Principles of
Water Resources Management

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Concepts and definitions

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Irrigators repairing a canal in Mexico

Principles of Water Resources Management - Concepts and definitions

1 The water cycle

The annual water cycle from rainfall to runoff is a complex system where several processes (infiltration, surface runoff, recharge, seepage, re-infiltration, moisture recycling) are interconnected and interdependent with only one direction of flow: downstream. A catchment is therefore one single system and more than the sum of a large number of subsystems (Figure 1).

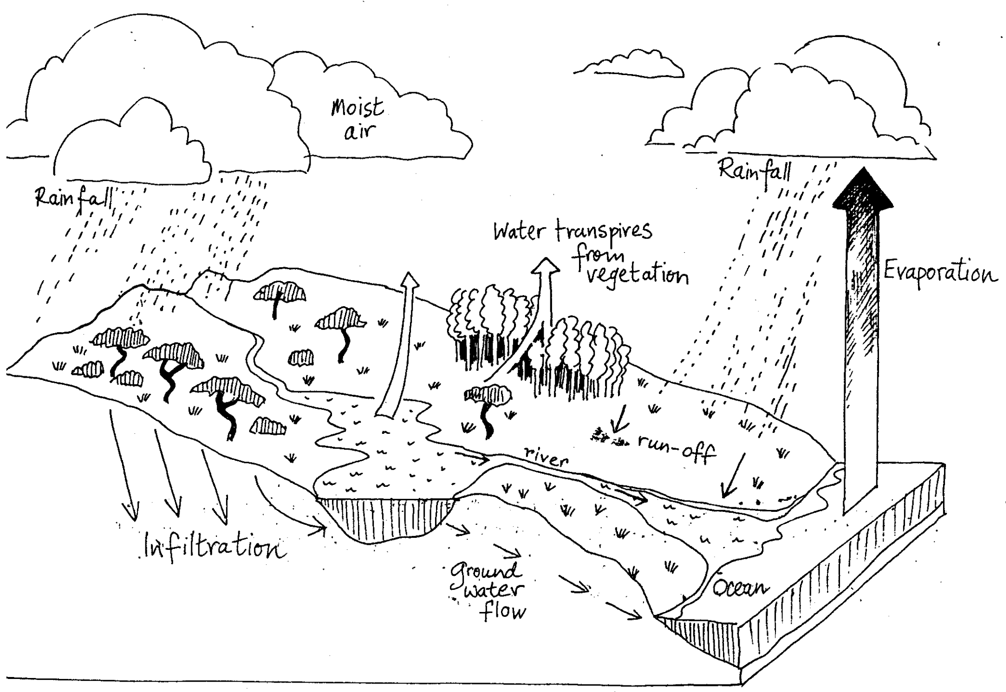

Figure 1: The water cycle (Pallett, 1997: 20)

Our water use is embedded in the hydrological system. It is therefore important that we consider the hydrological system and locate our water use in it.

The hydrological system is the source of water. Whereas water is finite, it is also renewable through the water cycle. The hydrological system generates the water that we need for drinking and other domestic use, for agricultural production (both rainfed and irrigated), for industrial production, for recreation, for maintaining the environment, etc.

The hydrological system also receives return flows from human water use. This can be in a form not often recognised, namely as water vapour from transpiration of crops and evaporation from natural and man-made lakes (so-called moisture feedback). "Grey" return flows normally are more conspicuous, such as sewage water from cities and industries that flow back into rivers. Such flows may also percolate into aquifers, often carrying with it pollutants (e.g. from irrigation). In heavily committed catchment areas, downstream users may depend on return flows as the source of their water.

Water use therefore influences the flow regime and has impacts downstream, both in terms of water quantity and water quality. My water use always implies "looking upstream" in order to assess water availability, and "looking downstream" in order to assess possible third party effects of my activity. Most people, however, forget the last part and tend to look only in the upstream direction, concerned as they are with securing the supply of water… (Figure 2)

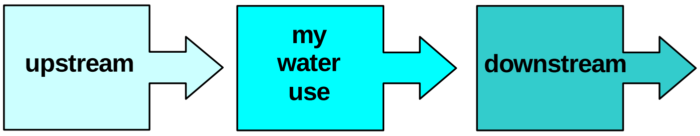

Figure 2: Everybody lives downstream..., and looks upstream

2 Three characteristics that make water special

Water has at least three important attributes with a bearing on management:

- Fresh water is *vital* to sustain life, for which there is no substitute. This means that water has a (high) *value* to its users.

- Although water is a renewable resource, it is practically speaking *finite*. Many uses of water are therefore *subtractible*, meaning that the use by somebody may preclude the use by somebody else.

- Water is a *fugitive* resource. It is therefore difficult to assess the (variations in) *stock* and *flow* of the resource, and to define the *boundaries* of the resource. This complicates the planning and monitoring of withdrawals as well as the *exclusion* of those not entitled to abstract water. Its fugitive nature makes it also more costly to harness, requiring the construction of reservoirs, for example.

The vital nature of water gives it characteristics of a *public good*. Its finite nature confers to it properties of a *private good*, as it can be privately appropriated and enjoyed. The fugitive nature of water, and the resulting high costs of exclusion, confers to it properties of a *common pool resource*.

Water resources management aims to reconcile these various attributes of water. This is obviously not a simple task. The *property regime* and *management arrangements* of a water resources system are therefore often complex.

It should be noted that there is no other natural resource with the same combination of these three characteristics (Table 1)! Water resources management aims to reconcile these various attributes of water. This is obviously not a simple task. The *property regime* and *management arrangements* of a water resources system are therefore often complex.

Table 1: Aspects of water and how they apply to other goods (after Savenije, 2002)

	Vital, no substitute	Finite, scarce	Fugitive
Air	+		+
Land	+	+	
Water	+	+	+
Fuel	+	+	
Food	+	+	
...			

3 The uses and value of water

Water use

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.)

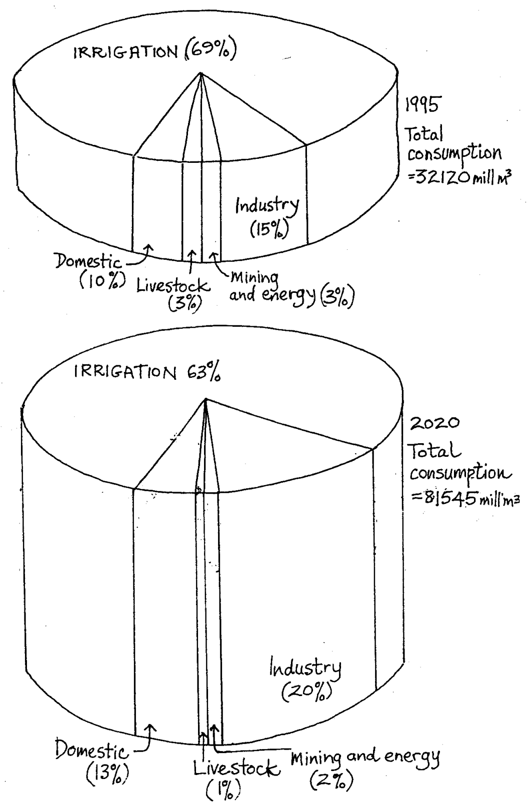

Figure 3: Water use in Southern Africa in 1995 and 2020 (Pallett, 1997:38)

Demand for, and use of water

Demand for water is the amount of water required at a certain point. The *use* of water refers to the actual amount reaching that point.

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, use by human beings and livestock, or pollution.

The terms "consumption", "use" and "demand" are often confused. The amount of water actually reaching the point where it is required will often differ from the amount required. Only a portion of the water used is actually consumed, i.e. lost from the water resource system. Return flows from a city, for example, may amount to as much as 20-40% of the amount of raw water abstracted. Return flows from irrigated fields may involve similar fractions of return flows. In both cases the water quality of these return flows may make them unfit for re-use without further treatment or dilution.

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", i.e. does not reach its intended destination (namely the roots of the plants). 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 net consumptive use, i.e. the transpiration of crops (60% in this example) plus the evaporation part of the "water losses" that can be considered really lost (Figure 4)!

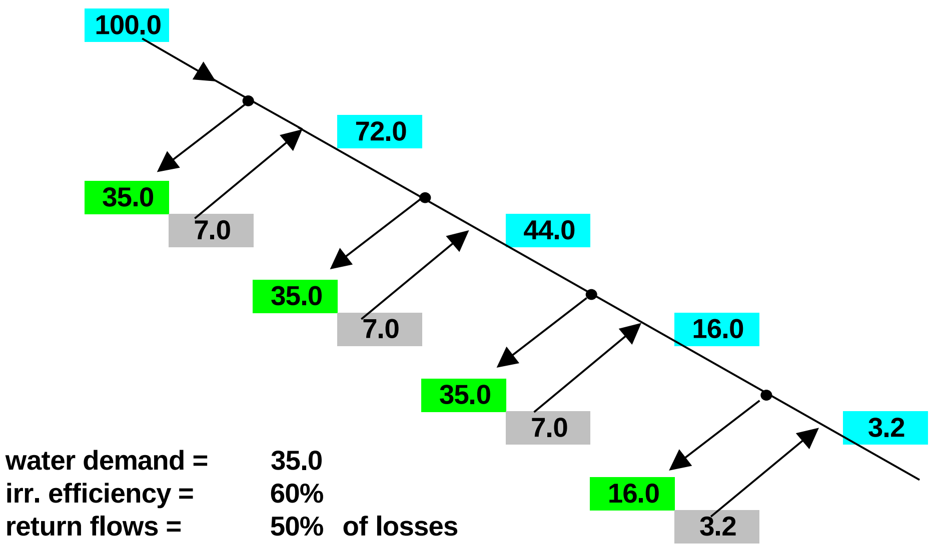

Figure 4: A cascade of inefficient irrigators; what is the total basin efficiency?

While the total available freshwater is limited (finite), demand grows. Hence the pressure on our water resources increases. If we also consider the possible implications of climate change, namely an increase in the variability of particular drought and flood events, the usable part of the water may actually *decrease*, further increasing the pressure on, and competition for, water. Hence the importance of the field of water resources management.

The value of water

The various uses of water in the different sectors of an economy add value to these sectors. Some sectors may use little water but contribute significantly to the gross national product (GNP) of an economy (see Table 2). Other sectors may use a lot of water but contribute relatively little to that economy. The added value of some uses of water is difficult, if not impossible to measure. Consider for instance the domestic use of water: how to quantify the value of an adequate water supply to this sector? And what is the value of water left in rivers in order to satisfy environmental water requirements?

Table 2: Contribution of various sectors in the economy of Namibia to Gross National Product (GNP), and the amount of water each sector uses (Pallett, 1997: 102)

Sector	Water use ($Mm^3\ yr^{-1}$)	Water use (%)	Contribution to GNP (%)
Irrigation	107	43.0	3
Livestock	63	25.3	8
Domestic	63	25.3	27
Mining	8	3.2	16
Industry & Commerce	7	2.8	42
Tourism	1	0.4	4
Total	249	100.0	100

The damage to an economy by water shortage may be immense. It is well known, for instance, that a positive correlation exists between the Zimbabwe stock exchange index and rainfall in Zimbabwe. The drought of 1991/92 had a huge negative impact on the Zimbabwean economy (Box 1).

Box 1: The impact of drought in Zimbabwe

During the drought of 1991/92, Zimbabwe's agriculture production fell by 40% and 50% of its population had to be given relief food and emergency water supplies, through massive deep drilling programmes, since many rural boreholes and wells dried up. Urban water supplies were severely limited with unprecedented rationing. Electricity generation at Kariba fell by 15% causing severe load shedding. As a result Zimbabwe's GDP (Gross Domestic Product) fell by 11%.

The value, and the pricing, of water is a hotly debated issue. Often, the focus is on the value, and price, of a specific water service, such as urban water supply. Although being part of one and the same hydrological cycle, the value of water differs, depending when and how it occurs. Whereas rainfall is generally considered to be a free commodity, of all types of water it has the highest value. This is because rainfall represents the starting point of a long path through the hydrological cycle (infiltration, recharge of groundwater, transpiration, moisture recycling, surface runoff, seepage, re-infiltration) (Hoekstra et al., 2001). Rainfall therefore has many opportunities for use and re-use: in rainfed agriculture, irrigation, for urban and industrial use, environmental services etc.

Water flowing in rivers has a lower value than rainfall. But also this “blue” water has different values, depending on when it occurs. Water flowing during the dry season (the base flow resulting from groundwater seepage) has a relatively high value, because it is a fairly dependable resource just when demand for it is highest. In contrast, peak flows during the rainy season have a lower value, although these peaks provide many important services, such as recharging aquifers, water pulses essential for ecosystems and filling of reservoirs for later use. The highest peak flows occur as destructive floods and have a negative value.

Generally, water can provide different types of value, including adding value to the economy, adding value to livelihoods and communities, and adding value to the environment. Thus, the value of water has different dimensions, including, but not limited to, the economic value, the social value, the cultural value and the ecological value. These different types of value cannot easily be compared as they are expressed in different metrics, and some may be difficult or impossible to quantify. But, as the saying goes, “not everything that counts can be counted.”

4 Integrated water resources management

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
- it is increasingly realised that there is a huge potential to increase crop production and achieve food security through more efficient use of rainfall through improved soil and water conservation and harvesting techniques
- structures 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 and maintenance, etc.) needs to be consistent.

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 following are the four dimensions that integrated water resources management takes into account (Savenije and Van der Zaag, 2000; see also Figure 5 and Box 2):

1. the *water resources*, taking the entire hydrological cycle into account, including stock and flows, as well as water quantity and water quality; distinguishing, for example, rainfall, soil moisture, water in rivers, lakes, and aquifers, in wetlands and estuaries, considering also return flows etc.
2. the *water users*, all sectoral interests and stakeholders
3. the *spatial dimension*, including
   - the spatial distribution of water resources and uses (e.g. well-watered upstream watersheds and arid plains downstream)
   - 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 dimension*; 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.

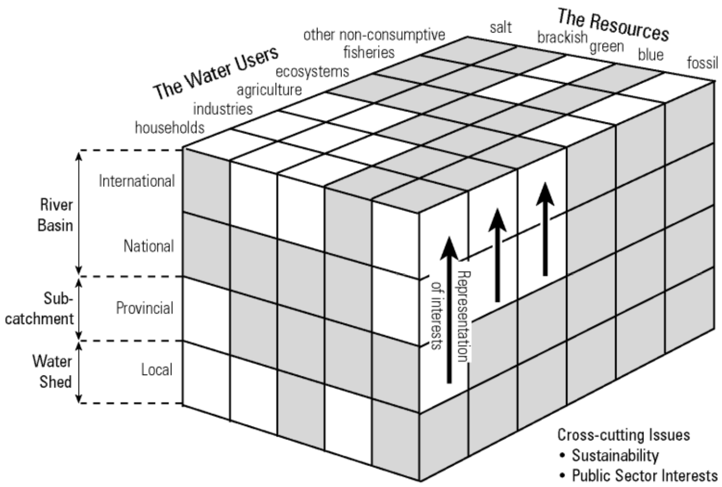

Figure 5: Three of the four dimensions of Integrated Water Resources Management (Savenije, 2000)

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 (Savenije and Van der Zaag, 2000; Loucks et al., 2000). 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.

Box 2: The four dimensions of IWRM (Savenije, 2000)

Dimension 1: Water Resources

The water resources include all forms of occurrence of water including salt water and fossil groundwater. An interesting distinction which can be made is between blue and green water. Blue water, the water in rivers, lakes and shallow aquifers, has received all the attention from water resources planners and engineers. Green water, the water in the unsaturated zone of the soil responsible for the production of biomass has been largely neglected but it is the green water that is responsible for 60% of the world food production and all of the biomass produced in forests and pasture. It is this resource which is most sensitive to land degradation. Fossil water, the deep aquifers that contain non-renewable water, should be considered a mineral resource which can only be used once at the cost of foregoing future use.

Dimension 2: Water Users

There are many different users of water and its functions. Functions can be split into production functions (for economic production activities), regulation functions (for maintaining a dynamic equilibrium in natural processes), carrier functions (to sustain life forms) and transfer functions (as a contribution to culture, religion and landscape). The uses include: households, industries, agriculture, fisheries, ecosystems, hydropower, navigation, recreation, etc. Water users consist of consumptive and non-consumptive (often in-stream) users. Besides on quantity, the users depend largely on the quality of the resource. With regard to the consumptive use an important concept is that of "virtual" water, where products are expressed in the amount of water required for its production. This concept is both useful as a measure for efficiency and for the discussion on food security

Dimension 3: Spatial Scales

Water resources issues are apparent at different levels: the international level, the national level, the province or district level and the local level. Parallel to these administrative levels are hydrological system boundaries such as river basins, sub-catchments and watersheds. Hydrological boundaries seldom concur with administrative boundaries. River basins seem appropriate units for operational water management but present problems for institutions that have a different spatial logic.

Different decisions on water resources management belong at different levels, meaning that the concept of ***subsidiarity*** (decision making at the lowest appropriate level) needs to be a guiding principle in the development of IWRM. Interests and decisions at lower levels need to be carried upward to be taken into consideration at higher levels, particularly to the national and international level. An important element in this process is the participation of stakeholders in decision-making processes at all levels.

Dimension 4: Temporal Scales and Patterns

Both the water resources themselves and the water uses have distinct temporal patterns. The temporal distribution of water resources is crucial (floods, droughts, base flows, flooding patterns) and so is the distribution over time of the demands (peak demands, constant requirements, cropping patterns, etc.). In water resources assessments the total amount of water available depends strongly on the possibility to capture flood flows. The staging of demands (simultaneous or staggered demands) can have a large influence on the development required.

We can now summarise our definition as follows:

> Integrated Water Resources Management seeks to manage water resources in a comprehensive and holistic way, taking account of the entire water cycle and the interests of all water users, while acknowledging the temporal and spatial variability in availability and the interactions with water quality and ecology.
>
> Managing water resources then requires transparent and participatory decision-making procedures that carefully weigh societal objectives and constraints, integrate these where possible and set priorities where necessary.

An alternative definition of Integrated Water Resources Management, which is widely cited, is the one proposed by the Global Water Partnership:

> Integrated Water Resources Management 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, 2000).

There are, however, many more definitions on IWRM. See Jonker (2007) for a review.

To accomplish the integrated management of water resources, appropriate legal, institutional and financial arrangements are required that acknowledge the four dimensions of IWRM. In order for a society to get the right arrangements in place, it requires a sound policy on water.

5 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 world-wide. 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.

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

a) **E**quity: 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) **E**cological 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) **E**fficiency: 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 with each other and with the different aspects (dimensions) of IWRM (Savenije and Van der Zaag, 2002). In order to emphasise the consistency of policies, despite the contradictions that will inevitably emerge, policy statements often are summarised in a “vision” statement that define a desired future that the policy contributes to.

An example is the Southern Africa Vision for Water. The Southern African vision has been formulated as a desired future that is characterised by:

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

A wider public is more likely to identify with, and remember, vision statements that are simple and short. An example is the South African water policy, which has been summarised in the South Africa white paper on water resources as follows:

> "Some for all forever."

Both examples from Southern Africa clearly demonstrate that there are two overriding issues that cut across IWRM however the latter is understood, namely: sustainability and the public interest.

Related to sustainability are: the maintenance of environmental quality (including water quality), financial sustainability (cost recovery), good governance (effective democratic control mechanisms) and the institutional capacity (capacity building, human resources, management instruments, appropriate policy and legal frameworks).

Related to the public interest are: equity (the basic right of access of people to water resources), poverty alleviation (the responsibility of society to nurture the interests of the least advantaged), gender (the central role of women in managing water; at the local level and beyond), security (protection against floods, droughts and hazards), food security and health, and, at a regional level, good neighbourliness and regional peace.

6 Sustainability of water resources (Savenije, 2000)

Since the appearance of the Brundtland report "Our Common Future" (WCED, 1987), sustainable development has been embraced as the leading philosophy that would on the one hand allow the world to develop its resources and on the other hand preserve non-renewable and finite resources and guarantee adequate living conditions for future generations. Brundtland defined sustainable development as “Development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs.” Former president of Botswana, Sir K. Masire, stated:

> "Our ideals of sustainable development do not seek to curtail development. Experience elsewhere has demonstrated that the path to development may simply mean doing more with less (being more efficient). As our population grows, we will certainly have less and less of the resources we have today. To manage this situation, we need a new ethic, one that emphasises the need to protect our natural resources in all we do." (cited in Savenije, 2000)

Sustainable development is making efficient use of our natural resources for economic and social development while maintaining the resource base and environmental carrying capacity for coming generations. This resource base should be widely interpreted to contain besides natural resources: knowledge, infrastructure, technology, durables and human resources. In the process of development natural resources may be converted into other durable products and hence remain part of the overall resource base.

Water resources development that is not sustainable is ill-planned. The American Society of Civil Engineers has recognised the importance of sustainability and has given the following broad definition of sustainable water resource systems (ASCE, 1998):

> Sustainable water resource systems are those designed and managed to fully contribute to the objectives of society, now and in the future, while maintaining their ecological, environmental and hydrological integrity.

In the remainder of this section three types of sustainability are briefly introduced: physical, economic and institutional.

Physical sustainability

Physical sustainability means closing the resource cycles and considering the cycles in their integrity (water and nutrient cycles). In agriculture this implies primarily closing or shortening water and nutrient cycles so as to prevent accumulation or depletion of land and water resources: Water depletion results in desertification. Water accumulation into water logging. Nutrient depletion leads to loss of fertility, loss of water holding capacity, and in general, reduction of carrying capacity. Nutrient accumulation results in eutrophication and pollution. Loss of top-soil results in erosion, land degradation and sedimentation elsewhere. Closing or shortening these cycles means restoring the dynamic equilibriums at the appropriate temporal and spatial scales. The latter is relevant since at a global scale all cycles close. The question of sustainability has to do with closing the cycles within a human dimension.

Economic sustainability

Economic sustainability relates to the efficiency of the system. If all societal costs and benefits are properly accounted for, and cycles are closed, then economic sustainability implies a reduction of scale by short-cutting the cycles. Efficiency dictates that cycles should be kept as short as possible. Examples of short cycles are: water conservation, making optimal use of rainfall where it falls (and not drain it and capture it downstream to pump it up again); water recycling at the spot instead of draining it off to a treatment plant after which it is conveyed or pumped back over considerable distances etc.

Strangely enough, economic sustainability is facilitated by an enlargement of scale through trade in land- and water-intensive commodities (the "virtual" water concept). The use of virtual water is an important concept in countries where the carrying capacity of a society is not sufficient to produce water intensive products itself.

The closing of cycles should be realised at different spatial scales:

- The rural scale, implying water conservation, nutrient and soil conservation, prevention of over-drainage and the recycling of nutrients and organic waste.
- The urban scale, both in towns and mega-cities, implying the recycling of water, nutrients and waste.
- The river basin scale, implying: soil and water conservation in the upper catchment, prevention of runoff and unnecessary drainage and enhancement of infiltration and recharge, flood retention, pollution control and the wise use of wetlands.
- The global scale, where water, nutrient and basic resource cycles are integrated and closed. The concept of virtual water is a tool for an equitable utilisation of water resources. This requires an open and accessible global market and the use of resource-based economic incentives such as resource taxing ("Green tax" which taxes the use of non-renewable or finite resources), as opposed to taxing renewable resources such as labour, which is the general practice today.

Institutional sustainability

In order to ensure sustainability, the right decisions have to be made. This requires that the relevant institutions are in place which can facilitate the proper decision processes. Moreover, institutions need to adequately respond to changing requirements and a changing environment in which they operate. They should have the capacity to adapt to emerging circumstances. Their adaptive capacities indicate whether they will prove to be sustainable institutions. According to Costanza (1994),

> A sustainable system is active and able to maintain its structure (organisation), function (vigour) and autonomy over time and is resilient in stress.

Integrated water resources management requires strong institutions; sustainable systems in Costanza’s sense. Sustainable institutions require good governance; while institutions that are governed wisely are likely to retain their resilience and will be sustained over time. Thus it appears that sustainable institutions and good governance go hand in hand. They need and presuppose each other.

7 Historical developments: towards IWRM

International awareness for the importance of water resources management issues is growing. Originally, the approach was typically sub-sectoral, mostly in relation to water supply, sanitation, irrigation and energy (hydropower). Engineers would predict the demand for water and the need for projects and subsequently provide in those needs. There was often a lack of coordination between sectors, and the needs of the environment were ignored. Recently, however, there is a growing consensus about the need for integrated approaches. Box 3 gives an overview of these developments.

Tony Allan has described the evolution of water resources management according to five water management paradigms, from (1) the pre-modern to (2) the industrial paradigm with its “hydraulic mission” of dam construction, followed by (3) the “green” paradigm that acknowledged the need to respect the environment, and (4) the “economic” paradigm which emphasised the scarcity value of water and the role of economic instruments in resolving some of the challenges, to finally (5) the IWRM paradigm which attempts to take a holistic perspective (see Figure 6).

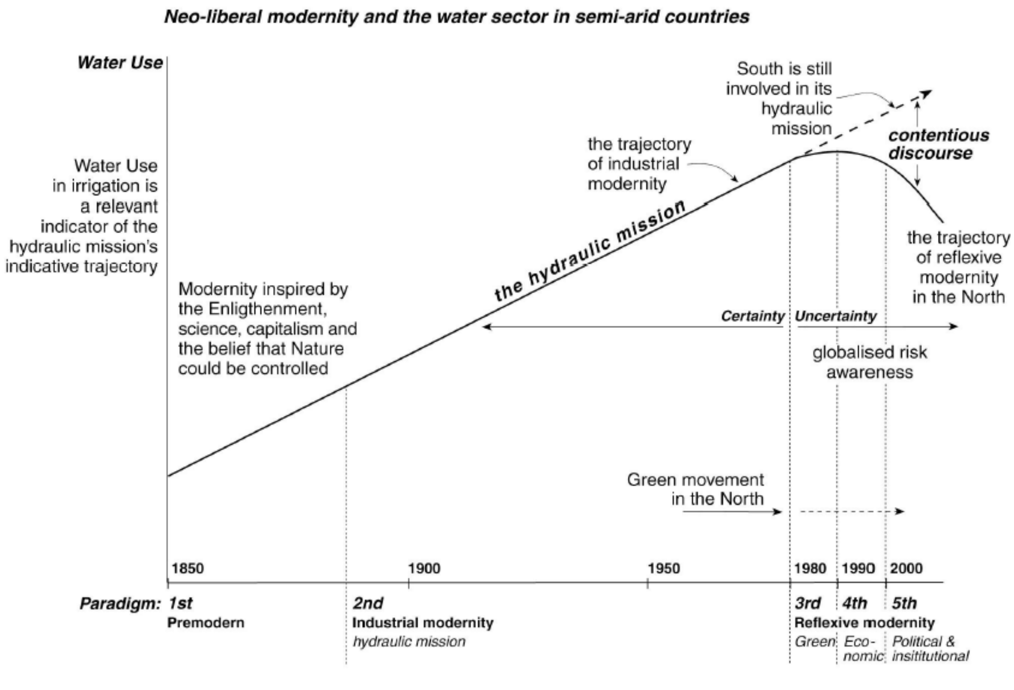

Figure 6: The evolution of water resources management according to Allan (2003), with the five water management paradigms

Box 3: From water resources development towards IWRM

1. **Water resources development (1960s-1970s)**
   - Dominant paradigm: water is a resource to be exploited
   - The engineering approach of "predict and provide"
   - Emphasis on infrastructure
   - Individual projects

2. **Water resources management (1980s-1990s)**
   - Recognition that water can be 'overexploited'
   - Accounting for ecological and social constraints
   - Regional and national planning instead of a project approach
   - Demand-side measures come into focus

3. **Integrated water resources management (1990s-present)**
   - Water management embedded in an overall policy for socio-economic development, physical planning and environmental protection
   - Public participation
   - Focus on sustainability

Box 4: Chronology of important international meetings and developments

1965-1974	International Hydrological Decade
1966	ILA adopts the Helsinki Rules on the Uses of the Waters of International Rivers
1977	UN Water Conference, Mar del Plata
1981-1990	International Drinking Water Supply and Sanitation Decade
1987	World Commission on Environment and Development submits Brundtland report
1992	International Conference on Water and the Environment, Dublin
1992	UN Conference on Environment and Development, Rio de Janeiro
1994	UN Conference on Population and Development, Cairo
1996	Global Water Partnership
1996	World Water Council
1997	Commission on Sustainable Development submits water assessment report
1997	UN General Assembly adopts the Convention on the Law of the Non-navigational Uses of International Watercourses
1997	First World Water Forum, Marrakech
2000	Second World Water Forum, The Hague
2000	World Commission on Dams submits final report
2000	United Nations Millennium Summit
2002	World Summit on Sustainable Development, Johannesburg
2003	Third World Water Forum, Kyoto
2004	ILA adopts the Berlin Rules on Water Resources
2006	Fourth World Water Forum, Mexico City
2008	International Year of Sanitation
2009	5th World Water Forum, Istanbul
2010	UN General Assembly adopts a resolution that declares access to clean water and sanitation a fundamental human right
2012	6th World Water Forum, Marseille
2012	Rio+20; development of the Sustainable Development Goals
2013	International Year of Water Cooperation
2014	The UN Watercourses convention comes into force with Vietnam's ratification
2015	The UN adopts the Sustainable Development Goals

During the last two decades, water has gradually received more and more attention during international meetings. Box 4 provides a chronology of important international meetings and developments.

At the UN Conference in Mar del Plata (1977), the emphasis was still on water supply and sanitation. The Brundtland Report of the World Commission on Environment and Development (1987) only mentioned the word “water” in relation to pollution and water supply. It was during the preparatory conferences for the UN Conference on Environment and Development (UNCED) that the concepts underlying Integrated Water Resources Management were widely debated.

The International Conference on Water and the Environment (ICWE) in Dublin (1992), led to the Dublin Principles (Box 5). The Dublin Principles formed in important input into Rio 1992 which culminated into the adoption of the Fresh Water Chapter (Chapter 18) of Agenda 21 (UN, 1992).

Chapter 18 (“Protection of the quality and supply of freshwater resources: application of integrated approaches to the development, management and use of water resources”) of Agenda 21 emphasised the need for an integrated approach to managing water resources:

> “18.3. The widespread scarcity, gradual destruction and aggravated pollution of freshwater resources in many world regions, along with the progressive encroachment of incompatible activities, demand integrated water resources planning and management. Such integration must cover all types of interrelated freshwater bodies, including both surface water and groundwater, and duly consider water quantity and quality aspects. The multisectoral nature of water resources development in the context of socio-economic development must be recognized, as well as the multi-interest utilization of water resources..”

Chapter 18 in fact gave the first definition of IWRM (Box 6).

In 1993, the World Bank published the influential policy paper on Water Resources Management (World Bank, 1993), which emphasises the need for IWRM, economic pricing, cost recovery, decentralisation, privatisation, management of international river basins and incorporation of environmental criteria in planning and management. The Commission on Sustainable Development (CSD) has put IWRM high on the international agenda, when in 1997 it published the first comprehensive assessment of global water resources.

In the same year the UN adopted the Law of the Non-navigational Uses of International Watercourses. This UN Convention is not yet in force, but is a landmark development in international water law.

After Dublin, with the call for integrated management, the high degree of fragmentation of the water sector in the international community, and in particular the UN family, became strongly felt. The water interest is fragmented over many different organisations, such as WMO, WHO, FAO, UNESCO, UNDP, UNEP and UNICEF.

Box 5: Dublin Principles (ICWE, 1992)

- 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)

Box 6: Integrated water resources management (UN, 1992)

18.8. Integrated water resources management is based on the perception of water as an integral part of the ecosystem, a natural resource and a social and economic good, whose quantity and quality determine the nature of its utilization. To this end, water resources have to be protected, taking into account the functioning of aquatic ecosystems and the perenniality of the resource, in order to satisfy and reconcile needs for water in human activities. In developing and using water resources, priority has to be given to the satisfaction of basic needs and the safeguarding of ecosystems. Beyond these requirements, however, water users should be charged appropriately.

18.9. Integrated water resources management, including the integration of land- and water-related aspects, should be carried out at the level of the catchment basin or sub-basin. Four principal objectives should be pursued, as follows:

(a) To promote a dynamic, interactive, iterative and multisectoral approach to water resources management, including the identification and protection of potential sources of freshwater supply, that integrates technological, socio-economic, environmental and human health considerations;

(b) To plan for the sustainable and rational utilization, protection, conservation and management of water resources based on community needs and priorities within the framework of national economic development policy;

(c) To design, implement and evaluate projects and programmes that are both economically efficient and socially appropriate within clearly defined strategies, based on an approach of full public participation, including that of women, youth, indigenous people and local communities in water management policy-making and decision-making;

(d) To identify and strengthen or develop, as required, in particular in developing countries, the appropriate institutional, legal and financial mechanisms to ensure that water policy and its implementation are a catalyst for sustainable social progress and economic growth.

Important steps in the process towards more coordination have been the formation of the Global Water Partnership (GWP) and the World Water Council (WWC), who both have the aim to coordinate the implementation of IWRM principles and practices worldwide. Although there is undoubtedly some overlap between the two organisations, the WWC concentrates on awareness raising at political levels, whereas GWP aims at the implementation of IWRM concepts at the operational level. Together they have been the driving force behind the second, third and fourth world water forums.

At the United Nations Millennium Summit in September 2000 world leaders placed development at the heart of the global agenda by adopting the Millennium Development Goals, which set clear targets for reducing poverty, hunger, disease, illiteracy, environmental degradation, and discrimination against women by 2015.

By 2015, some good progress towards achieving some of the MDGs has been made, but some targets have not been met. In response, the UN General Assembly adopted in September 2015 the Sustainable Development Goals, that replace the MDGs and that hold for all countries of the world. The Sustainable Development Goals constitute an ambitious agenda to eradicate poverty by 2030 (Box 7). Water runs through several of the 17 (!) goals, one of which is specifically dedicated to it.

During the 2nd World Water Forum, held in The Hague in March 2000, delegations of 113 countries met in the parallel ministerial conference, and adopted unanimously the concept of IWRM.

In November 2000, the World Commission on Dams submitted its final report. This Commission led an independent, international, multi-stakeholder process that addressed the controversial issues associated with large dams. It provided a unique opportunity to bring into focus the many assumptions and paradigms that are at the centre of the search to reconcile economic growth, social equity, environmental conservation and political participation in the changing global context. The final report (www.dams.org) provides a wealth of information. One of the conclusions was that the benefits and costs of dam developments should be much better estimated before constructing them, including the social costs (e.g. displacement of people living in the area to be flooded by the reservoir) and environmental costs. Follow-up activities can be found on http://www.unep.org/dams.

The World Summit on Sustainable Development in Johannesburg in 2002 called for countries to "develop Integrated Water Resources Management and Water Efficiency Plans by 2005". By end of 2007, a survey among 53 developing countries and countries in transition found that 38% (20) had indeed formulated IWRM/WE plans and were in the process of implementing them (UN Water, 2008).

Box 7: The Sustainable Development Goals of the UN 2030 Development Agenda

Goal 1	End poverty in all its forms everywhere
Goal 2	End hunger, achieve food security and improved nutrition and promote sustainable agriculture
Goal 3	Ensure healthy lives and promote well-being for all at all ages
Goal 4	Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all
Goal 5	Achieve gender equality and empower all women and girls
Goal 6	Ensure availability and sustainable management of water and sanitation for all
Goal 7	Ensure access to affordable, reliable, sustainable and modern energy for all
Goal 8	Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all
Goal 9	Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation
Goal 10	Reduce inequality within and among countries
Goal 11	Make cities and human settlements inclusive, safe, resilient and sustainable
Goal 12	Ensure sustainable consumption and production patterns
Goal 13	Take urgent action to combat climate change and its impacts
Goal 14	Conserve and sustainably use the oceans, seas and marine resources for sustainable development
Goal 15	Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss
Goal 16	Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels
Goal 17	Strengthen the means of implementation and revitalize the global partnership for sustainable development

Goal 6 Ensure availability and sustainable management of water and sanitation for all

Targets

6.1 By 2030, achieve universal and equitable access to safe and affordable drinking water for all

6.2 By 2030, achieve access to adequate and equitable sanitation and hygiene for all and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations

6.3 By 2030, improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally

6.4 By 2030, substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity

6.5 By 2030, implement integrated water resources management at all levels, including through transboundary cooperation as appropriate

6.6 By 2020, protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes

6.a By 2030, expand international cooperation and capacity-building support to developing countries in water- and sanitation-related activities and programmes, including water harvesting, desalination, water efficiency, wastewater treatment, recycling and reuse technologies

6.b Support and strengthen the participation of local communities in improving water and sanitation management

Source: https://sustainabledevelopment.un.org/topicsttp://www.un.org/sustainabledevelopment/sustainable-development-goals/

A significant number of experts who attended the 2nd World Water Forum in The Hague wanted access to water to be declared a human right. This did not materialise. However, two years later UN Committee on Economic, Social and Cultural Rights defined the right to water in General Assembly Comment No. 15 (2002) as the right of everyone "to sufficient, safe, acceptable, physically accessible and affordable water for personal and domestic uses." It further specifies that signatory states should ensure access to "a minimum essential amount of water [and] adequate sanitation," develop and implement a national water strategy and monitor progress made on realizing the right to water. The primary responsibility for the implementation of the right to water falls upon the States and their national governments (Box 8).

On 28 July 2010, the United Nations General Assembly adopted a non-binding resolution, sponsored by Bolivia, which declares that access to clean water and sanitation is a fundamental human right. The resolution also called on member states and international organizations to offer financial and technical assistance, in particular to developing countries, in order to provide clean, accessible and affordable drinking water and sanitation for everyone. The resolution invited the UN Independent Expert on the issue of human rights obligations related to access to safe drinking water and sanitation, to report annually to the General Assembly. The resolution received the support of 122 member states, while 41 countries abstained.

Box 8: General Comment on Right of Water by the Committee on Economic, Social and Cultural Rights, November 2002

The General Comment notes that water is a limited natural resource and a public commodity fundamental to life and health. The Committee has been confronted continually with widespread denial of the right to water in developing as well as developed countries. Over 1 billion persons lack access to a basic water supply, while several billion lack access to adequate sanitation, a primary cause of water contamination and diseases linked to water, the comment states. The continuing contamination, depletion and unequal distribution of water resources is exacerbating existing poverty. States parties have the duty to progressively realize, without discrimination, the right to water.

The human right to water entitles everyone to sufficient, affordable, physically accessible, safe and acceptable water for personal and domestic uses, the text states. While those uses vary between cultures, an adequate amount of safe water is necessary to prevent death from dehydration, to reduce the risk of water-related disease and to provide for consumption, cooking, personal and domestic hygienic requirements.

The right to water contains both freedom and entitlements; the freedoms include the right to maintain access to existing water supplies necessary for the right to water; and the right to be free from interference, such as the right to be free from arbitrary disconnections or contamination of water supplies, the text states. The elements of the right to water should be adequate for human dignity, life and health. The adequacy of water should not be interpreted narrowly, by mere reference to volumetric qualities and technologies. Water should be treated as a social and cultural good, and not primarily as an economic commodity. The manner of the realization of the right to water should also be sustainable, ensuring that the right can be realized for present and future generations.

Further, the General Comment notes that States parties have a constant and continuing duty, in accordance with the obligation of progressive realization, to move expeditiously and effectively towards the full realization to the right to water. Realization of the right should be feasible and practicable, since all States parties exercise control over a broad range of resources, including water, technology, financial resources and international assistance, as with all other rights in the Covenant.

Source: Office of the High Commissioner for Human Rights, Geneva; http://www.unhchr.ch/

8 Outstanding issues of debate

The developments since Rio demonstrate the global community's increasing concern with water. One can also discern a growing convergence about most of the concepts underlying Integrated Water Resources Management. There is hardly anybody who would disagree with the first three Dublin principles, namely that water management requires an integrated and participatory approach and that women should play a key role in all aspects of water management. There is also an emerging consensus that in terms of water allocation, basic human needs should receive priority; and that other uses should be prioritised according to societal needs and socio-economic criteria. The river basin is accepted as the logical unit for water resources management.

However, a number of important issues remain unresolved. These include:

- What does it mean if water is considered an economic good?
- Is there indeed water scarcity?
- Why is it so difficult to provide access to sufficient safe water and adequate sanitation services to the entire global population?
- How can we ensure that the private sector plays its - positive - part in the water sector, without the possible negative consequences?
- Should we aim for food self-sufficiency or for food security?
- Can we improve the efficient use of rainfall to increase food production?
- What institutional arrangements are required to implement IWRM? What does it mean if we say that we need good water governance?
- Should catchment institutions have executive functions, or should they only be platforms of coordination, with line institutions implementing decisions?
- Will the increasing pressure on the water resource inevitably lead to an increase in conflicts over water, locally and between riparian countries?
- How can be formalise upstream-downstream linkages, and positively deal with the fundamental asymmetry in water resources management?
- How much water does the environment require? Which priority should environmental water have?
- Do we need more dams?
- What may be the implications of climate change for water resources management?
- How does the Water-Energy-Food Nexus approach (Beson et al., 2015; Wichelns, 2017) relate to the IWRM concept?

There is also an emerging criticism of the IWRM concept (see e.g. Biswas, 2004; Shah and Van Koppen, 2006; Mollinga, 2008; Molle, 2008). There are many points of critique, but the following three stand out:

1. IWRM as a concept is ill-defined, and means different things to different people and audiences. It therefore lacks analytical clarity. To make things worse, the concept often is used with a certain "normative" connotation: IWRM is seen as "good". People are therefore tempted to (ab-)use it, and re-frame the things that they are used to be doing in new ways, but without fundamentally changing their approach (e.g. the dam, irrigation, drinking water, etc. sectors).

2. IWRM is the embodiment of a trend for the water sector to claim uniqueness, and therefore a special institutional space (see also section 2 above!). This has, however, created a problem of "institutional fit" with other sectors and

institutions, and also may have enhanced competition over scarce institutional resources. In all this may have decreased the capacity for an integrated approach of water and related development (think of spatial planning).

3. Many development countries point at the fact that what they need is water resources *development* before they can focus on water resources *management* – without hardware there is no way that water resources can be adequately managed (see e.g. Grey and Sadoff, 2007). Whereas in our reading the IWRM concept encompasses both the hardware and the software, many donors indeed tend to favour support for soft measures (e.g. institutional development) compared to hard measures (e.g. infrastructure development).

9 Exercises

1a What are in your opinion the main policy issues for the water sector in your country?

1b Which objectives for the management of water resources can be derived from these?

1c What would be suitable performance criteria for these objectives?

1d Which institutions should be responsible for the implementation of these objectives?

1e Which should the tasks and responsibilities be for these institutions?

2 What is the basin efficiency depicted in figure 4?

3 Which of the Sustainable Development Goals (SDGs) require proper water resources management?

4 Read two articles about water pricing: the paper by Rogers et al. (2002) and the paper by Savenije and Van der Zaag (2002). Describe the debate with respect to pricing of water. What does it mean that water is an economic good?

5 Read some of the following articles on IWRM: Biswas (2004), Van der Zaag (2005), Shah and Van Koppen (2006), Grey and Sadoff (2007), Mollinga (2008) and Molle (2008). Describe the different interpretations of current developments with respect to IWRM. What are the current key challenges? Which are, in your opinion, the most important and why?

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