POLICIES, STRATEGIES AND PLANNING FOR INTEGRATED RURAL WATER MANAGEMENT IN THE MEDITERRANEAN REGION

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ABSTRACT

The water demand for industry, agriculture, tourism and services in the Mediterranean is strongly increasing, whereas the available water resources remain constant or even decreasing in quantity. In the Mediterranean region, the water resources are becoming scarce not only in quantity but also in quality (Hamdy et.al 1999). The main causes can be found in an increase in the standard of living, in population growth and climatic changes. Often these water resources are polluted and a mismanagement can be stated. A higher industrial output, the increasing use of agro-chemicals in agriculture and the rapid growth of tourism result in higher degrees of water (and land) pollution. Climatic changes will lead to an even more erratic rainfall, higher temperatures and on average less precipitation.

Water resources planning in rural areas follows a hierarchical order: policy formulation, strategy development and the planning of measures is executed by different institutional levels. Integrated Rural Water Management makes use of all possible sources of water in an economic and sustainable way , taking into account the overall resource use and the (socio-) economic development. Supply management and demand management are the means to reach the goal; multiple use of water, conjunctive use of surface and groundwater, in-situ-moisture conservation, water harvesting, use of treated waste water and the use of low quality water are the techniques to apply.

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INTRODUCTION

Water use in the Mediterranean Basin is subject to dramatic changes due to a variety of reasons, among them, the increase in the standard of living, population growth and climatic changes. Conflicts inevitably arise regarding which water user group can use which part of

the available water resources and what resources have to be left untouched not to destroy the ecological equilibrium.

On national scale, the urban centres receive much greater attention to cover their water supply than the rural areas, the reason being of political (more voters) and/or of economic nature (e.g. location of export oriented industry close to urban areas).

An urgent need for new policies, new strategies and a new way of planning exists to achieve the goal of sustainable development of the Mediterranean region. A useful tool to satisfy the needs of rural areas is the application of "**Integrated Rural Water Management System**". Integrated Rural Water Management is referred here as a kind of application of the general principle of "**Integrated Water Resources Management**", which involves the co-ordinated planning and management of land, water, and other environmental resources for their equitable, efficient, and sustainable use.

Integrated Water Resources Management includes all human activities managing water resources and **making water available** for a desired purpose in an integrated manner. That is, all management **activities** for investigation, impoundment, transportation, transmission, diversion, drainage, desalination, or recapture of any portion of any water resources for any of the following purposes: domestic water consumption, sanitation, irrigation, flood control, prevention of soil erosion, siltation, reforestation, livestock watering, navigation, fisheries, wildlife preservation, recreation, tourism and commercial and industrial purposes.

When **competition** between the various water users (economic sectors) comes up,

- the most appropriate **policy** towards water resource use,
- a suitable **strategy** to overcome problems and to secure the long-term availability of the water resource and
- the best 'tactics', i.e. **planning** steps to reach the goal,

have to be chosen.

PROBLEM ANALYSIS

With particular regard to the [1]Mediterranean Basin's countries, and even though they have many similarities due to geography and history, there are remarkable contrasts between the MED-HIC having (with exception of Israel) heavier rainfall and the MED-LIC characterised often by aridity and water scarcity. It is not only the contrast of climate, but

also that of population growth, available resources and the standard of living as well as different kind of needs and demands.

The MED-HIC, with their almost constant population aiming to keep their high living standard and to increase touristic capabilities, go for more urbanisation and more industrialisation; and the MED-LIC with rapidly increasing populations having more interests to increase the low living standard, therefore aim at higher agricultural, industrial and touristic rates which are associated with a higher demand for various resources including the water resource. In the MED-LIC the water resources are becoming scarce not only in quantity but because of the degrading quality. Land is also subject to rapid degradation and losses in the land productivity.

The [1]Mediterranean Basin share considerable specific characteristics and features, but the differences between the highly industrialised (MED-HIC) and the less industrialised (MED-LIC) countries (and within these groups) have to be thoroughly considered when heading for sustainable development.

Land Resources and Land Use

In the region there are great differences in the land use and distribution of agricultural surfaces between one country to another, and this holds true among the Southern, Northern and Eastern Mediterranean regions. The extent of soils growth with respect to the total area of countries is always below 50% and even below 10% in some countries (like Algeria, Libya, Egypt) where the total land area mostly consists of desert.

Soil Degradation

In almost whole Mediterranean region, the uncontrolled utilisation of natural resources, exceeding the limit of ecological stability of natural ecosystem, always result in soil degradation. Erosion is the single largest threat to soil quality in Mediterranean basin. More than 50% of agricultural soils are threatened by erosion.

Agriculture and Water Use

In the Mediterranean region nearly 70% of the available water resources are allocated to agriculture. In the Northern MED-LIC less water is allocated for the agriculture sector and it shares nearly 50% of the whole available resources. Diminishing water resources in the

East and South of the Mediterranean basin appears as one of the main factors limiting agriculture development. The water needed for irrigation is even scarcer than the land itself. Land suitability for irrigation is becoming harder to find.

Despite the high priority and massive investment in the water resources development, the performance of large public irrigation systems has fallen short of expectations in MED-HIC and MED-LIC countries. Crop yield and efficiency in water use are typically less than originally predicted and less originally achieved. In addition, the mismanaged irrigation project schemes lead to the sterilisation of some of the best and most productive soils. Salinity now seriously affects productivity in the majority of Southern Mediterranean countries as well in the coastal zone. Salt affected soils in the region amount to nearly 15% of the irrigated lands.

Given the increased costs of future irrigation development schemes, together with the scarcity of land and water resources, the emphasis in the future will be more n making efficient use of water for irrigation and less on an indiscriminate expansion of the irrigated area. Irrigated agriculture will face two challenges of water shortage and dwindling financial resources. Despite theses

Drinking And Domestic Water

In the **MED-LIC**, expansion of cities into rural areas and tourism, the growing irrigation water demand, in addition to the high population increase, exert great pressures of demand on good quality drinking and domestic water. People in rural areas depend strongly on ground water, lifted often by hand from shallow aquifers. In the MED-LIC , villages, but very often even towns, are not supplied with water whose quality meets international portability standards. This results in many water-borne diseases that definitely exhaust sooner or later both the people's and the countries' health budget to get rid of such diseases.

The pollution of ground and surface waters, causing such problems, is due to:

- Untreated or partially treated domestic and industrial effluents are flowing into the rivers, canals and ditches;
- The domestic sewerage in some regions missing sanitation;
- The leakage of sewage collecting pipe-networks;
- The improper control of fertilisers and pesticides' usage by the farmers.

In the **MED-HIC**, the supply of clean water to rural areas is hampered by the high demand of urban and coastal touristic centres, especially in summer time. The supply to those centres of demand in sufficient quantities and quality becomes more and more difficult. The reason may be an overall shortage of water in the region, but often great losses within the distribution system are of equal importance.

In France, as an example, leakages in both public and private pipes and taps accounts for almost 40% of the total domestic distributed water, one half being lost in the network and the other half inside the buildings (LAKHTAKIA,1995). Low water prices and lack of metering in many places are among the reasons not to save. Tourism 's water demands are increasing rapidly as well. The coastal areas of the Mediterranean Basin are estimated to receive some 100 million tourists per year presently. This figure is expected to rise to 250 million tourists by the year 2025. The over exploitation of the coastal groundwater aquifers to meet these needs has caused already in many areas sea water intrusion. The wastes as well as the high amounts of wastewater into the aquifers mainly caused by the tourists are very much likely not only to affect the coastal strip but also the sea itself.

Sectoral Water Issues

The "Western" system of values, where short-term economic benefits rank much higher than long-term "immaterialistic" benefits, and the harshness of economic competition between the countries hinder the process of sustainable development. A balanced combination of national strategies and international cooperation is needed to achieve economic development and protect the environment simultaneously.
The following theses can be formulated :

** Economic development needs adequate water supply in quantity and quality.*
The sectors of agriculture, industry, tourism and services need high water quantities to develop. The water quality needed in each sector differs to a great extent.
A number of countries of the Mediterranean basin have carried out water quantity assessment studies, but seldom combined with the development of water use alternatives (under the frame conditions of limited supply) and ever hardly combined with water quality master plans.

** Economic development aggravates the problem of water quantity as well as of water Quality.*

The production of more agricultural or industrial goods and an increase in services (e.g. in tourism) means higher water use and more water being polluted, thus decreasing the "water basis" of production. In low-rainfall countries with limited water treatment facilities the competition for good quality water between the economic sectors will increase, resulting in severe constraints mainly for the agricultural sector.

** Water quality issues are strongly related to water quantity issues.*

The shortfall in water quantity in the different countries of the basin has been compounded by a decrease in quality due to the accelerated contamination of underground and surface water. An integrated water management approach should be implemented to satisfy the needs of each sector.

Agriculture

In the MED-LIC, agriculture gets the lion's share of sectoral water use; its share is almost 80% (HAMDY & LACIRIGNOLA, 1994). Even though agriculture has been an intensive activity in these countries for food supply and income generation, it is only Turkey that has gained self-sufficiency in food production.

Food imports from abroad alleviate the insufficiency of food production in this region and this is unavoidable in the present situation and will most probably continue in future.

The large quantities of water needed for irrigation, the often low water use efficiency and the uncontrolled use of fertilisers and pesticides, however, aggravate groundwater and surface water problems. The increasing tendency towards more industrialisation and tourism will render agriculture unable to be more widespread. Unless agriculture finds means (1) to use less water quantities and (2) to use water of lower quality but on a sustainable basis to produce more food output, it will be the loser in such an economic competition. Preconditions for higher efficiencies are (1) a higher education level and better training of farmers, (2) capital or credit facilities for investments in irrigation, (3) produce prices high enough to make farming profitable.

It is worth mentioning also that agriculture can contribute to decreasing the water pollution by controlling and managing the types of agro-chemicals and their use. Egypt's ban on herbicides to control aquatic weeds in irrigation canals has been a good example in this respect.

Fig. 1 shows schematically the present water use in MED-LIC.

In the **MED-HIC**, agriculture plays a minor role economically, but because of the large amounts of water needed to irrigate and the fertilizers and pesticides being used leading to surface and groundwater depletion and pollution, agriculture is under pressure.

In general, the water problems in rural areas of the MED-HIC are much less pronounced than in MED-LIC.

Constraints for Irrigated Agriculture

The main constraints inhibiting the development of irrigated agriculture in both developed and developing countries of the Mediterranean are:

- Lack of funds and substantial delays in their allocation;
- Lack of professional and technical manpower and training facilities and equipment;
- Lack of knowledge and absence of appropriate research to develop new technologies and approaches and absence to incentives to adopt them;
- General institutional weakness and lack of co-ordination between various government bodies;
- Lack of appropriate and consistent policies for land and water development in both large and small scale projects;
- Resources: the land and water on which agriculture depends.

These problems include, major problems of soil erosion, global warming trends, contamination and pollution of water supplies and salinization and water logging of irrigated areas. Agriculture is viewed as a contributor to, as well as, a victim of many of these environmental difficulties.

Sustainability and irrigation development

Irrigation has been under heavy attack by many environmentalists on the basis that it transforms a part of the territory and produces changes that in the long run may not prove

sustainable. While there is little doubt that irrigation development involves profound changes in the physical and sociological environment, these changes have proved to be sustainable overtime. Indeed, irrigation, when properly managed, is a highly sustainable undertaking if certain basic conditions are met. If the reasons and causes of failures of irrigation are analysed, common denominators can be found in all of them, which can be listed in the following:

- Diminishing water resources;
- Weak financial viability;
- Decreasing productive areas;
- Reduced land productivity;
- Land fragmentation;
- Low price for agriculture products.

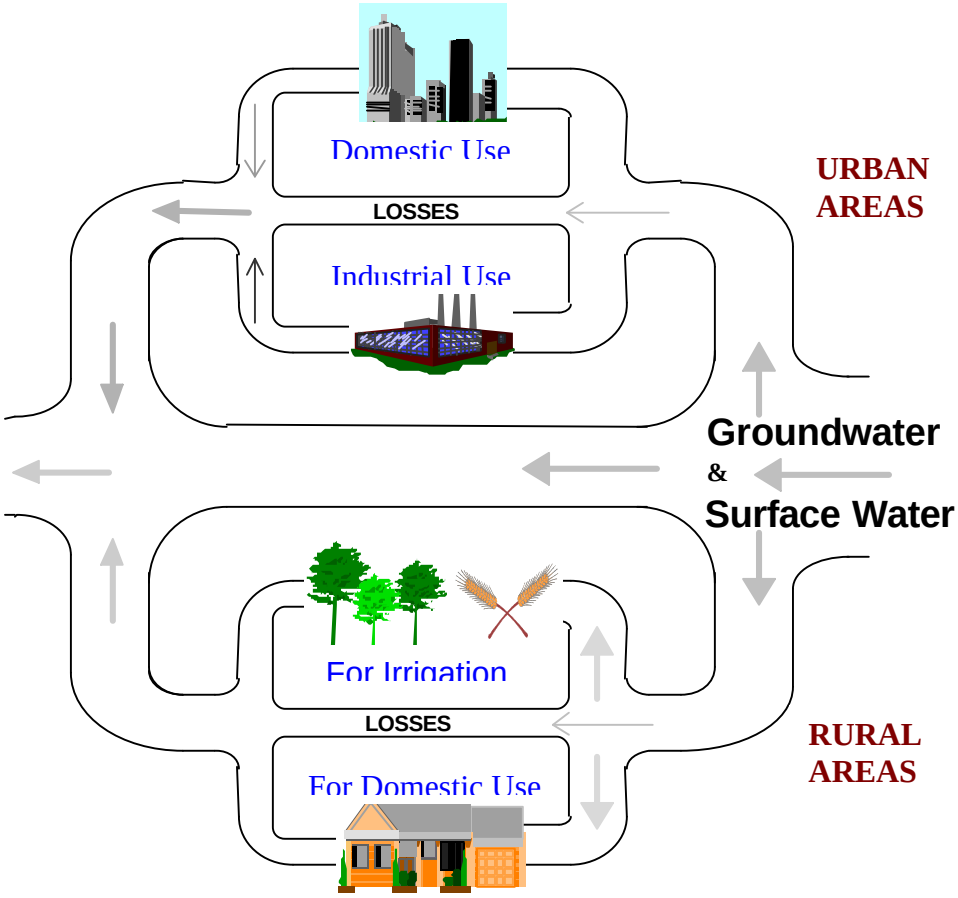


Fig.1: The present situation in the less industrialized countries of the Mediterranean Basin

The equilibrium of irrigation system is delicate. There are many threats that can disturb the balance and affect the viability and sustainability of the system. Adequate financial and technical measures are needed to make irrigation durable investment.

Almost 36% of the water resources available in the MED-HIC are used for irrigation .

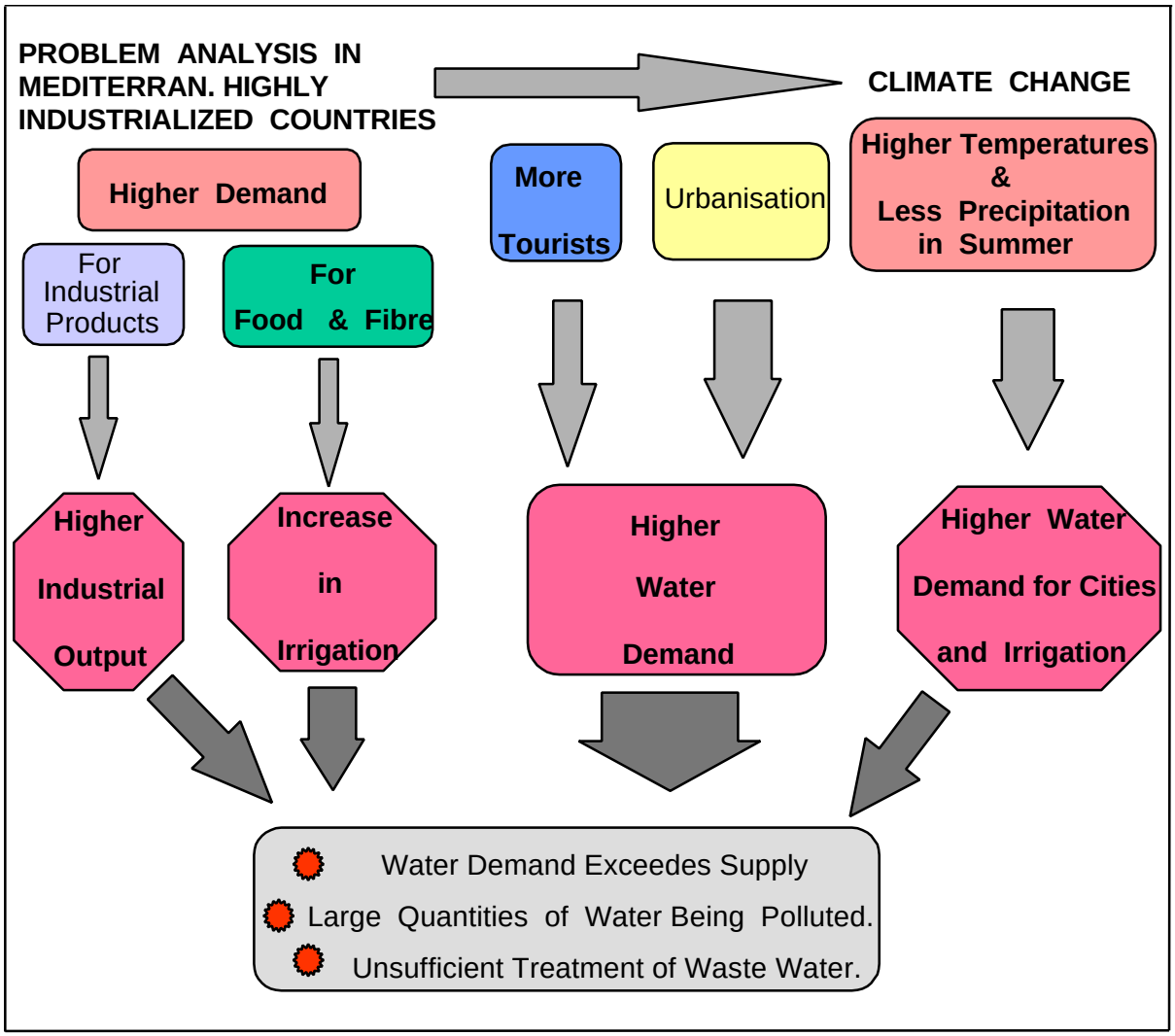


Fig. 2: The present situation in the Mediterranean highly industrialized countries (MED-HIC)

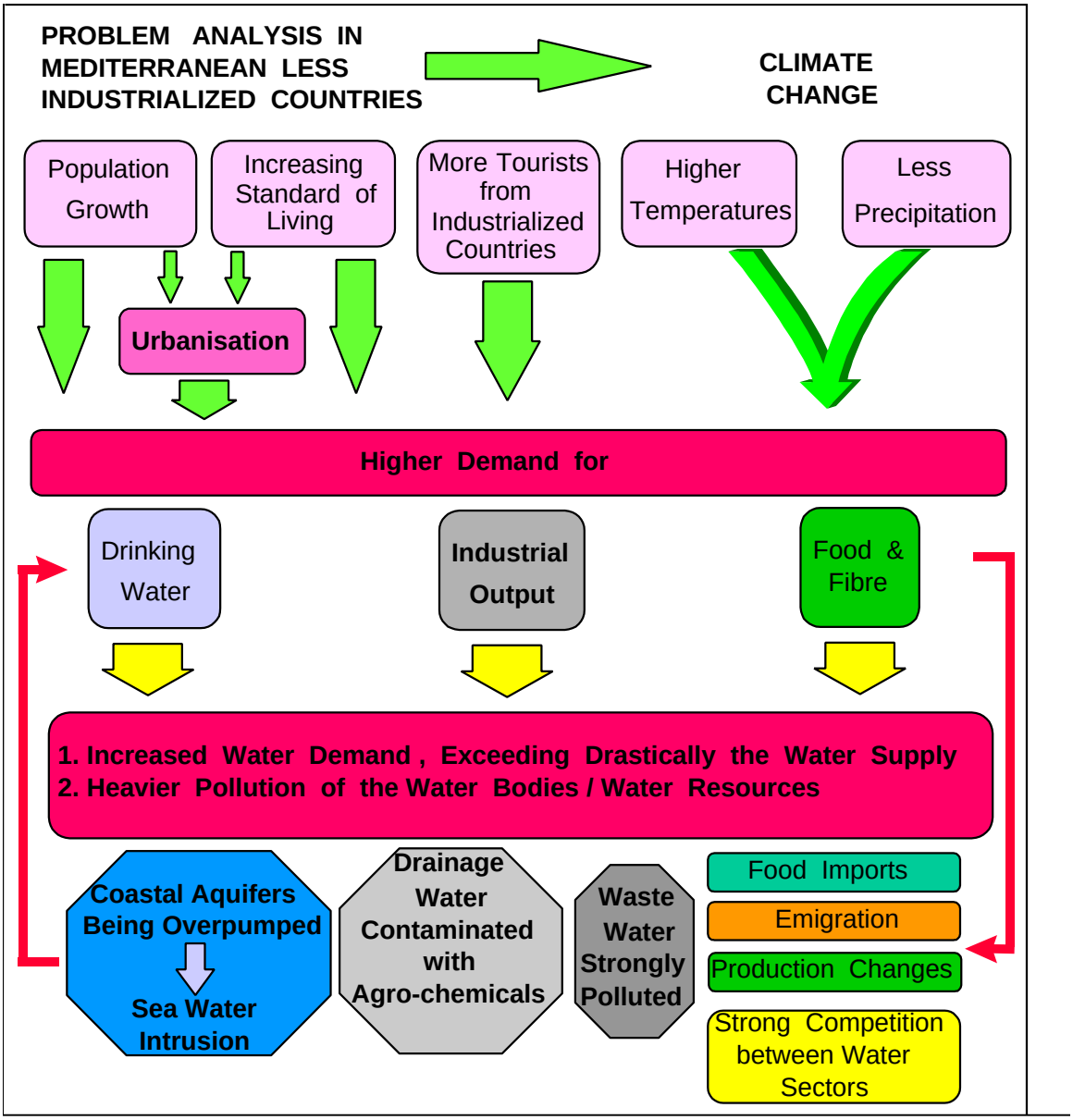


Fig. 3: Present situation in the Mediterranean less industrialized countries (MED-LIC)

POLICY OPTIONS

Policy is defined here as 'a **frame of reference** or a set of **principles** or rules determining what and how things are done'.

All policy decisions should be directed towards **sustainability** which includes:

- ***Justice to nature:*** Our environment and ecosystems have a value in their own right, and hence efforts to protect these resources, habitats and biodiversity are warranted.

- ***Justice to future generation:*** Our descendants have the right to at least the same if not better economic and environmental conditions and quality of life as we enjoy. Our actions now should not preclude them from fulfilling their goals and desires in the future.

- ***Justice within our own generation:*** Unless we achieve greater equity or justice among peoples living in this generation it is not likely we will make much progress preserving nature and sustainability of future generation (LOUCKS 1994).

As mentioned above, the concept of "**Integrated Water Resources Management**" (IWRM) involves the coordinated planning and management of land, water and other environmental resources for their equitable, efficient and sustainable use.
Its objectives should be the **basis** for any water related policy; they encompass the UNCED principles:

- Water has multiple uses, and **water and land** must be managed in an **integrated** way.
- Water allocation should take account of **the interests of all** who are affected.
- Water should be recognized as an **economic good** (CALDER 1998).

The general principle that water is an economic good should, on my opinion, be supplemented: Water is a **social** good, too.

The problems come up when putting these principles into practice:
Assuming, a limited quantity of water, e.g. 15.000 m^3, has to be distributed. This quantity

- can sustain the life of 100 nomads and 450 heads of cattle for 3 years;
- can be supplied to 100 rural families, to cover their water demand for 3 years, too;
- may be diverted to an urban area to supply water to 100 families for 2 years;
- can be used to irrigate 1 hectare of paddy for 1 year (1 ha paddy per year means roughly 10 – 15 tons of rice),

can be used for tourists, supplying 100 guests with all amenities of a luxury life (shower, swimming pool etc.), but for 55 days only. (All figures taken from FAO sources.)

The chosen policy determines the use of limited supplies of water.

Who is **responsible** for policy formulation, who guarantees, that "the interests of all, who are affected" are really safeguarded? In first instance, its a **national** task (parliament, government), but, to a lower extent, it is a duty of regional and even local decision makers, too (Fig. 4).

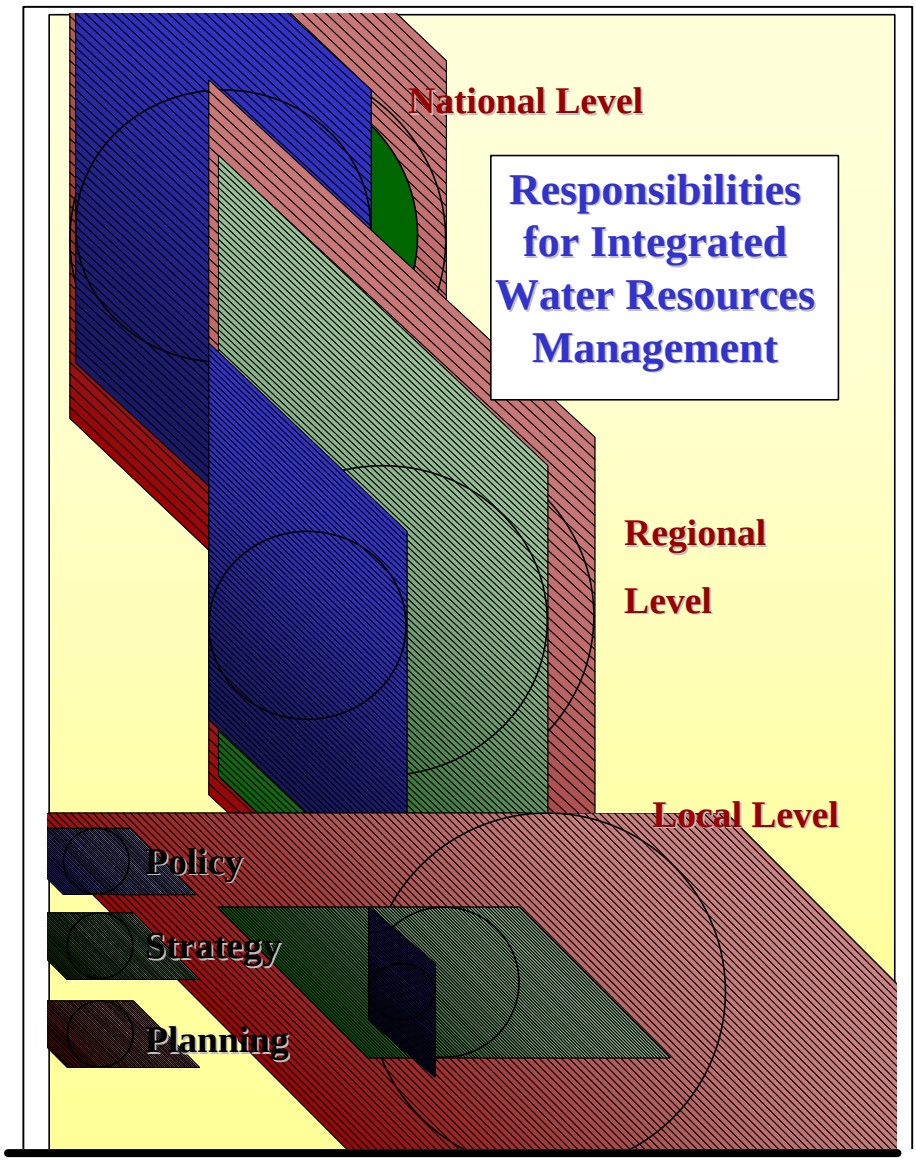


Fig. 4: In the MED-LIC, decisions on policy, strategies and planning measures are distributed among the three levels shown. For MED-HIC, which are EU-members, a growing number of decisions are taken by the European Commission.

STRATEGIES

Strategy applies to the devising of a **general plan of action** so as to achieve an end with the means available.

The "**Integrated Water Resources Management**" (IWRM) strategies seek to ensure:

- **A long-term, viable economic** future for basin dependents (both national and trans-national).
- **Equitable access** to water resources for basin dependents.
- The application of principles of **demand management** and appropriate **pricing policies** to encourage **efficient usage** of water between the agricultural, industrial, and urban supply sectors.
- In the short term, the **prevention of** further **environmental degradation** and, in the longer term, the **restoration** of degraded resources.
- The safeguarding of local **cultural heritage** and the **local ecology** as they relate to water management and the maintenance and encouragement of the potential for water-related tourism together with linkages between tourism and conservation (CALDER 1998).

Integrated Water Resources Management strategies should recognize that:

- Solutions must focus on underlying **causes**, not merely on symptoms.
- Issues must be approached in an **integrated** way.
- In general, development of sound resource management and collective responsibility for resources will take place at the (**sub)regional or village** level..

Integrated Water Resources Management implementation programs should:

- Comprise an overall strategy that clearly **defines**
  - the management **objectives**,
  - a range of **delivery** mechanisms that enable these objectives to be achieved, and
  - a **monitoring** schedule that evaluates program performance.
- Recognize that the development of water resources management strategies may require **research** to assess the resource base, and through the use of **models** and the development

of **Decision Support Systems**, to determine the **linkages** between water resources development and the impacts on the environment, **socio-economics, equity, and ecology.**

- Ensure that mechanisms and policies are established that enable long-term support to programs of environmental **recovery** (CALDER 1998).

Basis for any strategic decision on rural water resources is a sound **assessment** of the present and future **supply and demand situation** at the various levels.

On national or regional level, the establishment of a '**Water Master Plan'** has shown to be a very useful tool for strategic decisions to show,

- what water resources are **available** when and where in the country
  - in terms of surface water (rivers, streams, lakes)
  - groundwater (what depth, rate of recharge, fluctuation)
- how much water is **stored** in reservoirs, for which purpose and what losses occur,
- how much water is **used** for which purpose (i.e. how the present water demand is covered).

Only in rare cases, the **quality** aspects are covered in those Water Master Plans.
To have a sound basis for strategic decisions, it is necessary to know

- the water **quality** in surface and groundwater sources,
- what water quality is needed for what **purpose** (and in what quantity),
- **how** to avoid future **pollution** and **seawater intrusion**,
- **how** to avoid **overpumping** of (inland) aquifers.

Fig. 5 shows possible water resources and some management activities at local / regional, national and trans-national level.

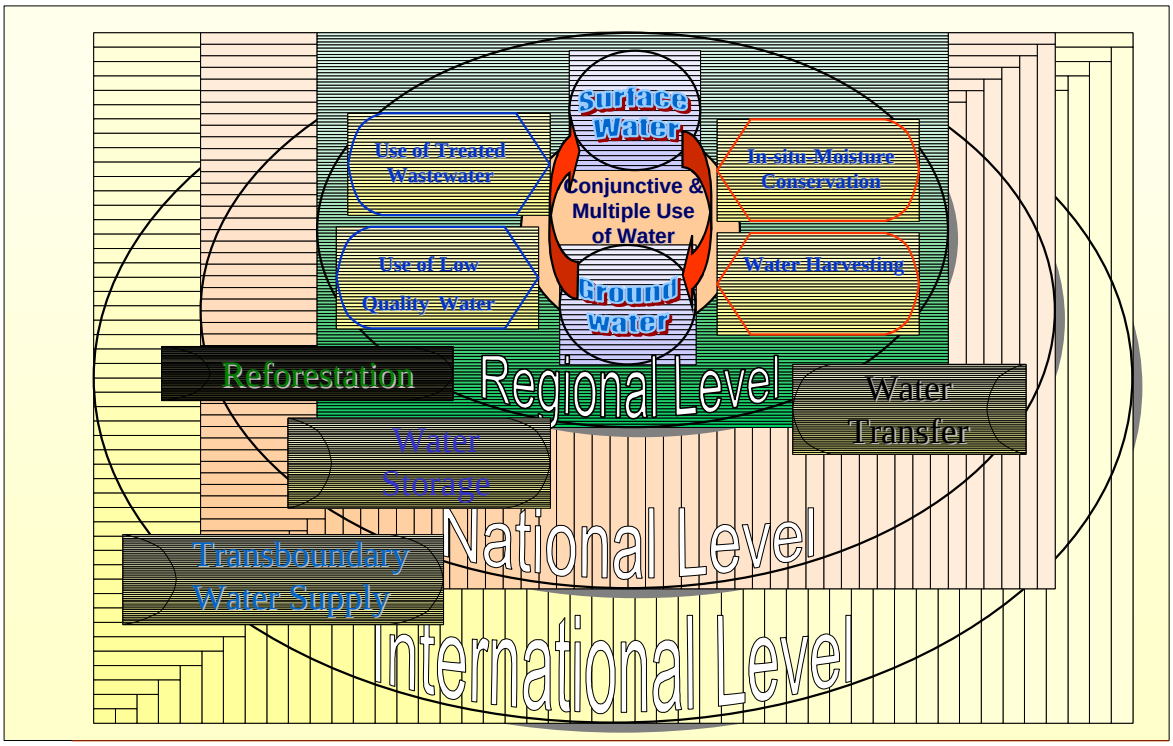


Fig. 5: Possible water resources and management activities at various levels

Fig. 6 depicts the optimized water use in urban and rural areas in less industrialized countries of the Mediterranean. Conjunctive use of surface and groundwater, multiple use of water e.g. for agriculture, forestry and aquaculture, application of water harvesting techniques (PRINZ 1996, PRINZ et al. 1998), and water re-use / recycling are some of the improved techniques to cover the increased demand.

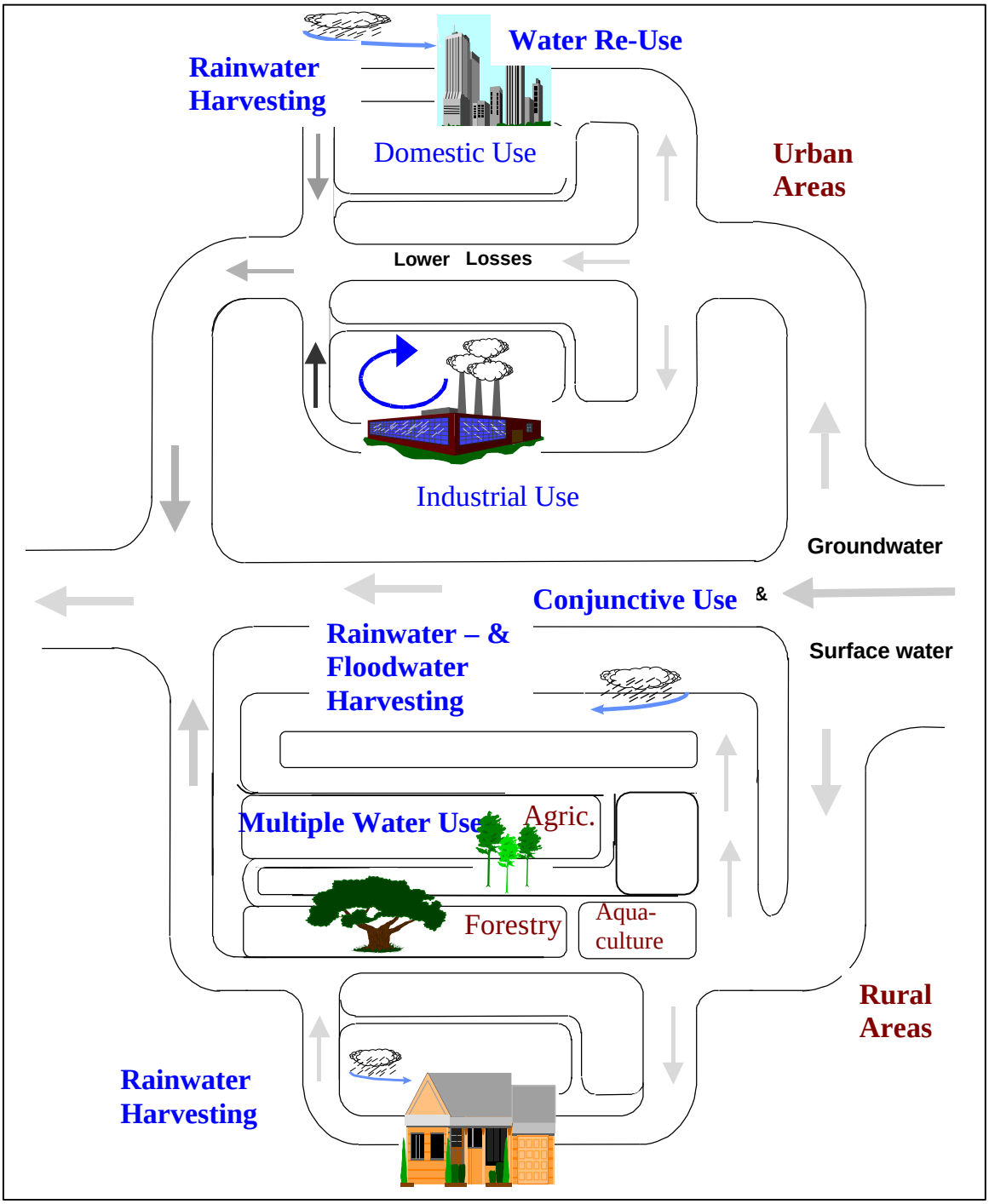


Fig. 6: Improved water use in less industrialized Mediterranean countries

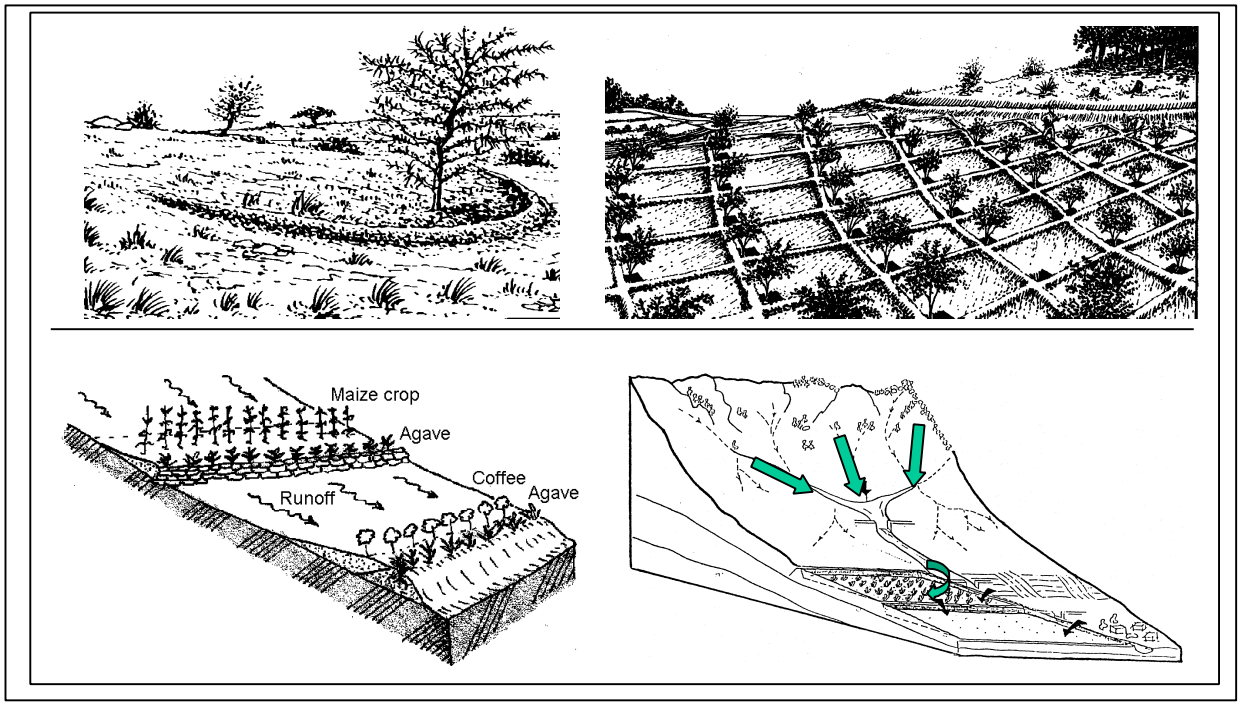
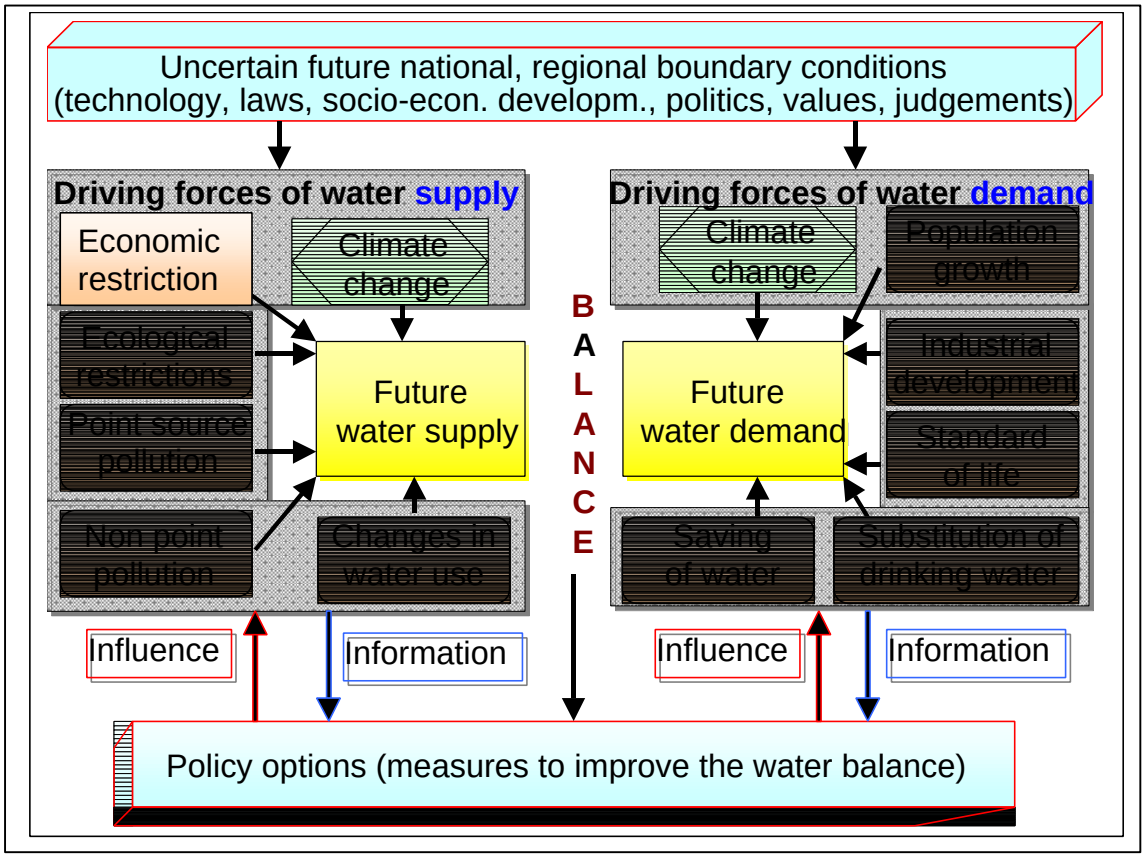


Fig. 7: Rainwater harvesting techniques for crop production;
Source: PRINZ 1999

The right strategy for integrated rural water resources management has not only to include all relevant aspects of **supply and demand** management, but has to take into account the **ecological consequences** of the development of water resources. This includes a possible spreading of water-related diseases (like malaria, schistosomiasis), the loss of wetlands, subsidence due to overpumping etc.

Planning has to take into account the most probable development of resource use. For each country or region the decisive factors and their magnitude for the next decades to come have to be determined. The driving forces for future water supply and water demand with boundary conditions and policy options given are shown in Fig. 8.



1. Fig. 8: The driving forces for future water supply and water demand . As boundary conditions change frequently, a certain flexibility in regard to the appropriate strategy is necessary.

2. Decision Support Systems

3. There are many Decision Support Systems available and it is not an easy task to select the most appropriate an.

Example Application of Decision Support System in Strategic Planning

What is the best water pricing approach to adopt?

1. **Defining the problem: Consider what interests (stakeholders) will be affected**!
   - Basin economics?
   - Equity?
   - Environment?
   - Ecology?
   - Trans-national interests?
   - Others?

   Consider the linkages!
   Construct "model" in DSS.

cont.

2. Generating alternative solutions:
Run „model“ in DSS for different pricing approach scenerios and calculate impacts on stakeholders.

3. Evaluating alternatives:

- Consider impacts in relation to each stakeholder.
- Consult with stakeholders
- Look for “incremental change” solutions
- Look for ‘satisficing’ solutions rather than optimum

4. Indicating the best for implementation:

- Include “preferred” option in strategy.

Source: CALDER 1998

Decision Support Systems can assist strategy developers by:

1. Defining the problem
2. Generating alternative solutions
3. Evaluating the alternatives
4. Indicating the best for implementation.

The chapter on planning gives another example on the application of a Decision Support System.

PLANNING

Planning in water resources management for rural areas is mainly done in the (sub) region or the location concerned.
Water resources development is vital for rural areas and one of the prerequisites to gain agricultural production but at the same time it can have a negative impact on the environment unless careful planning and design to the problem is carried out.

- When heading for sustainable use of water resources, various aspects, aside of the technical ones, have duly be taken into account:
- Financial aspects

- Socio-economic aspects
- Environmental aspects
- Institutional aspects.

The chosen technological solution should address the existing financial as well as socio-economic situation of the area under consideration. One sided, technical water development – without complementary measures and programs to help the people a new balance in their system – is one of the main causes of project failure (KORTENHORST et al. 1988). This calls for the issues of appropriate technology. In this context any technological solution, for instance, building a dam or diverting a stream or pumping groundwater for irrigated agriculture needs to be planned and designed within the level of financial as well as socio-economic situations of an area, at the same time thinking about both the physical and biological environment. As such it is possible to make use of the available water in a sustainable way.

Financial Aspects

The financial structure of water resources development in rural areas is an important mechanism that allows decision-makers to formulate, analyze, and compare alternative development plans. Any new investment plans of the water resources development for irrigation address the following criteria as part of overall economic feasibility analysis: operating costs; maintenance costs; capital cost recovery; benefits; and maintenance of adequate service levels. These help to look into which technical options can be implemented with relatively minimum financial requirement. In this case the continuity of financing the project needs to be clearly known for the sustainability of the project. One way of doing this is by strengthening the financial situation of the water users so as to at least cover the running costs of the water resources development project. Moreover, a new investment plan should at the same time forecast the possible outcomes or benefits of the water resources development project.

The consequence of the lack of attention to the financial requirement throughout the designed project life is that many projects are not sustainable and therefore, after all, not feasible. Instead, they are dependent on substantial financial help from the government-help that is not made available in sufficient quantities.

Socio-economic Aspects

The socio-economic aspect of water resources development for rural areas helps to identify the felt needs of the water users (farmers in this context) as well as the contribution of the project to the area under consideration. The proposed water resources development should bring a change on the living standard of primarily the water users and the community. The greatest benefit of, for instance, irrigation facilities are that the area can at least be self-sufficient in food and fodder if the systems are managed carefully. As mentioned before, the socio-cultural aspects should also be clearly defined based on the existing social organization of the area under consideration. As such it is possible to suggest the ways in which the organization can serve water users associations.

The failure of many irrigation schemes is not always associated with the structural design aspects. But it is also due to lack of attention to the socio-economic situation of an area. Experiences in many developing countries show that, whenever decisions for constructing a vital irrigation scheme are taken for other than socio-economic reasons, the result always has been a total failure (BABAN 1995). Therefore, before any investment decision is made concerning the implementation of water resources development from irrigation scheme, the socio-economic merits of the project proposal should be subjected to an analysis. Ideally, such an analysis includes the socio-economic impact of the project on the national level as a whole, on the intended direct beneficiaries (the farmers), and on the managing agency.

The lack of basic data – in particular about the socio-economic situation of the intended beneficiaries – generally necessitates in-depth investigations into the constraints and possibilities of agricultural innovations being adopted (Kortenhorst et al. 1988). Hence, the local social, economic and institutional conditions must influence project design if the project is intended to be locally acceptable, workable and sustainable.

Environmental Aspects

In recent years, those involved in the development and use of water resources have become increasingly concerned about the unintended effects of large development initiatives on human health and on land, water, air, and other natural and cultural resources. A few years ago, cost-benefit analysis alone determined the fate of the project. Today, ecological consideration and the awakened public play deciding roles (BAUMANN et al. 1988). Quite a number of water resources development projects have been developed and some of them are still flourishing at the cost of the environment. In response to such concerns, many nations have established legislative, regulatory, and institutional frameworks to protect and improve these interests. Some of the key environmental concerns associated to agricultural water use are reflected in:

- ***Salinity***: caused by excessive application of irrigation water. This in turn raises the groundwater table, and thereby pushing up the soluble salts to the surface of the ground. For the long-term sustainability of agriculture, techniques like drainage should continue to receive priority.
- ***Water pollution***: caused by wastewater from domestic and industrial use, which is untreated and discharged to rivers, irrigation canals, and drainage ditches.
- ***Potential groundwater contamination***: caused by mainly due to 'excessive' application of nitrogen, phosphate, and potash fertilizers.
- ***Impact of herbicide and insecticide use***: use of insecticides and herbicides, against insects and to control weeds respectively, contributes to the change of the natural environment.
- ***Effect on human health:*** the increasing incidence of malaria and schistosomiasis, resulting from the expansion of the irrigation areas, is a major concern in irrigated areas of many countries of the world.

Therefore, a complete picture of environmental issues related to water resources, such as water quality parameters and accurate estimates on the costs of land and water degradation to the national economy should be outlined so as to run the water resources development

project in a sustainable way. Alternative design options need to be presented and evaluated in terms of their impact to the environment.

Institutional Aspects

Much can be talked about the technical, financial, socio-economic, and environmental aspects of water resources development. But it will be a failure to create and maintain sustainability unless the concept of institution building is integrated. Institutional arrangement helps to create the capability to organize, manage, and sustain water resources development projects. The institutional arrangements for developing and managing water resources are the transmission gears between policy objectives and field-level performance (GUGGENHEIM, 1992). Whereas policies raise questions about *what* is to be done, institutional analysis asks *who* is expected to do it, and with what resources, and *how* are the institutional building blocks expected to interact. Therefore, a clear picture of institutional frameworks, based on the socio-cultural situation of the area under consideration, should be established by legislation, which provides basic operative norms.

How to bring supply and demand into equilibrium

'Supply Management' and 'Demand Management' are the tools to bring both sides into equilibrium. Whereas '**Supply Management'** tries to increase the available quantities of water by making best use of all sources of water, '**Demand Management'** is heading for a decrease in water use by education, training, technological innovations and water pricing.
Supply Management in rural areas of the Mediterranean means:

- Optimal, conjunctive use of surface and groundwater sources (giving due attention to sustainability aspects);
- Application of the various techniques of in-situ moisture conservation (e.g. tied ridges);
- Application of 'Rainwater Harvesting', 'Floodwater Harvesting' and 'Groundwater Harvesting' techniques (PRINZ 1996, PRINZ 1999);
- Collection and use of treated wastewater;
- Use of low-quality water for tree cropping and aquaculture (Fig. 9).

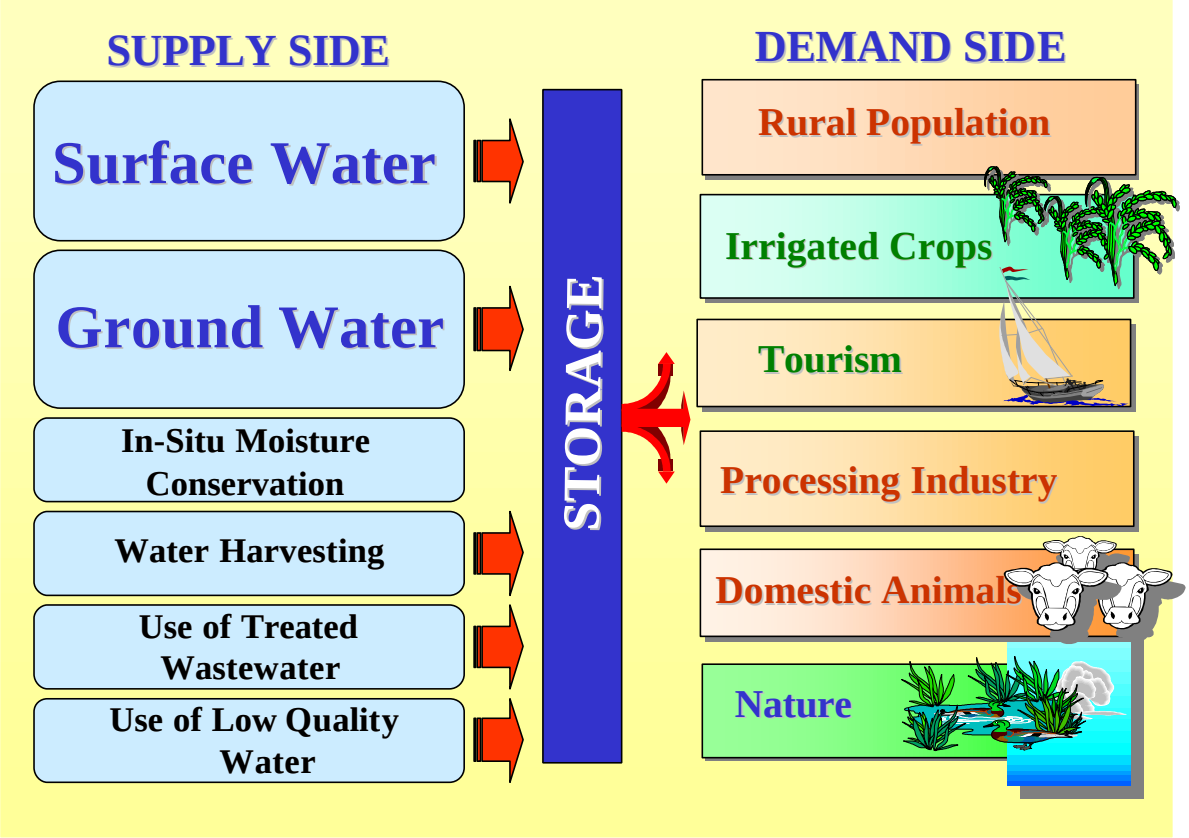


Fig. 9: Ultimate goal of water resources planning in rural areas is bringing supply and demand into equilibrium.

All of these techniques have their pros and cons and it is the task of the local or regional planner, to make best use of them, keeping the negative aspects at an as low level as possible.

Water storage in reservoirs and artificial recharge of groundwater play an ever increasing role in supply management.

The time dimension in planning

A planning of the water related measures well ahead of the time of need should be self-evident, but is often neglected. The establishment of a time axis of the necessary actions to be taken at the various levels in close collaboration between the levels is a must(Fig. 10).

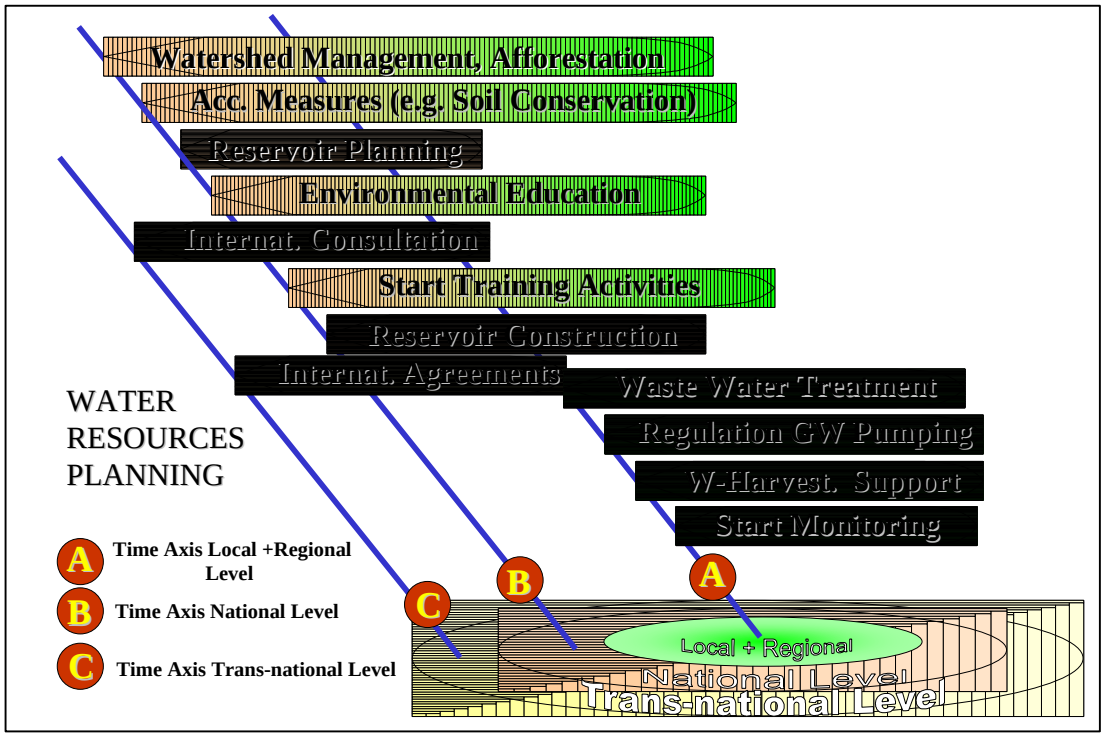


Fig. 10: Time axis for water resources planning at various levels (Example)

STEPS IN THE DECISION MAKING PROCESS OF WATER RESOURCES DEVELOPMENT

A 'Decision Supply System' in rural water resources planning may look as follows:

STEP 1 : DEFINING THE NEEDS

1.1. Analysis of the present supply & demand situation
(= Non - project - situation)

Method : Interviews with farmers, administration and extension personnel; use of questionnaire; Scaling : 7 - 9 categories

1.2. Analysis of future supply & demand situation

- Define time frame
- Define frame conditions (physical, socio-economic, land use.)
- Problem analysis ("What creates the problem ? ").

Method : As in 1.1., plus evaluation of statistical data :

Demography data, data on natural resources, meteorology and hydrology, data on land use etc. (Data from various Government services).

1.3. Are needs met ?

- Present / future needs
- Whose needs are met ? (Social stratification)
- Special attention to domestic & crop water demand
- Degree of probability (inter annual & inter seasonal varieties of rainfall e.g.)

Method : Questions posed to water users (7-9 categories)

STEP 2 : FORMULATING OBJECTIVES

2.1. Developing a 'Water Resources Development Strategy'

2.1.1. Supply Management Strategy, including

- Afforestation/ maintaining forests
- Improving in - situ rainwater use
- Applying water harvesting (mid storage)
- Recharge of groundwater
- Use of groundwater resources
- Multiple use of water
- Re-use of water
- Diversion of surface water
- Storage of surface water

Method :

- Discussion with water users & administration,
  decisions taken by decision makers (group or individual)
- Utilisation of any data available
- Definition of time frame and spatial scale essential.

2.1.2. Demand Management Strategy, including

- Reducing water losses
- Improving water use efficiently
- Changing cropping pattern
- Changing production methods
- Changing production methods
- Water pricing

Method : as with 2.1.1.

2.2. Defining, categorizing & quantifying objectives

- What targets shall be reached in what period of time
  with what means.

Method : Taste of the decision maker, with/ without Decision
Support Model.

2.3. Goal analysis

- Consisting with felt needs, regional/national plans ?
- Primary, secondary, tertiary effects of goal oriented
  water resources development taken into account ?
- Are parallel actions in developing other natural
  resources (e.g. soil conservation, agricultural
  intensification) planned, which may support/ hinder

to reach the goal ?

Method : data collection and analysis by decision maker with/ without Decision Support Model.

STEP 3 : ASSESSING RESOURCES AND CONSTRAINTS

3.1. Basic data collection

3.1.1. Data on physical resources (hydrology, soil, topography, geology)

3.1.2. Data on land use (Valuable ecosystems, vegetation, agricultural production, forestry etc.) ; calculation of crop water requirements and irrigation water demand.

3.1.3. Data on human resources (Socio-cultural background, farm labour, skills. etc).

3.1.4. Data on informational resources (for water used) and extension service.

3.1.5. Capital resources (farm income, bank loans, other income sources, etc.)

Sources : Questionnaire to be filled by water users ; analysis of statistical data & cartographic sources (maps) ;

Method : Decision Support Model (DSM)

3.2. Assessing constraints

- What elements can be a bottle neck for water resources development (physical, biotic human, informational, capital resources.)

Method : Questionnaire, statistical data, cartographic information, Filling in DSM.

STEP 4 : IDENTIFICATION OF POTENTIAL OPTIONS & OF SCREENING CRITERIA

- Options will belong either to demand or supply management ; several options might be viable.
- Example : - Rain water management and supplementary irrigation in rainy season
  - Rain water harvesting and aquaculture.
  - Dam construction and water distribution network.
- Screening criteria help to evaluate the options

Method : DSM, GIS, based on questionnaire with works for options.

STEP 5 : DESCRIBING AND EVALUATING ALTERNATIVES

- Combine options to implementable, comprehensive alternatives which will meet the identified needs.
- Prepared cost-benefit analysis for the alternatives ; calculate Internal Rate of Return etc.
- Set up a list of criteria and subcriteria which are assumed to fulfill the concept of sustainable water resources development (i.e. technical, socio - economic, financial, environmental and institutional criteria).
- Questionnaire data is the evaluation (sub) citeria.

Method : DSM like MCDM/AHP.

- Pairwise comparisons
- Weighting
- Transformation of scales
- Aggregation of individual judgments (geometric mean)
- Setting Local, Global Priorities

- Test on consistency

STEP 6 : SELECTION OF BEST ALTERNATIVE AND ITS IMPLEMENTATION

- It is the task of the decision maker to select the best alternative, based on the results of the analysis under taken.

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