.) to guarantee the sustainability of in-stream functions (fishery, flora and fauna, estuary functionings, etc.). Apart from ecological concerns, these functions are connected to the livelihood of poor and marginal groups of society. Criteria are urgently needed for deciding on ecological water requirements and the build up of institutions that could cater for policies which comply with these criteria.

Water has, by and large, been treated as a ubiquitous good and its significance for human health and well-being has been duly stressed (Drinking Water and Sanitation Decade). Apart from drinking water supply, considerable attention has been devoted to water supply to costly and inefficient irrigation schemes. In an era of growing scarcity and thus competition and threats of degradation, the prevailing sectoral and piecemeal approach is outdated. Similarly, the role of water in the 'income generation equation' and in development more generally, must be given increasing attention. In addition, environmental sustainability must be recognised as an overall pre-requisite for human welfare, development and security. These considerations together call for an integrated approach where the value that may be generated alongside with the costs are used as a guide for management strategies.

One principle approach is to guarantee that the poor get access to required quantities of water through life-line and block tariffs. A complementary approach is to channel subsidies to the poor and not to the water.

5.8 WATER, DEMOGRAPHY AND AFFLUENT LIFE-STYLE

Repeated reference to water use in the text above, implies that attention must be given to factors that determine pattern of use and also to what extent this pattern may comply with environmental contexts and various objectives of society. Demography, poverty and life-style stand out as the most decisive factors in this regard. At a general level, it is natural that increases in population mean a growing demand for water, both in terms of direct use but also in terms of various goods and activities that require water. But there is no direct, proportional relationship.

During this century, world population has grown about 3.5 times, from about 1.6 to 5.8 billion, whereas water withdrawals have increased about 10 times, from about 500 cu km to about 5,000 cu km (Falkenmark & Lundqvist 1995; UNCSD, 1997). Whereas the population growth is possible to predict with a fair degree of probability during the next couple of decades, the rate of additional withdrawal may not follow the same pattern as during recent decades. The rate of withdrawal during past decades partly mirrors the lack of systematic effort to use whatever amounts of water that is accessible in the most worthwhile manner. A general lack of performance criteria - for individual user or sector - and virtually no attempt to achieve a high allocation efficiency, has contributed to a more rapid rate of withdrawal as compared to accomplishments. With improvements in water use efficiency within sectors as well as in terms of overall use in a society, i.e. improved allocation efficiency, more value could be generated from existing supplies and additional withdrawals may generate relatively more per unit of water than what has been the case up to now. Food production, which is the major consumer of water, could be done much more efficiently and industrial water use may be reduced while production expands (see, for instance, Postel 1992, 141).

Generally speaking, there are two circumstances that will play a key role in terms of possibilities for a sustainable water management. One has to do with size and consequences of destitution and

poverty. The other problem refers to affluence in life styles and consequences of exorbitant consumption and irresponsible resource exploitation.

A considerable worry is related to the fact that the geographical pattern of population growth is inversely proportional to resource situation, i.e. there is a high or very high rate of population growth in resource poor regions and modest or low growth in areas that are well endowed with water and to some extent other resources. The challenge is compounded by the fact that areas depicting high population growth rates, widespread poverty and low availability of water, by and large, consist of societies where industrial development, social and political stability, etc. are weak. Poverty alleviation measures - which have proved to have a positive check on demographic trends - are crucial in such areas and may be seen to represent true water management efforts. In the absence of such measures, the water scarce countries/regions are exposed to very considerable risks of being trapped in a vicious circle of poverty, resource degradation, social and political instability and high rates of morbidity and mortality. Such a scenario is not only hitting people in these areas. It will also have considerable repercussion at a wider regional and, probably, global scale. Poverty alleviation measures in combination with social programmes - which have proved to have a positive check on demographic trends - are crucial in such areas and may be seen to represent true water management efforts.

Two circumstances play a key role for sustainable water management. One has to do with size and consequences of poverty. The other one refers to affluence and consequences of exorbitant consumption. Poverty alleviation measures represent true water management efforts.

The other worry is related to trends in consumption among a segment of the world population. For instance, changes in food habits show that a growing proportion of meat in the diet, something which has consequences for availability of food stuff for poor. Growing affluence and life-styles which incorporate exorbitant consumption, mean increased pressure on natural resources, environmental threats and an indirect squeeze on the poor.

Various acts of solidarity and conventions intended to curb irresponsible resources utilisation, environmental pollution and exorbitant consumption, are more needed than ever before.

6. REFERENCES

Allan, J.A. 1994. Water - a substitutable resource? Department of Geography, SOAS, University of London (Mimeo).

Allan, J.A. 1995. Water in the Middle East and in Israel-Palestine: Some local and global issues. In M. Haddad and E. Feitelson (eds.) Joint Management of Shared Aquifers. Palestine Consultancy Group and the Truman Research Institute of Hebrew University, Jerusalem. pp. 31-44.

Blomqvist, A. 1996. Food and Fashion. Water Management and Collective Action among Irrigation Farmers and Textile Industrialists in South India. Ph D diss. 148. Linköping Studies in Arts and Science. Linköping.

Burrill, A. 1997. Assessing the Social Value of Water in Its Uses. Institute for Prospective Technological Studies, Sevilla. European Commission. EUR 17297 EN.

- Drangert, J. O. 1993. Who cares about water? Household water development in Sukumaland, Tanzania. Ph D diss. 85. Linköping studies in Arts and Science. Linköping.
- Enderlein, U. 1996. Water quality standards and Water policy for safeguarding human health. Background papers for Workshop on Chapter 4 of the Comprehensive Global Freshwater Assessment, 18 - 19 May. New York.
- Engelman, R. and P. LeRoy. 1993. Sustaining Water. Population Action International, Washington, D.C.
- Falkenmark, M. 1986. The massive water scarcity now threatening Africa - Why isn't it being addressed? *Ambio*. 18, 112-118.
- Falkenmark, M. & J. Rockström. 1993. Curbing Rural Exodus from Tropical Drylands. *Ambio*. XXII, 7, 427-437.
- Falkenmark, M. and J. Lundqvist. 1995. Looming Water Crisis. New Approaches Are Inevitable In: L. Ohlsson (Ed.) *Hydropolitics: Conflicts over Water As a Development Constraint*". Zed Publishers. London.
- Gleick, P.H., P. Loh, S. Gomez, J. Morrison. 1995. California Water 2020: A Sustainable Vision. A Report of the Pacific Institute for Studies in Development, Environment, and Security, Oakland, California.
- ICWE. 1992. The Dublin Statement on Water and Sustainable Development. International Conference on Water and Environment, Dublin, Ireland.
- Kemper, K. 1995. The Cost of Free Water. Water Resources Allocation and Use in the Curu Valley, Ceará, Northeast Brazil. Ph D diss. 137. Linköping Studies in Arts and Science. Linköping.
- Lundqvist, J. 1997. The Triple Squeeze on Water. Rainwater, Provided Water and Waste water in Socio-economic and Environmental Systems. (Manuscript). Tema V, Linköping.
- Lundqvist, J. & P. Gleick. 1997. Sustaining Our Waters into the 21st Century. Stockholm Environment Institute. Stockholm.
- Meybeck, M. D. Chapman and R. Helmer. 1989. Global Freshwater Quality: A First Assessment. World Health Organization and United Nations Environment Programme, Basil Blackwell, Oxford.
- Najlis, P. 1996. Personal communications. UN: DPCSD
- Pallett, J. (Ed.) 1997. Sharing Water in Southern Africa. Desert Research Foundation of Namibia. Windhoek.
- Postel, S.L. 1992. Last Oasis: Facing Water Scarcity. W.W. Norton and Co., New York.
- Postel, S.L. 1996. Dividing the Waters: Food security, Ecosystem, Health and the New Politics of Scarcity. Worldwatch Papers 132. Washington.
- Rogers, P., R. Bhatia and A. Huber. 1996. Water as a social and economic good: how to put the principles into practice. Paper prepared for the Technical Advisory Committee of the Global Water Partnership at its semi-annual meeting in Windhoek, Namibia. November.

Sandström, K. 1995. Forests and Water - Friends or Foes? Hydrological implications of deforestation and land degradation in semi-arid Tanzania. Ph D diss. Linköping Studies in Arts and Science 120. Linköping.

Serageldin, I. 1995. Toward Sustainable Management of Water Resources. Directions in Development Series. The World Bank, Washington, D.C.

Shuval, H. 1997. Israel; National Water Resources Conservation Planning and Policies for Rapid Economic Development and Conditions of Severe Scarcity. In: Lundqvist & Gleick.

Stanners, D and P. Bourdeau. 1995. Europe's Environment. The Dobris Assessment. European Environment Agency. Copenhagen.

UN (CSD). 1997. Comprehensive Assessment of the Freshwater Resources of the World. Economic and Social Council, fifth session, 5-25 April. E/CN.17/1997/9/.

United Nations Conference on Environment and Development (UNCED). 1992. Agenda 21: Chapter 18, Freshwater. United Nations Publications.

Warner, D.B. 1995. Health: The forgotten imperative in freshwater development." Paper presented at the 5th Stockholm Water Symposium, August.

World Bank. 1993. Water Resources Management - A World Bank Policy Paper. Washington, DC.

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