Water framework planning

Contents

1. Scope

1.1 General

Water occurs as **surface water** and **groundwater** and is regarded as a **renewable resource**. The **water supply** of a region is normally **limited**. **Quantitative** renewal through the **hydrological cycle** depends essentially on **rainfall**, with **wide quantitative and periodic variations** as well as **considerable regional differences**.

The water **supply** rarely meets **demand** in terms of quantitative, periodic and geographical distribution, or in terms of **water quality**. This calls for **controlling measures**, i.e. targeted water resources management. **Water resources management** therefore signifies the **regulation** of all **human uses of, and effects on, surface water and groundwater**, thereby necessitating the development of objectives and general conditions covering all sectors for the utilisation of water resources by competing users, **guaranteeing the environmental compatibility of water resources management activities**.

Over-use, changes in land-use, climatic shifts etc. may in the **long term impair the capacity for renewal**, thereby reducing **water supplies** and **their use**.

A **distinction** should be made between those **uses** which do not involve actual **water consumption** (e.g. water used for cooling purposes) and those in which **water is wholly or partially consumed or contaminated**. Measures to **protect against the damaging effects of water** (e.g. flood protection) should be regarded as uses.

Peripheral conditions of **water resources management** are determined not only by **technical and economic considerations** but **also** by sociological, socio-cultural, legal, medical/hygienic and political aspects.

Water resources management is a vital tool of infrastructure policy and is **particularly important for**

- safeguarding the basis of life in rural and urban areas of habitation, through the provision of an adequate supply of safe drinking water
- improving **hygiene** in rural and urban areas of habitation, through controlled removal of sewage and waste, with measures to check the spread of water-borne diseases where necessary
- increasing **agricultural production** through soil improvement, irrigation and drainage
- promoting **industrial production** through the supply of potable and industrial water
- developing the **transport** system through the development of shipping routes on rivers, canals and lakes
- improving **energy supply** through development of hydroelectric power and supply of cooling water for thermal power stations
- **extracting mineral resources** through regulated pumping and discharge of groundwater (mine drainage water)
- protecting and preserving natural habitats by satisfying ecological water demand and measures to protect areas of water
- developing aquaculture by safeguarding natural and artificial habitats for aquatic organisms
- safeguarding habitats and agricultural and industrial production sites through measures to protect against flood and, where applicable, erosion, desiccation and desertification
- reducing the workload of women through targeted water provision
- developing tourism by safeguarding recreational areas on rivers, lakes and coasts.

In certain cases, these activities may be in competition with one another.

1.2 Definitions and principles of water framework planning

According to the relevant **German guideline** (16), the **General Water Resources Management Plan** embodies **interrelated aspects and dependencies of the water resources management system** within a **planning area**. It should set out **water resource conditions** in this planning area and **allow an assessment of the likely effects of changes**.

General Water Resources Management Plans are normally drawn up for **natural geographical units**, i.e. river basins or parts thereof. The **area limits** are the **overground watersheds**. General Water Resources Management Plans for economic areas or parts of economic areas should if possible be developed on the basis of general plans for the relevant river basins.

For the **planning area** it is necessary to clarify at the different levels (local, regional, national) **when, where and how much water** is **available** or needs to be **provided**, and where applicable in what **quality**, and what **water resources management activities** are necessary to **balance supply and demand**. These measures should be examined in terms of their financial, economic and ecological viability. In this process it is necessary to take account of **current** and **foreseeable future general conditions** within the planning area and within the overall natural geographical unit (e.g. river catchment area). **Planning horizons** are normally between **10 and 30 years**.

A **General Water Resources Management Plan** summarises statements on

- current and foreseeable water demand
- possible ways of meeting water demand out of the water supply in the form of hydrological balances
- hydrogeological conditions in the planning area
- current and future occurrence and availability of water in terms of quantity and quality and periodic and geographical fluctuations
- possible ways of developing usable supply (formation of new supply, regenerative capacity)
- drainage control and flood protection (flood risks, high-water peaks, flood plains)
- maintenance of water purity (burden imposed by outfalls, self-cleaning properties)
- potential risks for surface water or groundwater due to existing or future uses (accidents, unsafe transportation of harmful substances, improper storage of refuse, commercial and industrial waste, discharge of agricultural pollutants such as fertilisers and pesticides)
- need for regulations covering those who discharge contaminants (quantities, quality, degree of pretreatment).

It is necessary to examine not only **standard circumstances** but also **critical circumstances** and **periods**, which are particularly important for correct design of water management schemes. Investigations must be carried out to see which **bodies of water** and which **hydrologically important areas and regions** require precautionary safeguards.

A **General Water Resources Management Plan** does **not** provide **planning data** and **dimensional values** for **specific individual projects**. Rather, it provides a **basis** for **defining general conditions applicable to large areas** for **overall infrastructural development**, e.g.:

- housing policy (urban and regional planning, rural development)
- location issues for the development of trade and industry
- conservation areas (flood plains, erosion protection, groundwater protection, with resettlement measures where necessary)
- statutory safeguards and conservation measures
- conditions governing emergency water supplies.

A **General Water Resources Management Plan** does however embrace the **applicable general conditions of water management**, and **incorporates** relevant **measures**. Only in this way can **appropriate solutions** be found and the important goal of **regionally** and **socially fair distribution of water** be achieved.

The **General Water Resources Management Plan** is a **governmental** (i.e. state) **function** which in Germany is performed at a **number of levels**:

- ministry, highest water authority
- water management administration (relevant offices, hydro-meteorological, hydrometric and hydro-geological departments)
- independent administrations (associations, user groups, cooperatives, traditional structures at target-group level).

To **establish priorities** for the utilisation and protection of water resources and keep the **General Water Resources Management Plan** permanently updated it is necessary to have a suitable **legal framework** and a **properly functioning administration** with the requisite powers and technical expertise; this includes the ability to **resolve international problems**.

2. Environmental impacts and protective measures

Very often the **impact of an individual project**, such as a small dam or the diversion of a small part of the runoff, is minimal and is **limited** to the local area, making a quantitative assessment of the impact difficult. If a **number of projects are combined**, such as chains of dams on a river course, or if the entire discharge is diverted, the **effects may be serious**.

Regulatory water management activities and the **impact** which they have essentially relate to:

- the damming and diversion of **surface water** (dams, reservoirs, small barrages, diversion works, pumping stations, open channels, pipelines) for the purpose of discharge regulation, flood protection, supply of drinking water and industrial water, hydroelectric power generation etc.); activities often serve a number of purposes at once (e.g. multi-purpose reservoirs), which means that many different aspects have to be coordinated within a complex framework;
- extraction of **groundwater** (dug wells, bore wells, spring water chambers), preferably for supplying drinking water and irrigation water; if these facilities are not properly designed, there is a high risk of contamination both of water drawn and of underground water stocks;
- **transportation** from the place of extraction to the place of consumption (portable vessels, open

channels, pipelines); there is a high risk of contamination with all open and accessible systems;
- collection and utilisation of **rainfall** (cisterns, "rainwater harvesting"); over-use of this naturally limited supply is largely ruled out.

Water stocks can be adversely affected both in terms of **quantity**, i.e. in their quantitative, geographical and periodic availability (over-use), and in terms of their **quality** (pollutants).

In the case of **surface waters,** a **change in runoff conditions** means changes of **flow cross-section, head, roughness and runoff rates**. Changed **flow behaviour** causes changes to erosion and sedimentation processes. **Damming** can reduce high-water peaks, but also causes **flooding of ecologically valuable areas, forces resettlement, creates stillwater zones** and **interferes with the habitats of aquatic flora and fauna**, particularly migration conditions for fish. In addition, **water that is accessible to humans and animals** promotes the **spread of water-borne diseases** (malaria, bilharzia, parasitic diseases and dysentery).

The **large number** of **hydrological** and **hydraulic variables** alone necessitates the provision of a **reliable database**, **backed up by long-term observations**. Flawed planning assumptions, e.g. of possible flood discharges, causing dam failure or incorrect operation of barrages, can cause excessive flooding, resulting in serious damage.

In the case of **groundwater**, **over-use** may be caused by **wells that are situated too close together** or where drawdowns overlap, causing progressive **lowering of the water table**. **Formation of new water reserves** can be **adversely affected by changes in land-use**. Discharges of pollutants, be they **intermittent** (accidents, improper storage of waste, well contamination) or **widespread** (agricultural fertilisers and pesticides, large-area disinfestation of locusts etc.), may **impair groundwater quality**.

Long-term lowering of the water table over **large areas** may be necessary in the case of land used for agricultural purposes in order to prevent **saturation** and **salination**. However, in most cases this is **harmful** to **natural vegetation** and **crops** which then **increase water demand** because of the **irrigation** required and may intensify existing **over-use**.

Connate groundwater is a **non-renewable water resource** and therefore should **not be exploited if at all possible**.

Improved water resources management frequently generates **secondary and tertiary effects** such as an **increase in demand** (increase in per capita consumption of drinking water, increase in livestock numbers, expansion of agricultural irrigation) with further **effects** on the **ecological** and **social framework** for example (destruction of vegetation and soil through over-grazing and trampling by livestock, deforestation to create farming land, intensification of erosion by water and wind, conversion of nomads to a settled form of existence, concentration of habitation in well-supplied areas, closer contact and also conflicts of interest between different ethnic groups).

Often the **situation** arises where urgent environmental problems can only be **resolved** by considering other regions in a **national analysis** (otherwise, for example, building flood defences may expose those living downstream to greater risk of flood).

A **General Water Resources Management Plan** should contribute to the **sustainability of water management projects** through a **long-term, multi-sector and large-area approach**, **preserving natural water resources** and **ensuring maximum environmental compatibility**.

An essential conservation element in a General Water Resources Management Plan involves **early consideration** of the **environmental effects of water management activities** for the following reasons:

- Development planning and social **priorities** and likely **effects** of water management activities should be **compared** and **evaluated**; different **activities** or activities planned for different social groups and **decisions** should be made **transparent** by setting out the costs and benefits (the **involvement of the population groups affected** is extremely **important**); this will enable alternative solutions to be developed at an early stage;
- **Preventive environmental protection** i.e. the avoidance or minimisation of environmental problems in advance is generally far more **effective** and **economical** than corrective environmental protection, i.e. a subsequent clean-up or "rehabilitation" of polluted and partially destroyed environments afterwards.

A **General Water Resources Management Plan** provides planners with a **tool** whereby **negative environmental effects** and **flawed developments** can be **avoided** or at least **alleviated**, and requisite **counter-measures** or **compensatory measures** can be **envisaged**.

Depending on geo-ecological conditions and utilisation of the natural geographical unit, **water management activities** may, for example, affect the following:

- the **climate** (e.g. air temperature, air humidity, evaporation, radiation and heat),
- the **quantity** of available groundwater and surface water (acceleration of drainage through flood control, drainage retardation, infiltration),
- the **quality** of the groundwater and surface water (dilution, reduction or concentration of pollutants),
- **soil quality** and the area usable for agricultural and forestry purposes (groundwater level, soil degradation, erosion, sedimentation),
- **habitats** for terrestrial and aquatic flora and fauna (alteration and intersection of habitats, marshes, swamps),
- **health** and hygiene (living conditions for pathogenic organisms, drainage and sewage).

Measures to prevent negative environmental effects in the various areas of use (e.g. agriculture, industry) must be set forth in the General Water Resources Management Plan, but they must be tackled in the individual sectors.

3. Notes on the analysis and evaluation of environmental impacts

3.1 Interrelated aspects

A **General Water Resources Management Plan** must **take account** of all possible **effects of water management activities** on the environment. It must deal with the **present situation** in the planning area, which can vary **considerably** from one country to another.

The **water situation** may be **characterised** by the following:

- extremely high or low annual rainfall depending on the region,
- risk of no rain falling for several years,
- very low rates of groundwater regeneration,
- extremely heavy rainfall and flooding,
- low level of consumption and low percentage of population being supplied,
- unreliable supply,
- irrigation accounting for a high percentage of demand,
- extensive re-use of waste water and salt water, inclusion of sea water desalination.

For **analysis** and **assessment of the environmental effects of water management activities** it is necessary to consider the **entire process chain** i.e. the hydrological cycle from the primary stage of rainfall through to the disposal of sewage and waste materials.

A **prerequisite** for the above is a **reliable database** which also **describes** the **present environmental situation** (inherited problems) of the natural geographical unit in question or of the region. In this way it is possible to **establish** the **scale of the current environmental problem** i.e. the changes brought about by past activities, and to estimate the **effects of measures planned**.

Such **databases** (e.g. hydrological journals, environmental registers, geological reports) are unavailable in many countries and must first be **compiled** or replaced with suitable indicators in order to make a reasonable assessment of measures planned. **National regulatory bodies** and **international organisations** may be able to provide **important information**; such information can **rarely be transferred directly** to the case in hand, partly because **individual regulations** and **parameters** should be understood as **part of an overall system**, which cannot be assumed to exist in all countries. For example, when determining the **limits** for **discharge of pollutants** into surface waters, the **uses** and **self-cleaning properties** of water-courses must be **taken into account**.

The **framework plan** provides a valuable **basis** for **assessing possible alternative forms of development and expansion**. Such **evaluations** must, however, proceed from the **same objectives**. Attempts to evaluate alternatives on the basis of a single assessment criterion (e.g. cost index, "index of harm") fail to take account of the many different aspects involved.

It is **important** to **reduce** the almost infinite number of possible **criteria** to be included. For example, it is possible to exclude from the outset those **projects** or **development variants** which fail to satisfy certain **minimum requirements** (for example, no housing or industrial developments or removal of groundwater should be permitted in water conservation areas or flood plains).

Environmental impacts should be **prioritised** in **different ways** depending on the existing water situation;

- Regions with scarce water resources: Priority given to adequate quantitative provision, water-saving measures.
- Regions with adequate supply: Priority given to health and hygiene, quality assurance.
- Regions with a (temporary) surplus: Priority given to flood prevention.

Generally speaking, **problems of water wastage** (e.g. irrigation with connate groundwater) demand greater attention.

3.2 Analysis of use and quality of natural water resources

3.2.1 Determination of natural water supply

The **natural water supply** is **determined** by **processes** in the **hydrological cycle**, essentially by **rainfall** and factors such as evapotranspiration, overground and underground drainage, seepage, new groundwater formation etc. **Considerable influence** is brought to bear by **controlling variables** such as climate, vegetation, topography, soil, geo-hydrological conditions etc., and also anthropogenic influences such as land-use (large area irrigation, areas of habitation with low infiltration and increased runoff).

The **supply** is mainly determined by

- stocks in overground reservoirs,
- drainage into bodies of surface water,
- underground water stocks including the geological (connate) water stocks which, however, are not renewable and should not, therefore, be regarded as usable stocks where possible,
- new groundwater formation (normally only a small fraction of rainfall, depending mainly on evaporation, surface drainage, infiltration, climate, vegetation, soil type, topography, groundwater level, geo-hydrological conditions).

Drainage, new groundwater formation or other **parameters of the hydrological cycle** are normally compared with **averages over many years,** including a **description of extreme values** (wet years, dry years). For the Water Resources Management Plan these details are vital for **orientation**, but must also be considered in the context of a **chronological** and **geographical breakdown** as there may be extreme seasonal and regional variations. If, for example, the **hydrological year** consists of a decidedly **dry season** and a **rainy season**, but in addition there are substantial **fluctuations in rainfall quantity** from year to year, **long-term average values** for surface drainage and groundwater supply should **not be used in project planning**.

In **many countries** the **database is often inadequate**. The **measuring stations are too far apart.** A **Water Resources Management Plan** provides information on how the **measuring network density** may be **increased**. The **necessary data** (e.g. water levels and run-offs, detritus and suspended matter in surface waters, groundwater levels, physical, chemical and biological parameters of water quality, hydrometeorological and hydrogeological data) must be **observed** and **evaluated** according to applicable **international standards** (such as WMO, FAO, WHO). These must be **published regularly in hydrological journals** in the interests of sound planning, otherwise **separate measuring campaigns** will be necessary, which will be **costly** yet **inadequate** in view of their brevity.

3.2.2 Determination of usable water supply

The **usable water supply** is regarded as that **proportion of the natural water supply** which can be exploited, taking the following aspects into account:

- Catchment	Nature and position of body of water or aquifer, geological and geomorphological conditions for well construction, diversion works and reservoirs, available technologies.
- Distribution	Periodic and quantitative redistribution (storage), geographical redistribution (transfer).
- Economy	Costs of development, extraction, treatment and distribution, wastewater treatment
- Chemical/hygienic toxicology	Water quality, risks of contamination, treatment technology, water pollution control measures for bodies of water, recycling
- Ecological, resource protection and use-related aspects	Destruction of valuable, groundwater-dependent vegetation stocks, drying-up of water holes and water courses, karstification of soils, erosion, drying-up of marshes and swamps
- Other reasons for water management	e.g. shipping, hydroelectric power generation, priority of use outside the planning area

Certain minimum requirements (of quantity, area etc.) must be satisfied as a matter of priority in order to allow for ecological considerations.

3.2.3 Determination of water demand

Water demand comprises essentially the following **components**:

- drinking water for people and animals, trade and industry and - at least in densely populated areas - for fighting fires
- water for industrial use
- irrigation water

- water to maintain a minimum rate of flow and for shipping
- water for hydroelectric power generation
- service water, e.g. cooling water for power stations

Future demand is forecast from an **analysis of current demand** and **changes in demand** over past years, a **comparison with similar periods in other regions** and a knowledge of **changes in population,** of per capita consumption, which depends in particular on the level of sophistication of household water supplies (well, communal standpipe, house connected to main), the **development of trade and industry** and **irrigation development**.

In **many countries**, **irrigation** needs account for the majority of demand, while **industrial and commercial demand** is still relatively **modest**, but must be expected to grow with increasing industrialisation in many countries.

As far as the **drinking water supply** is concerned, the **basic demand** that may be considered adequate and reasonable depends on the **consumption habits** of the population and **climatic** and **cultural conditions**. According to (4), an **adequate basic supply** can be achieved with **20-40 l/cd**. These values increase with rising standards of supply. The following may be assumed as **guidelines** to reasonable consumption quantities:

up to 40 l/cd with communal standpipes

up to 60 l/cd with outdoor mains connection

up to 120 l/cd with indoor mains connection.

Losses in many **distribution systems** amount to 50 to 100% of actual consumption and must be taken into consideration when assessing demand.

Future changes in water demand are determined by

- growing population
- agglomeration in densely populated areas
- expansion of food supply and thus of irrigation systems
- development of trade and industry
- rise in per capita consumption
- increased demand for hydroelectric power.

When attempting to **forecast** future development of **water demand** there is a risk of **estimates proving wrong** due to **unforeseen changes** of a demographic, socio-economic or technical nature. Therefore a **General Water Resources Management Plan** should be designed so as to be **flexible** and must be **updated** at suitable intervals so that specific **estimates** can be made of **alternative forms of development** or **development scenarios**, assessing their effects on ecosystems, natural resources and resource utilisation.

In all **demand analyses**, possible ways of **controlling consumption** and of controlling **development trends** should also be examined (priorities, quotas, tariffs, reliability of supply). In particular, ensuring that tariff revenue fully covers costs is an important means of promoting efficient water use; this also enforces the "polluter pays principle". It may be **necessary** to **defer the development of new water reserves**, until all possible ways of **saving water** or **rehabilitating contaminated water** have been fully exploited.

3.2.4 Hydrological balance and general planning

Various **measures can be derived** from a **comparison** of **usable supply** and **demand** in the hydrological balance, taking aspects of **nature and resource conservation** into account:

• To increase resource utilisation:

- building reservoirs
- tapping groundwater
- increasing rates of delivery
- expanding the distribution system
- desalination of seawater, where applicable

• To improve the quality of treated water:

- improvement of treatment technology
- mixing with less contaminated water from other areas

• To protect the quantity and quality of the resource:

- erosion protection, reforestation
- designation of water conservation areas, restriction of pesticide and fertiliser use
- improvement of sanitation and hygiene education
- building of sewage treatment plants
- restriction of discharge of pollutants into surface waters
- rehabilitation of bodies of water
- preservation of self-cleaning properties of bodies of water by refraining from expansion or through expansion in a way similar to nature
- "conjunctive use" of surface water and groundwater

• To reduce water consumption and promote rational use of water reserves:

- fundamental changes in behaviour through consciousness-raising
- water-saving (elimination of leaks in supply networks, control of consumption with water meters, water and sewage tariffs adequate to cover costs)
- induced recharge of groundwater
- use of rainwater
- separation of service water and drinking water supplies

- multiple use of water in households, trade and industry
- use of water-saving irrigation techniques (tariffs adequate to cover costs)

• To protect soil and vegetation

- rehydration and induced recharge of groundwater
- lowering water table to protect against salination.

Shaping of general economic conditions is **vitally important** in all the areas mentioned. Many **changes** can be decisively **instigated** and **controlled** through an active **subsidy policy** (e.g. through start-up financing), through **fiscal policy** (e.g. higher taxation of undesirable variants) and through the establishment and imposition of **tariffs** (price policy). The question of **feasibility** and also the abilities of the affected population should also be considered very carefully. The widely held **opinion** that **water is "free"** is **false**. People must be made **conscious** of the **value of the resource**.

3.3 Analysis of effects on ecosystem, natural resources and resource utilisation

Water resources management projects can have **a major impact** on ecosystems and natural resources, which are either observable **directly** or only through a number of **indirect consequential effects**.

Direct effects normally arise immediately through
- water extraction:

lowering of surface waters and decline of groundwater table, runoff depletion, destruction of flora and fauna habitats
- water storage:

raising of water level, inundation of land
- contamination:

discharge of dangerous and/or oxygen-depleting substances, discoloration, odour
- water retention:

endangerment of periodically flooded areas (such as swamps, marshes)

Secondary and tertiary effects may also occur through complex **interactions**, for example due to socio-economic or socio-cultural effects, and may only be **observable in the long term**. Two examples will serve to illustrate this:

- To assess the major **effects** which a **barrage dam** may have on the environment, it is not sufficient merely to examine the feasibility of the project in terms of soil physics, hydraulics and engineering. Information is also needed to allow a realistic assessment of water demand, water supply, sediment transport and deposition in the reservoir, changes in the downstream flow regime and conflicts of use between catchment area, user area and downstream area.

- The construction of deep wells equipped with motor-driven pumps in the savanna of the northern Sahel resulted in previously nomadic livestock farmers becoming partially settled, with a simultaneous **increase in livestock numbers**. Particularly when certain wells dry up, overgrazing and progressive desertification occurs in the area of facilities which are still productive. Since living conditions are no longer regulated by the available water supply in the upper groundwater levels of the region, the ecological and socio-economic situation suffers accelerated deterioration.

Increased availability of water may also **result in salination** of soils if unsuitable irrigation techniques are used in arid and semi-arid areas.

3.4 Analysis of effect on health and hygiene

When **assessing the water supply** in a planning area, attention should be paid to the **availability of hygienic and non-toxic water**. Not only the quantity but also the quality of the water is important. Furthermore the **quality parameters** to be considered depend on the **use envisaged**, and may differ widely depending on whether, for example, drinking water, irrigation water or power-generating water is required.

Water quality can be **affected positively** through **water quality** and **conservation objectives** formulated on the basis of a **General Water Resources Management Plan**, through **wastewater treatment**, through **restrictions on use of bodies of water,** through the **designation of groundwater conservation areas** and through **hygiene education activities** carried out in parallel with water supply projects.

In the **assessment** of the future **changes in water consumption** it is frequently overlooked, for example, that **increased consumption** will result in an **increased volume of wastewater**. Wastewater is often collected in open channels and fed to surface waters, or simply allowed to seep away in the immediate vicinity of the source. This has the effect of polluting the surface water, while the groundwater is subject to the greatest risk. For example, **watering of vegetable plantations with wastewater** may cause permanent health damage.

Therefore **no water supply** should be laid on without adequate **drainage** to alleviate environmental loading. This applies both to the **drinking water** and to agricultural irrigation water.

Additional efforts to promote **organised self-help** in the form of **education and hygiene campaigns**, which **women** often play a **decisive role** in planning and implementing, help to avoid over-use and contamination of water.

The **rapid development** of **agricultural production** in many countries not only creates steadily **growing demand for irrigation water**, but also results in **greater consumption of artificial fertilisers and pesticides**. Uncontrolled use of these chemicals can also lead to **pollution of surface waters and groundwater**. The use of **drainage water** for agricultural **irrigation** - a process that is often repeated several times in succession - may **increase the salt content** of the water, thereby causing salination problems for downstream users.

Damming of surface water causes **solids** carried by the incoming water to become **deposited in the reservoir**. This causes progressive **silting** and, with the introduction of nutrients, **eutrophication** of the water. This **nutrient-rich shallow-water environment** - in conjunction with the climatic conditions prevailing in many countries - causes **vectors to flourish,** resulting in the spread of water-borne diseases such as malaria, bilharzia or guinea worm.

3.5 Socio-economic and socio-cultural impact

The **hydrological balance** set out in a **General Water Resources Management Plan** is an important factor in targeted **regional development**. It also provides a basis for **decisive and far-reaching socio-economic** and **socio-cultural** changes.

The **opening-up** of new **supplies of usable water** may lead to an **uncontrolled influx of large groups of people** from water shortage areas. Besides the risk of over-use of the natural resources, this may also bring **people from different groups together**; **social systems** previously functioning as the **basis for survival strategies**, may become **threatened** and **vulnerable**.

The ecological consequences of **barrages to protect against flood** and to safeguard the supply may affect the **livelihoods** of fishermen living by the water if the fish population changes. In the **storage basin area, agricultural and horticultural land will be lost** and normally cannot be replaced, for topographical and pedological reasons. This may have **serious socio-economic consequences** for the **affected population**. In the **downstream** area, this may result in a **depleted flow of water** with consequent **lowering of the water table**, or to **deterioration of soil quality** in the fields along the watercourse, if the land is no longer periodically flooded with nutrient-rich water. This likewise **impairs the economic basis of the population**.

Improved irrigation facilities for agriculture and horticulture can lead to **changes in cultivation practices** (artificial fertilisation, monocultures), so that after a brief increase in yield the soil will become progressively depleted, **leading in turn to increased fertiliser use.** Furthermore it may lead to **salination of the soil** and serious **material contamination** of **surface waters** and **groundwater**.

A **socio-economic analysis** should include sex-specific and group-specific investigations showing to what extent **women** or individual **social groups** are affected by **water resources management activities**, as either **injured parties** or **beneficiaries**.

Regional and **traditional forms of land-use**, often unwritten water, soil and grazing rights, ethnic structures, preferential rights of upstream river dwellers etc. are all **important** and may also be restrictive. It is **imperative** that a **General Water Resources Management Plan** take account of these factors.

3.6 Administrative and political framework

A **General Water Resources Management Plan** requires an **administrative and legal framework** (water legislation). It must be possible to establish rules and also policy objectives (priority of uses, prohibition of multiple use, allowance for traditional forms of use, international and cross-border rules etc.) for **implementation** by means of a **suitable administration** or appropriate organisations.

It is therefore **vital** to **create** or **strengthen** the **authority** or **institution** responsible for water resources management. It is **essential** to establish the necessary **decision-making procedures and bodies**, to **eliminate** the **fragmentation of powers** which is often encountered, to make adequate **financial provision** and deploy **qualified** and **well-motivated staff**. It is **crucially important** to ensure **appropriate involvement** of **women** and **other groups** in **decision-making bodies and procedures**.

4. Interaction with other sectors

A **General Water Resources Management Plan** is **absolutely fundamental**, not only to the handling of all problems associated with **water management**. It goes to the heart of overall **infrastructural development** of the **planning area** and **lays down general conditions** for individual plans in the various sectors. It is therefore of **overriding importance** for **planning measures** in individual sectors, primarily affecting the following:

- Spatial and Regional Planning
- Planning of Locations for Trade and Industry
- Overall Energy Planning
- Urban Water Supply
- Rural Water Supply
- Wastewater Disposal
- Solid Waste Disposal
- Inland Ports
- Shipping on Inland Waterways
- Ports and Harbours, Harbour Works and Operations
- Shipping
- River and Canal Engineering
- Erosion Control
- Rural Hydraulic Engineering
- Large-Scale Hydraulic Engineering
- Weirs, Hydroelectric Power Stations
- Surface Mining
- Thermal Power Stations

5. Summary assessment of environmental relevance

As a **planning tool** used at the right time, a **General Water Resources Management Plan** can contribute significantly to the **preservation of natural water resources** and **help prevent**

environmental damage by establishing parameters. It enables **water resources** to be **managed** in such a way as to **protect resources** and **ensure their long-term sustainability**.

A **General Water Resources Management Plan** lays down the **basic parameters**, not only from the technical and economic points of view, but also embraces and describes the **interactions** of the **many different factors at work within the water system**, as well as taking account of **ecological, socio-economic and socio-cultural conditions**. A **General Water Resources Management Plan** points in the direction of **possible future development** of **living conditions and economic circumstances** in relation to water. It provides a **basis** whereby different ways of **using water resources** may be identified, **compared** with one another and **assessed** to see how **water resources management projects** can be **planned and implemented in an environmentally acceptable way**.

This **planning** must take account of possible **side-effects and consequences**, and the draft plan should include proposals for avoiding **adverse effects**, monitoring **important environmental indicators** and possibly implementing **compensatory measures**. **Target groups** should be **involved** from the outset in the **development of this draft plan**.

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Key-words

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* Groundwater
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