

Principles of Integrated Water Resources Management (IWRM)

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Introduction

The world's fresh water resources are under increasing pressure. Growth in population, increased economic activity and improved standards of living lead to increased competition for and conflicts over the limited freshwater resources. A combination of social inequity, economic marginalisation and lack of poverty alleviation programmes also force people living in extreme poverty to overexploit soil and forestry resources, which often results in negative impacts on water resources. Lack of pollution control measures further degrades water resources (GWP-TAC4, 2000; Gleick, 1993, Savenije 2000). This calls for a need to find appropriate ways to co-ordinate policy making, planning and implementation in an integrated manner across sectoral, institutional and professional boundaries and to take into account the even more complex co-ordination issues arising over the management of international watercourses. These attempts have given birth to a new school of thinking and action to be taken in the water sector termed Integrated Water Resources Management (IWRM). The purpose of this paper is to reiterate at a glance the guiding principles of IWRM with a bias towards Southern Africa for the Global Water Partnership Youth Forum. The paper does not attempt to be exhaustive but gives a brief scenario for digestion during this Forum.

Definition of IWRM

There is growing awareness that comprehensive water resources management is needed, because:

- fresh water resources are limited;
- those limited fresh water resources are becoming more and more polluted, rendering them unfit for human consumption and also unfit to sustain the ecosystem;
- those limited fresh water resources have to be divided amongst the competing needs and demands in a society
- many citizens do not as yet have access to sufficient and safe fresh water resources
- techniques used to control water (such as dams and dikes) may often have undesirable consequences on the environment
- there is an intimate relationship between groundwater and surface water, between coastal water and fresh water, etc. Regulating one system and not the others may not achieve the desired results.

Hence, engineering, economic, social, ecological and legal aspects need to be considered, as well as quantitative and qualitative aspects, and supply and demand. Moreover, also the 'management cycle' (planning, monitoring, operation & maintenance, etc.) needs to be consistent (van der Zaag, 2000; van der Zaag 2001).

Integrated water resources management, then, seeks to manage the water resources in a comprehensive and holistic way. It therefore has to consider the water resources from a number

of different perspectives or dimensions. Once these various dimensions have been considered, appropriate decisions and arrangements can be made. The challenge ahead for water resources management is to strike a balance between the use of the resource as a basis for the livelihood of the world's increasing population and the protection and conservation of the resource to sustain its functions and characteristics.

Due to the nature of water, integrated water resources management has to take account of the following four dimensions:

1. the *water resources*, taking the entire hydrological cycle in account
2. the *water users*, all sectoral interests and stakeholders
3. the *spatial scale*, including
 - 3.1 the spatial distribution of water resources and uses
 - 3.2 the various spatial scales at which water is being managed, i.e. individual user, user groups (e.g. user boards), watershed, catchment, (international) basin; and the institutional arrangements that exist at these various scales
4. the *temporal scale*; taking into account the temporal variation in availability of and demand for water resources, but also the physical structures that have been built to even out fluctuations and to better match the supply with demand (van der Zaag 2001).

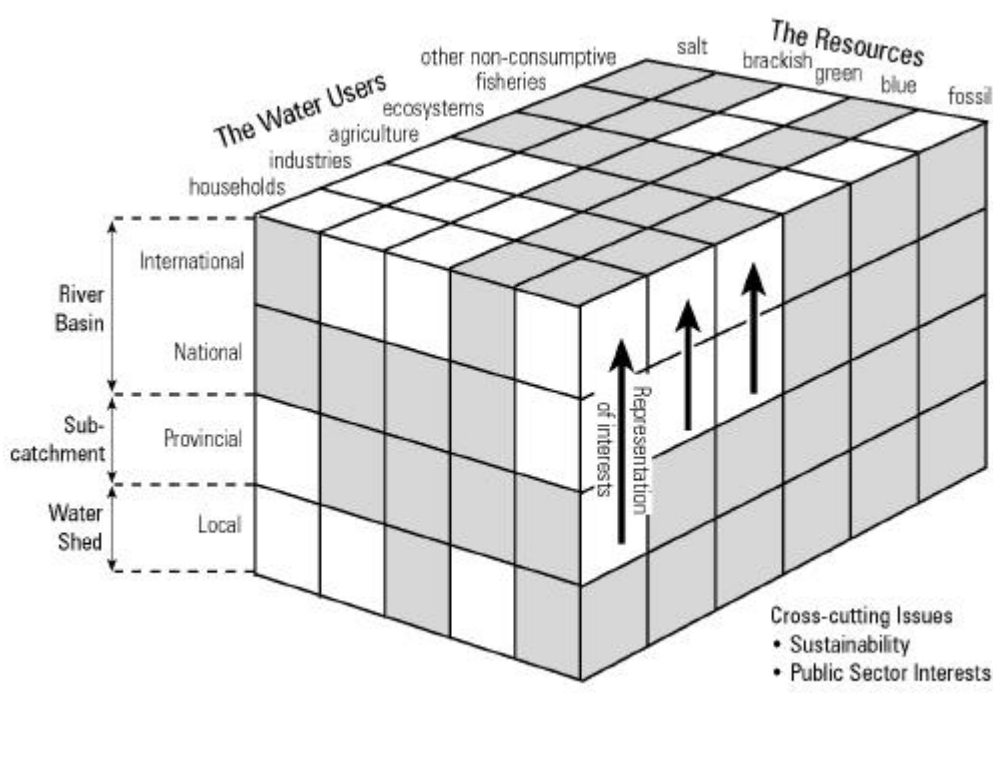


Figure 1 Three of the four dimensions of Integrated Water Resources Management (Savenije, 2000)

IWRM depends on context and the since some of its concepts are widely being debated an unambiguous definition does not exist currently. For the purposes of providing a common framework the following definitions have been suggested:

Integrated Water Resources Management (IWRM) is a process, which promotes the coordinated development and management of water, land and related resources, in order to maximise the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems (GWP-TAC4, 2001).

IWRM is a process which aims to ensure the coordinated development of water resources with a view to optimising social and economic welfare without compromising their sustainability (CAPNET, 1999).

Integrated Water Resources Management therefore acknowledges the entire water cycle with all its natural aspects, as well as the interests of the water users in the different sectors of a society (or an entire region). Decision-making would involve the integration of the different objectives where possible, and a trade-off or priority-setting between these objectives where necessary, by carefully weighing these in an informed and transparent manner, according to societal objectives and constraints. Special care should be taken to consider spatial scales, in terms of geographical variation in water availability and the possible upstream-downstream interactions, as well as time scales, such as the natural seasonal, annual and long-term fluctuations in water availability, and the implications of developments now for future generations (van der Zaag 2001).

The Dublin Principles as a Guide to IWRM

Whereas certain basic principles underlying IWRM may be commonly applicable, independent of context and stage of economic and social development, there is no universal blueprint as to how such principles can be put into practice (GWP-TAC4, 2000). Current thinking on the crucial strategic issues in water resources is heavily influenced by the so-called Dublin Principles, which were formulated during the International Conference on Water and the Environment in Dublin, 1992, as a preparation for the UN Conference on Environment and Development (UNCED) in Rio de Janeiro the same year. During the Rio conference, the concepts of Integrated Water Resources Management were widely discussed and accepted (Box 1).

Box 1 Dublin Principles (ICWE, 1992)

- Fresh water is a finite, vulnerable and essential resource which should be managed in an integrated manner
- Water resources development and management should be based on a participatory approach, involving all relevant stakeholders
- Women play a central role in the provision, management and safeguarding of water
- Water has an economic value and should be recognised as an economic good, taking into account affordability and equity criteria.

Associated key concepts:

- Integrated water resources management, implying:
 - An inter-sectoral approach
 - Representation of all stakeholders
 - Consideration of all physical aspects of the water resources
 - Considerations of sustainability and the environment
 - Sustainable development, sound socio-economic development that safeguards the resource base for future generations
 - Emphasis on demand driven and demand oriented approaches
 - Decision-making at the lowest possible level (subsidiarity)
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Consensus over several issues have emerged in the last few years:

- In terms of water allocation, basic human needs have priority; other uses should be prioritised according to societal needs and socio-economic criteria
- The river basin is the logical unit for water resources management
- Participatory approaches in decision-making, and the crucial role of women.

There are three important outstanding issues of debate:

- Privatisation, and more generally the role of the private sector in water management
- The value of water (the social, economic and ecological value)
- The pricing of water

It is obvious that these remaining issues are very important strategically. Countries are currently dealing with them individually. It is sometimes feared that outside pressure may in cases lead to countries making the wrong decision, and by so doing jeopardising fundamental policy principles. This may, for instance, be the case when a water utility is privatised without the country having an effective regulatory body to supervise the operations of the privatised utility.

Principle I: Water as a finite and vulnerable resource

A holistic approach; This principle recalls the need for a holistic approach to management, recognizing all the characteristics of the hydrological cycle and its interaction with other natural resources and ecosystems. The statement also recognizes that water is required for many different purposes, functions and services; holistic management, therefore, has to involve consideration of the demands placed on the resource and the threats to it.

Resource yield has natural limits; The notion that freshwater is a finite resource arises as the hydrological cycle on average yields a fixed quantity of water per time period; this overall quantity cannot be altered significantly by human actions (desalinization of seawater is becoming feasible in some locations but still at a very limited scale). The freshwater resource may be regarded as a natural capital asset, which needs to be maintained to ensure that the desired services it provides are sustained (GWP-TAC4, 2000).

Whilst the worlds oceans may seem unbounded, the amount of fresh water actually available to people is finite- and a mere fraction of the water visible from outer space. There is a fixed amount of water, which neither decreases nor increases (Table 1). Fresh water is a renewable resource because of the water cycle (Table 2). The world's water is depicted in Figure 2, showing also the distribution between fresh and salt water. From a human perspective the source of freshwater is rainfall. Most of this rainfall (some 80% or more) is used directly for vegetative growth, such as natural vegetation, pasture, rain-fed maize etc. This process, known as transpiration, is highly productive and produces in Southern Africa the bulk of food crops.

Only a small portion of the rainfall flows into rivers as surface water and recharges groundwater. This water is used for domestic water supply, industrial production, irrigated agriculture etc. This is the water that we tend to harness through infrastructure development (e.g. dams, wells) and that we tend to pollute.

If we talk about Integrated Water Resources Management, we mean to consider the entire water cycle. This means that we also look at rain-fed agriculture production, soil and water conservation within the watershed, rainwater harvesting techniques etc. To facilitate the comprehensive thinking in terms of the entire water cycle, three types of water can be distinguished, together forming the 'rainbow' of water (van der Zaag 2000).

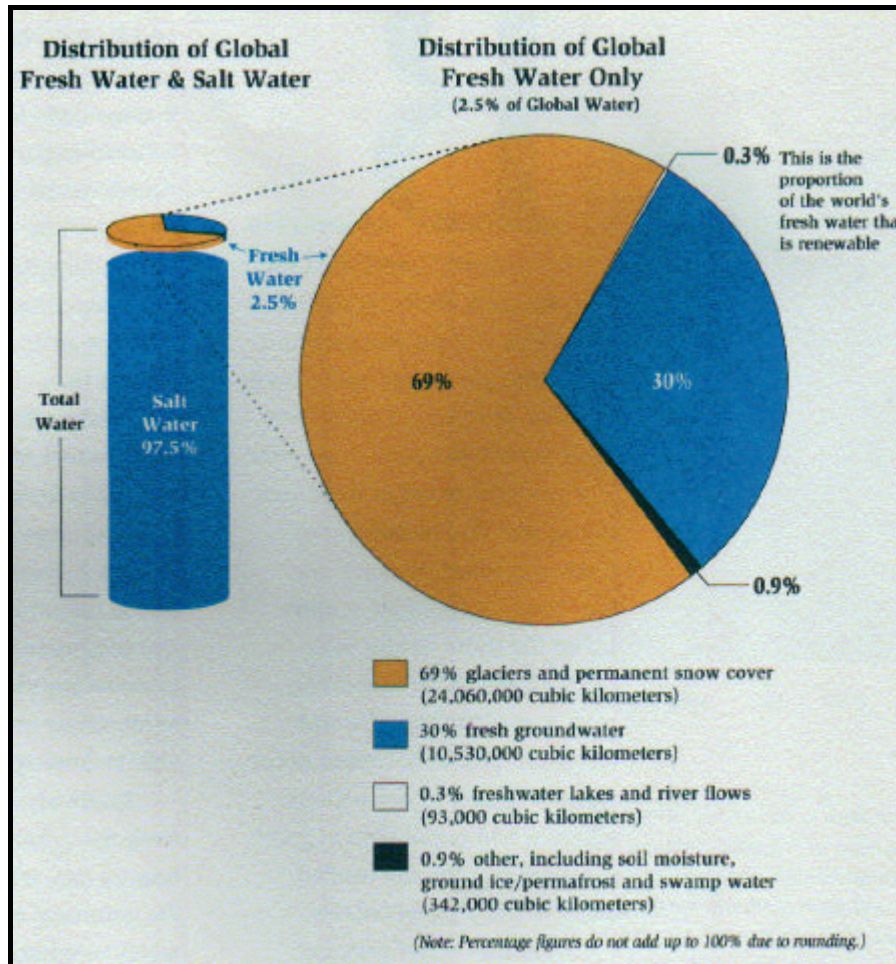


Figure 1 The world's water (Shilomanov, 1993; Engelman & Leroy 1993).

Table 1: Amount of water on earth (Savenije, 2000)

Water occurrence	10 ¹² m ³	Amount of water	
		% of all water	% of fresh water
World oceans	1,300,000	97	
Salt lakes and seas	100	.008	
Polar ice	28,500	2.14	77.6
Atmospheric water	12	.001	.035
Water in organisms	1	.000	.003
Fresh water lakes	123	.009	.335
Water courses	1	.000	.003
Unsaturated zone	65	.005	.18
Saturated zone	8,000	.6	21.8

Total fresh water	36,700	2.77	100
Total water	1,337,000	100	

Table 2: Annual water balance of the earth (Savenije, 2000)

	Area 10^{12} m^2	Storage $10^{12} \text{ m}^3/\text{a}$	Precipitation $10^{12} \text{ m}^3/\text{a}$	Evaporation $10^{12} \text{ m}^3/\text{a}$	Runoff $10^{12} \text{ m}^3/\text{a}$
Oceans	361	1,328,500	403	449	-46
Continents	149	8,190	107	61	46

A rainbow of water

The rainbow of water distinguishes three types of water depending on their occurrence in the water cycle (Figure 1).

- ‘white’ water = rainfall and that part of rainfall which is intercepted and immediately evaporates back to the atmosphere
- ‘blue’ water = water involved in the runoff (sub-)cycle, consisting of surface water and groundwater (below the unsaturated zone)
- ‘green’ water = water stemming directly from rainfall, that is transpired by vegetation (after having been stored in the unsaturated zone) (Falkenmark, 1996)

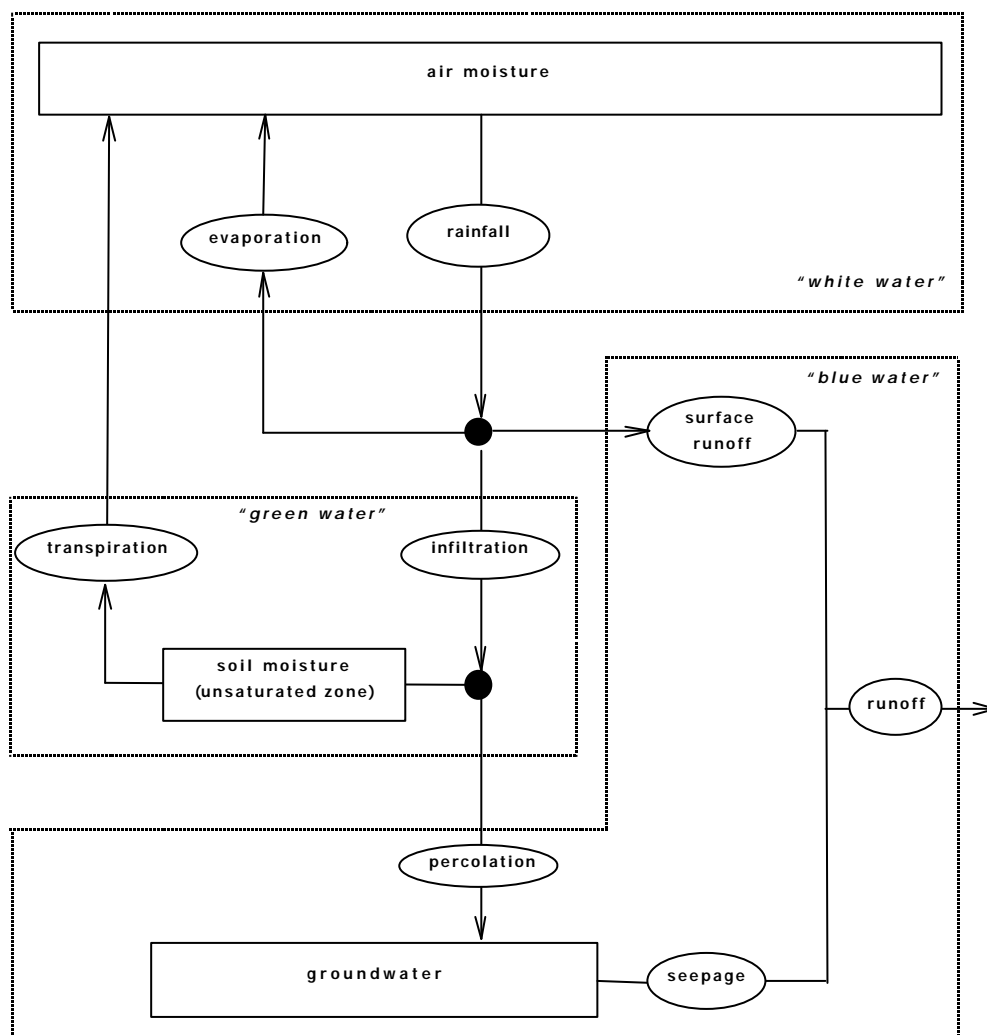


Figure 3 The hydrological cycle, with 'white', 'green' and 'blue' water, and the two partitioning points (van der Zaag 2000).

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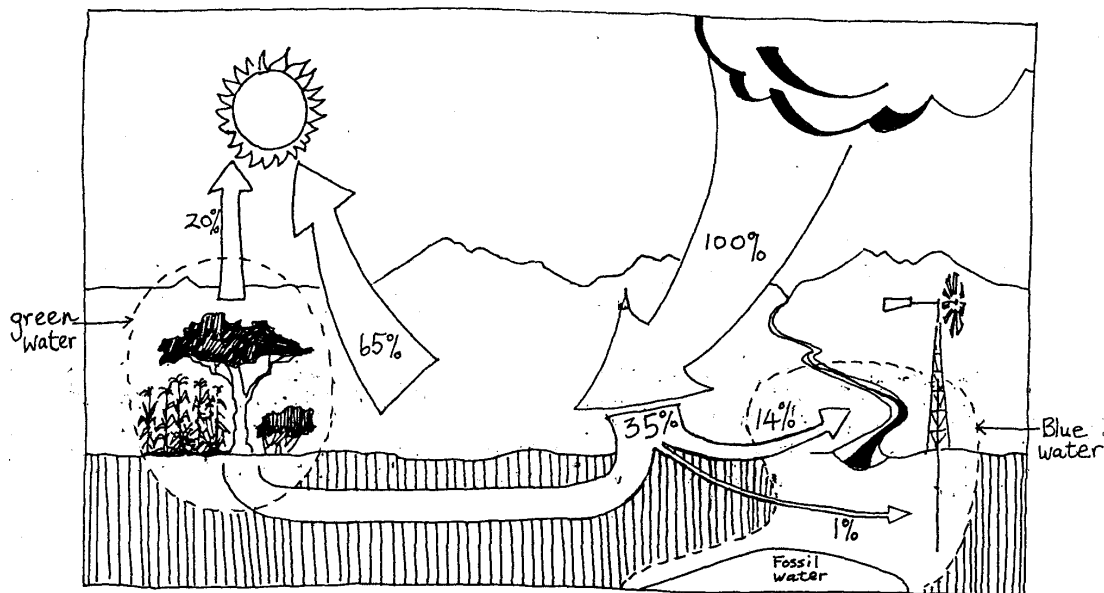


Figure 4 Schematic water balance for Southern Africa, showing the average partitioning of rainfall (Pallett 1997)

Water use

Effects of human activities; Human beings can clearly affect the productivity of the water resource. They can reduce the availability and quality of water by actions, such as mining of groundwater, polluting surface- and groundwater and changing land use (afforestation, deforestation, urbanization) which alter flow regimes within surface water systems. More positive effects can, however, arise from regulation of the natural temporal and spatial variability of flows. When water is used for non-consumptive purposes and involves return flows, planned reuse can increase effective resource flows and the total quantity of services provided. It also has to be recognized that the value or welfare derived from the water resource assets will vary with the uses to which the assets are put.

Upstream-downstream user relations; The effects of human activities lead to the need for recognition of the linkages between upstream and downstream users of water. Upstream users must recognize the legitimate demands of downstream users to share the available water

resources and sustain usability Excessive consumptive use or pollution of water by upstream users may deprive the downstream users of their legitimate use of the shared resource. This clearly implies that dialogue or conflict resolution mechanisms are needed in order to reconcile the needs of upstream and downstream users (GWP-TAC4, 2000).

There are a large number of types of water use. Among these are:

- Rainfed agriculture
- Irrigation
- Domestic use in urban centres and in rural areas
- Livestock
- Industrial and commercial use
- Institutions (e.g. schools, hospitals, government buildings, sports facilities etc.)
- Waste and wastewater disposal
- Cooling (e.g. for thermal power generation)
- Hydropower
- Navigation
- Recreation
- Fisheries
- The environment (wildlife, nature conservation etc.)

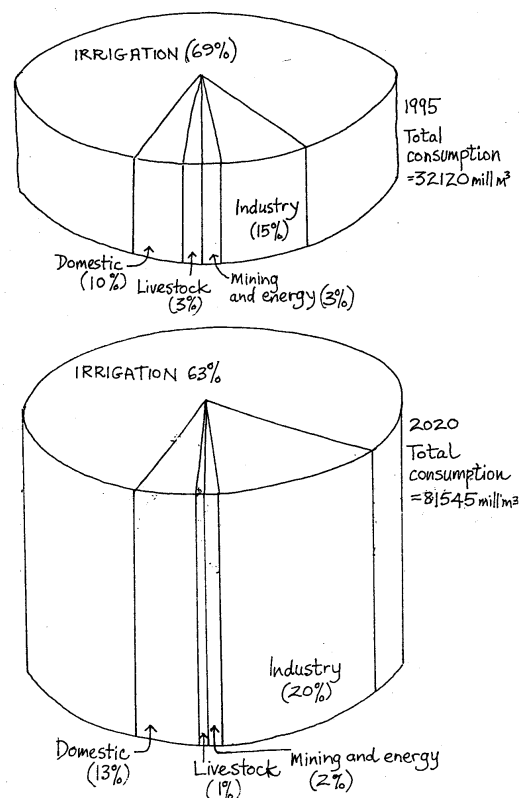


Figure 5 Water use in Southern Africa in 1995 (Pallett, 1997)

We can distinguish *withdrawal uses* and *non-withdrawal* (such as navigation, recreation, waste water disposal by dilution) uses; as well as *consumptive* and *non-consumptive* uses.

Consumptive use is the portion of the water withdrawn that is no longer available for further use because of evaporation, transpiration, incorporation in manufactured products and crops, or use by human beings and livestock (van der Zaag 2001).

The concepts “consumption” and “demand” are often confused. Only a portion of the water demand is actually consumed, i.e. lost from the water resource system. It is important also to note that water use generates return flows, grey water, black water and yellow water to adding more colours to the rainbow.

A similar confusion exists when talking about water losses. It depends on the scale whether water is considered a loss or not. At the global scale, no water is ever lost. At the scale of an irrigation scheme, a water distribution efficiency of 60% indeed means that slightly less than half of the water is lost. Part of this water, however, may return to the river and be available to a downstream user. At the scale of the catchment, therefore, it is the transpiration of crops (40% in this example) that can be considered a loss!

A holistic institutional approach; Holistic management not only involves the management of natural systems; it also necessitates coordination between the range of human activities which create the demands for water, determine land uses and generate water-borne waste products. Creating a water sensitive political economy requires coordinated policy-making at all levels (from national ministries to local government or community-based institutions). There is also a need for mechanisms which ensure that economic sector decision-makers take water costs and sustainability into account when making production and consumption choices. The development of an institutional framework capable of integrating human systems - economic, social and political - represents a considerable challenge (GWP-TAC4, 2000).

Principle II: Participatory approach

Real participation; Water is a subject in which everyone is a stakeholder. Real participation only takes place when stakeholders are part of the decision-making process. This can occur directly when local communities come together to make water supply management and use choices. Participation also occurs if democratically elected or otherwise accountable agencies or spokespersons can represent stakeholder groups. Additionally there are circumstances in which participation in decision-making can take place through market processes; if appropriate pricing systems are in place, local governments, community organizations or irrigation districts could signal their demands for bulk water services. The type of participation will depend upon the spatial scale relevant to particular water management and investment decisions and upon the nature of the political economy in which such decisions take place.

Participation is more than consultation; Participation requires that stakeholders at all levels or the social structure have an impact on decisions at different levels of water management. Consultative mechanisms, ranging from questionnaires to stakeholder meetings, will not allow real participation if they are merely employed to legitimize decisions already made, to defuse political opposition or to delay the implementation of measures which could adversely impinge upon a powerful interest group.

The lowest appropriate level; Participation is an instrument that can be used to pursue an appropriate balance between a top-down and a bottom-up approach to IWRM. For some decisions the appropriate decision unit is the household or the farm; participation depends on the provision of mechanisms and information to allow individuals and communities to make water sensitive choices. At the other end of the spatial scale the management of international river basins will require some form of cross-national coordinating committees and mechanisms for conflict resolution (GWP-TAC4, 2000).

Principle III: The important role of women

Involvement of women in decision-making; Women's participation as decision-makers is interwoven with gender hierarchies and roles within different cultures leading to the existence of communities that ignore or impede women's participation in water management. Although "gender issues" have been reflected in all statements on IWRM since the Dublin and Rio conferences, there is still a long way to go before rhetoric is replaced by operational mechanisms and actions to ensure an equitable participation of women in IWRM. Therefore special efforts must be made to ensure women's participation at all organizational levels.

Women as water users; It is widely acknowledged that women play a key role in the collection and safeguarding of water for domestic and -in many cases - agricultural-use, but that they have a much less influential role than men in management, problem analysis and in the decision-making process related to water resources. The fact that social and cultural circumstances vary between societies suggests that the need exists to explore different mechanisms for increasing women's access to decision-making and widening the spectrum of activities through which women can participate in IWRM.

IWRM requires gender awareness; In developing the full and effective participation of women at all levels of decision-making, consideration has to be given to the way different societies assign particular social, economic and cultural roles to men and women. There is a need to ensure that the water sector as a whole is gender aware, a process which should begin by the implementation of training programmes for water professionals and community or grass root mobilisers (GWP-TAC4, 2000).

Principle IV: Water as an economic good

Water has a value as an economic good; Many past failures in water resources management are attributable to the fact that water has been -and is still - viewed as a free good, or at least that the full value of water has not been recognized. In a situation of competition for scarce water resources such a notion may lead to water being allocated to low-value uses and provides no incentives to treat water as a limited asset. In order to extract the maximum benefits from the available water resources there is a need to change perceptions about water values and to recognize the opportunity costs involved in current allocative patterns.

Value and charges are two different things; Concern has been voiced over the social consequences of the economic good" concept: How would this affect poor people's access to water? (While the Dublin principles refer to water as an economic good, water is referred to as

an economic *and social* good in Chapter 18 of Agenda 21). To avoid confusion over this concept there is a need to distinguish clearly between *valuing* and *charging* for water. The value of water in alternative uses is important for the rational allocation of water as a scarce resource (using the “opportunity cost” concept), whether by regulatory or economic means. *Charging* for water is applying an economic instrument to affect behaviour towards conservation and efficient *water* usage, to provide incentives for demand management, ensure cost recovery and to signal consumers' willingness to pay for additional investments in water services.

Useful water value concepts; The following concepts of water value have been found useful within IWRM. The full value of water consists of its use value - or economic value - and the intrinsic value. The economic value which depends on the user and the way it is used, include: value to (direct) users of water, net benefits from water that is lost through evapo-transpiration or other sinks (e.g. return flows), and the contribution of water towards the attainment of social objectives. The intrinsic value includes non-use values such as bequest or existence values.

Useful water cost concepts; The full cost of providing water includes the full economic cost and the environmental externalities associated with public health and ecosystem maintenance. The full economic cost consists of: the full supply cost due to resource management, operating and maintenance expenditures and capital charges, the opportunity costs from alternative water uses, and the economic externalities arising from changes in economic activities of indirectly affected sectors.

The goal of full cost recovery; The recovery of full cost should be the goal for all water uses unless there are compelling reasons for not doing so. While, in principle, the full cost needs to be estimated and made known for purposes of rational allocation and management decisions, it need not necessarily be charged to the users. The cost, however, will have to be borne by someone. Estimation of full cost may be very difficult. In situations involving conflict over water attempts should be made to at least estimate the full economic cost as the basis for allocation.

Water has a combination of characteristics that make it different from any other good. Individually, these characteristics are maybe not so restrictive, but in combination they make that water has to be dealt with in a very special way. The following characteristics have been grouped by Savenije, (2001):

1. water is essential: There is no life without water, no economic production, no environment
2. water is scarce: The amount of water available is limited by the amount of water that circulates through the atmosphere on an annual basis
3. water is fugitive: Water flows under gravity. If we don't capture it, its gone. The availability of the water varies over time, and so does the demand for water. It flows through our fingers unless we store it
4. water is a system: The annual water cycle from rainfall to runoff is a complex system where all processes are interconnected and interdependent with only one direction of flow: downstream
5. water is bulky: All of the above would not be a problem if we could transport the water easily from one place to another as we do with fuel or food. Then we could move water from an area of access (the mine) to an area of shortage (the user)
6. water is irreplaceable: Water can only be diluted with water to turn it into water. That is the most important aspect of it. Although other economic goods like food and fuel have

alternatives, water has not.

7. water is complex: Water is not freely tradable and its market is complex.

Savenije, (2001) argues that water cannot be treated strictly as an economic good i.e. classical economic principles of supply and demand do not readily apply. Cautionary steps have to be adopted therefore when dealing with this irreplaceable commodity which is basic like air.

Conclusion and policy principles

For a country to change its water management towards a more holistic and integrated management system, it will require to review its water policy. This is currently on-going in many countries in Southern Africa, or has been recently concluded. A water policy often starts with the definition of a small number of basic principles and objectives, such as the need for sustainable development and desirable socio-economic development (van der Zaag, 2000).

Three key policy principles are known as the three 'E's as defined by Postel (1992):

- a) **Equity:** Water is a basic need. No human being can live without a basic volume of fresh water of sufficient quality. Humans have a basic human right of access to water resources (see Gleick, 1999). This policy principle is related to the fact that water is often considered a public good. Water is such a basic requirement for human life and survival that society has to defend the uses of the water resources in the public interest. From here a number of other issues can be derived, such as security (protection against floods, droughts, famine and other hazards).
- b) **Ecological integrity:** Water resources can only persist in a natural environment capable of regenerating (fresh) water of sufficient quality. Only sustainable water use can be allowed such that future generations will be able to use it in similar ways as the present generation.
- c) **Efficiency:** Water is a scarce resource. It should be used efficiently; therefore, institutional arrangements should be such that cost recovery of the water services should be attained. This will ensure sustainability of infrastructure and institutions, but should not jeopardise the equity principle. Here comes in the issue of water pricing, and whether or not water should be priced according to its economic value.

Much of water resources management deals with finding suitable compromises between these policy principles that sometimes are conflicting.

The Southern Africa Vision for Water has been formulated as a desired future characterised by:

Equitable and sustainable utilisation of water for social, environmental justice, regional integration and economic benefit for present and future generations.

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