GOOD PRACTICES GUIDE
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The Interregional Cooperation Programme INTERREG IVC, financed by the European Union’s Regional Development Fund, helps Regions of Europe work together to share experience and good practice in the areas of innovation, the knowledge economy, the environment and risk prevention. EUR 302 million is available for project funding but, more than that, a wealth of knowledge and potential solutions are also on hand for regional policy-makers.
GOOD PRACTICES GUIDE
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1. INTRODUCTION

1.1 THE WATER CoRe PROJECT

WATER CoRe is an Interreg IVC project providing an exchange platform for water scarcity and drought issues on regional and local level for all European regions. Policies and practical experiences related to management of water scarcity and droughts already exist in Europe. WATER CoRe will compile this knowledge and make it accessible for all regional and local actors in the EU in order to create their own tailor-made approaches.

The 14 partners from 7 EU Member States are committed to exchanging good practices by adapting these to their local or regional conditions. The overall objective of the project is to create tools to improve water management in all regions of Europe. In addition, the partners wish to raise the awareness of inhabitants and stakeholders in partner regions about the water saving potential. The thematic working groups cover various topics such as the demand-side of water management, handling drought periods, climate change effects, public awareness and participation.

The project will result in a digital exchange platform, a good practice handbook, a survey specifying the opportunities to exchange good practices within the partnership, regional action plans to transfer experiences between regions, an e-learning programme with thematic modules as well as policy recommendations (see Fig. 1.1). Special attention will be given to regions in Central and Eastern Europe by establishing a focal point on water scarcity and droughts in Hungary.

![Figure 1.1: Workflow and products of the WATER CoRe project](image)

WATER CoRe leads to improved water scarcity and drought management policies and instruments in all partner regions. Regional politicians of the partner regions have underlined their commitment to this project in a Memorandum of Understanding. Via the project homepage the results are accessible also to other European regions.
1.2 THE WATER CoRe GUIDE

The WATER CoRe Guide focuses on practical solutions for dealing with water scarcity and drought in Europe. Solutions are grouped in five main themes:

- Water demand side management (technical)
- Water demand side management (economic/financial)
- Drought management
- Adaptation to climate change
- Communication and participation

Within these themes, the solutions are presented as general concepts, applicable throughout Europe. The concepts are illustrated by good practices from the WATER CoRe partners (see Fig 1.2).

My problem has to do with...

Water demand side management (technical)
- Management and planning
- Water saving
- Efficient and sustainable irrigation
- Leakage reduction
- Networking, metering and monitoring
- Water reuse

Water demand side management (economic)
- Stimulating water efficiency
- Strengthening economic values
- Taxing and pricing

Drought management
- Concept 1
- Concept 2
- Concept...

Adaptation to climate change
- Forecasting and modelling
- Adaptation strategies
- Mitigation strategies
- Implementation and governance

Communication and participation
- Awareness raising and education
- Dissemination of information
- Public and stakeholder involvement

So my solution may be...

And good examples are...

Good practices of the Water CoRe partners

Figure 1.2: Structure of the WATER CoRe Guide

The Guide is written for professionals, working for (regional) governments, water authorities, consultants or non-governmental organisations (NGO’s). It may also be valuable for students and scholars in water management, (spatial) planning, governance and sustainable development and policy makers on the European level.

1.3 STRATEGIES FOR PREVENTION AND MITIGATION OF WATER SCARCITY AND DROUGHTS

Regarding the impacts of water scarcity and drought, it becomes clear that actions have to be taken to mitigate the impact of water scarcity and droughts. This guide focuses on the strategies which are covered by the experience of the WATER CoRe project partners. Many of these strategies were implemented as a reaction on a pressing local issue. Therefore, the good practices are developed under the consideration of local conditions. Due to the broad spectrum of possibilities, the good practices of the WATER CoRe community do not cover all existing measures to tackle water scarcity and droughts. To get information about strategies beyond WATER CoRe, the project partners carry out a complementary survey on the water scarcity and drought issue in Europe. It is planned to incorporate this broader view on our information platform of the project, the WATER CoRe E-Learning module (see chapter 9.2).
2. WATER SCARCITY AND DROUGHTS – WHAT IS BEHIND ALL THIS?

2.1 TERMS AND DEFINITIONS

Water scarcity and drought – These are two terms which are often named in the same breath – and sometimes treated as synonyms. Nonetheless, they describe different issues:

Within this guide, water scarcity is understood as “a situation of long-term water imbalance, caused by water demand exceeding the level of water resources available” (EUC 2007a). It is therefore not only a natural phenomenon but a coincidence of natural and socio-economic factors in the affected region. Although this definition is widely used within the EU, RJSBERMAN (2004: 1) points out “that there is no commonly accepted definition of water scarcity”. The same obtains for the differentiation to other terms like ‘water shortage’ and ‘water stress’: in many publications (e.g. of the European Commission and the EEA), ‘water scarcity’ and ‘water stress’ are used synonymously, while several authors differentiate between both terms. For example, FALKENMARK et al. (1989) provides for the ‘Falkenmark-index’ a quite differenting definition of water scarcity: They distinguish between ‘water stress’, when water resources in a country per capita per year are below 1700 m³, ‘water scarcity’ when the supply is below 1000 m³ and ‘absolute scarcity’ when below 500 m³. With this definition, the balance of water availability and water demand is not taken into account and water stress is less severe than water scarcity.

Of course, the definition given above fails to give an answer to an important question (RJSBERMAN 2004): Did an observed water scarcity occur because a very high demand exceeds high water availability (demand problem) or did the scarcity occur when low water availability cannot satisfy even a moderate demand (supply problem)?

Droughts are caused by temporary decrease in water availability, usually due to rainfall deficiency, often in combination with high air temperatures and evapotranspiration rates (EUC 2007a). Meteorological preconditions for droughts are resulting from global weather patterns, compressional warming (high pressure), local conditions, e.g. mountain barriers, the absence of rainmaking disturbances and/or the absence of humid airstreams (EUC 2006a). In contrast to water scarcity, droughts are no long-term conditions but a temporal event (although the time span of droughts is variable). Furthermore, the definition shows that droughts are a natural phenomenon, although its severe and spatial distribution may increase due to impacts of man-made climate change. It is common to distinguish between “meteorological drought” (as expression for precipitation deficit), “hydrological drought” (when deficits in surface and subsurface water supply occurs), “agricultural drought” (when soil moisture in the root zone is below the demand of the crop) as well as “socio-economic drought” (“when the demand for an economic good exceeds supply as a result of a weather-related shortfall in water supply”; EUC 2006a: 13). Although these definitions are quite common, HEIM (2002) announces a great disagreement also for drought definitions.

The availability of freshwater is crucial for all fields of human life (household, industry, agriculture) and, of course, for animals and plants. The very origin of usable freshwater is rain or, in some cases, juvenile groundwater. Rainwater feeds the hydrological storages of the landscape (groundwater, soil, rivers, lakes, glaciers and wetlands) where it is available to be used for different purposes. In regions with very low precipitation, the use of groundwater or of water from allochthonous rivers is necessary. For human use, not only the existence of water is important but also the access: For instance, the using of groundwater requires at least the idea of its existence and the ability to construct a proper well. Therefore, the availability of physical existing water may be hampered due to the technical reasons. Furthermore, limitations in water quality (pollution) may restrain the factual availability.

According to the International Glossary of Hydrology (IHP/OHP 1998), water demand is the “actual quantity of water required for various needs over a given period as conditioned by economic, social and other factors”. These various needs can be divided in four sectors: agriculture, industry, public water supply and energy production.

AGRICULTURE: water is crucial for agricultural production. The water demand for additional irrigation depends on climate factors, the efficiency of irrigation (loss due evaporation, leakage etc.) and the crop. Especially crops that are not adapted to the climate of the particular region may lead to excessive water needs for irrigation. Because of pathogenic organisms and harmful substances (e.g. heavy metals), water for irrigation should fulfil a minimum of quality requirements.

INDUSTRY: The industry demands water as process water, where it supports the manufacturing or treatment process. This implies the usage of water for washing, transport and cooling processes but also as component of the product. The latter is of particular importance in food and beverage production.

PUBLIC WATER SUPPLY: Public water supply implies the demand of households (normally also public buildings and public infrastructure as well as, in some cases, small industries) for drinking and washing purpose, but also for garden watering and comparable purposes. For public water supply, it should meet drinking water quality, except for the use of rainwater in gardening and toilet flush.
ENERGY PRODUCTION: Power plants (especially coal and nuclear plants) need water for cooling purposes and – in closed circuits – for heat transport. The cooling water is taken from rivers. All over Europe, 44% of the total freshwater abstraction is related to energy production purpose (EEA 2009a). A small part (up to 1-5%) of the abstracted water evaporates in cooling towers; the rest is redirected back into the river.

For the example of Europe, Fig. 2.1 shows the division of freshwater abstraction to sectors. Between the European countries, a broad variety of percentages exists. For example, the focus on water abstraction for manufacturing industry, energy production and public water supply lies on the Western Europe countries, while water abstraction for agriculture irrigation is mainly conducted by the countries of Southern Europe.

Together with climate factors, the water demand is the driving force which puts pressure on the water resources of a region. The demand depends on demographic and economical factors.

DEMOGRAPHIC FACTORS: Population development is a control factor of water demand, especially regarding the public water supply.

Generally, the water demand increases with population growth. Related to the area, the drinking water demand of urban regions is therefore higher than the water demand of rural areas. But not only the total population and the spatial distribution of population but also structural demographic factors play an important role: The size of households effects the water consumption per capita: Some kind of water consumption, like car washing, laundry and garden watering, are tied more closely to the household than to the individual. Therefore, the water consumption per capita decreases with household size. Furthermore, water saving measures are more effective in larger households (EEA 2009a). In Europe, there is a general trend of smaller households (single households, less children per couple, more single parents, less generations per household), especially in urban regions. Within the EU-15 member states, the average number of people per household decreased from 2.8 [1981/82] over 2.4 [2002; EUROSTAT 2004] to 2.3 (2007; EUROSTAT 2010).

ECONOMICAL FACTORS: Beside population development, water demand is mainly controlled by economical factors. Important is the proportion between the agricultural sector, industry and tertiary sector. The decrease of water use in industries such as steel production, may lead to a decrease of water abstraction.
2.2 IMPACTS OF WATER SCARCITY AND DROUGHTS

Droughts are often referred to as natural disasters, because they may cause severe impacts on natural resources, socio-economic stability and human well-being. As shown in Fig. 2.2, water scarcity can be a consequence of droughts. Therefore, droughts may increase the impact of water scarcity. Although some of the impacts of water scarcity on one hand and droughts on the other are partly comparable (especially regarding the impact on environment), they may occur in different time scales and intensities.

The water deficit and therefore reduced availability during short term droughts or long term water scarcity may affect the water storage compartments of the landscape: These are the soil, groundwater, rivers, lakes and wetlands.

A very sensitive and mutable storage compartment is the upper soil. It is exposed to evaporation as well as the extraction by plants. A decrease of soil water content may lead to a reduced plant growth or to a hampered development of fruits, blossom etc. At the worst, the soil moisture can decrease down to the permanent wilting point, which leads to the dieback of the plant. In agriculture, water stress may increase the water demand for irrigation, meaning that the farmers are confronted with either higher water costs or crop failure.

The discharge of rivers will decrease when the inflow from runoff water and ground water stops. Under normal conditions, the groundwater-fed inflow (base flow) assures a minimum channel flow even during drought events, but headwaters in particular may temporarily run dry. Low water events may cause problems to water organism. The temperature of the residual water increases faster. This may lead to a reduced oxygen concentration, which can be lethal for fishes.

The discharge of cooling water from power plants may lead to critical thermal loads. Shutdown or reductions of output decrease the thermal load but may lead to increasing prices for electricity. At the same time, the demand for electricity increases due to the higher consumption e.g. from refrigerators and air condition. Although several power plants in Europe were affected during the heat wave in 2003, no overall shortages took place, but regional power outages were reported from Italy in June [FINK et al. 2004]. Furthermore, low water levels increase the concentration of pollutants in the residual water. Organic pollution contributes to further oxygen reduction.

Shipping traffic may be hampered due to low water level: This leads to economic losses for shipping enterprises. The transport of goods may partly relocate on rail or road. Therefore, low water levels that hamper shipping cause indirect ecological damages due to increasing emissions [VON HAUFF & KLUHT 2003].

The sensitivity of lakes, ponds and wetlands depends on its water supply (rain, groundwater, rivers), withdrawals and local conditions (depth; percolation into the underground…). Especially rain-fed ponds may fall dry soon after a rain event and without linkage to drought or water scarcity.
The groundwater level falls when the capillary rise (evaporation), consumption by plants and groundwater runoff exceeds the groundwater recharge. In comparison with soil water content, this is a long-term process. Therefore, short drought events may be compensated without severe groundwater rising. Because forests are mainly supplied by groundwater and therefore less vulnerable to temporal dry spells, forest damages may occur when long-term water scarcity affects groundwater level. Low groundwater level may also reduce the baseflow which can aggravate low water situation in river systems during a drought event.

In coastal regions, groundwater exploitation may lead to the intrusion of seawater and therefore to groundwater salinisation. In Europe, this issue affects mainly the Mediterranean regions but also the Netherlands and Denmark.

Forest fires may occur with focus on the Mediterranean region, but also in Central Europe. In general, forest fires are part of the natural ecosystems, but its frequency increased dramatically within the last decades due to negligence or arson. Today, only 1% of forest fires in the Mediterranean region are caused by lightning (MPI AG Feuerökologie). During drought events, high temperatures and low moisture encourages the initialisation and spreading of forest fires. Forest fires may lead to loss of biodiversity, erosion and desertification. Due to the loss of interception capacity and because burnt areas tend to water repellence of the soil surface (e.g. FOX et al. 2007), areas affected from forest fires normally provide higher runoff ratios than intact forests. Furthermore, forest fires may cause severe economical losses for the forestry. During the heat wave over large areas of Europe in 2003, 25,000 forest fires burned altogether about 650,000 ha of forest (UNEP 2004).

2.3 WATER SCARCITY AND DROUGHTS: A CONCERN FOR EUROPE?

Water scarcity is a worldwide problem: In less developed countries, water is the limiting factor for crop production and, therefore, for food supply. In these countries, population growth, an increasing water consumption goods, an anticipated reduction of groundwater recharge in semiarid areas due to climate change and water pollution will enhance the challenges for sufficient water supply (TEUTSCH & KRUEGER 2010). Worldwide, severe conflicts on water, desertification, crop failures and deficit on clean freshwater take place. Focussing Europe as a whole, the dimension of these problems seems to be relatively minor. Therefore, the question may arise why water scarcity and drought is stressed out as a European issue. Taking a look on a map showing the Water Exploitation Index (WEI)1 of Europe around the year 2000, the reason for this becomes more obvious: A large area of Europe has to deal with medium or severe water scarcity. The focus of severe water scarcity lies in Southern Europe, which is part of the Circum–Mediterranean region. Here, a growing water demand mainly for agriculture and tourism has to deal with relative scarce water resources. The Circum-Mediterranean region is identified as one of the most exposed regions in the world to water scarcity (TEUTSCH & KRUEGER 2010). Although only a relatively small part of Europe belongs to this region, the northern coastline of the Mediterranean Sea completely belongs to Europe. This shows the potential impact of Europe on the region but also its involvement in Mediterranean issues. A big quantity of the agricultural products of Southern Europe is produced for the Western and Central European market and therefore transported as “virtual water”. Furthermore, Southern Europe is a favoured travel destination for the rest of Europe which leads to the fast development of the extremely water consuming tourist sector (the water usage of tourists can be on average over four times as much water per day as a local resident; EUC 2010a). Therefore, Europe as a whole is responsible for the excessive water demand in the Mediterranean region. Counteractive measures to mitigate the impact of water scarcity and droughts have to be taken immediately.

Several dry spells in the past, for example in 2003, in 2007 and, recently in the spring of 2011 also show the concerns of Western and Central European countries. The examples mentioned above show that the impact of such dry spells may cause severe ecological damages and economical losses even in Europe’s humid climates. The map of the water exploitation index (Fig. 2.3) shows that not only Southern Europe but also some parts of Western and Central Europe are currently facing water stress. This is not mainly due to climate circumstances but also to high water demand, especially for power plant cooling purposes. Considering the possible impacts of climate change, the further rising demand for water (EUC 2010) and an increasing vulnerability due to e.g. land use change (e.g. TURNER et al. 2003) water scarcity and droughts become also an issue not only in Southern Europe but also in other parts of Europe. Therefore, precaution measures have to be taken to prevent a further worsening.

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1 The WEI “is calculated annually as the ratio of total freshwater abstraction to the total renewable resource” (EAA 2009a: 17)
2.4 EU-POLICY ON WATER SCARCITY AND DROUGHTS

The awareness of the need to take actions regarding water scarcity and droughts became part of the European environmental policy. This progress was additionally reinforced by the IPCC Fourth Assessment Report, which directs people's (and therefore policies) attention towards the climate change issue. A first specific step for a common European policy regarding water scarcity and droughts was the Communication from the Commission to the European Parliament and the Council: “Addressing the challenge of water scarcity and droughts in the European Union” (EUC 2007). Two follow-up reports were published short after the Communication (EUC 2008, 2010a) to show both progress and weaknesses. In the second follow-up report (EUC 2010a), it is highlighted that the priorities of the Communication (EUC 2007) remain valid and that much more effort is needed. A main concern is the delay in implementation of the Water Framework Directive in some Member States which are most affected by water scarcity (EUC 2010a).

According to this communication, water scarcity and droughts became one of the priorities of EU regional policy in the period 2007-2013. The communication focuses on seven policy recommendations:
1. **Putting the right price tag on water**: The use of market-based instruments with a focus on the “user pays” principle is declared an important strategy of EU policy. Therefore, the Water Framework Directive (WFD) offers opportunities to implement market-based instruments. According to the communication, this potential is not exhausted so far, although the second Follow-up report (EUC 2010a) indicates a high level of metering domestic water supply and an increasing level of legal metering non-domestic water use, for instance the metering of groundwater extractions in some southern European river basins.

2. **Allocating water and water related funding more efficiently**: These tasks aim at an improved land-use planning and on financing water efficiency (European funds and State aids to improve technologies/infrastructures which improve water efficiency). The Common Agricultural Policy (CAP) is an important instrument to implement water saving measures within the rural development policy. From 2010, member states will have to define standards at farm level (EUC 2010a).

3. **Improving drought risk management**: In the past few years, responsive crisis management is progressively accompanied by risk management, which focuses on prevention. Analogue to flood prevention strategies, the EU recommends the implementation of drought risk management plans. An operational European Drought Observatory and early warning system should set up for implementation by 2012. By now, the prototype of the European Drought Observatory (EDO) is launched online (edo.jrc.ec.europa.eu). Furthermore, several member states have already implemented drought monitoring, e.g. Spain, Italy, Poland, Austria, Portugal and the United Kingdoms (EUC 2010a). To facilitate the exchange of information, the EEA intends to implement a European Water Scarcity and Drought Network (EAA 2009).

4. **Considering additional water supply infrastructures**: As common in flood protection planning, the Commission focuses a strategy which accounts for the “water hierarchy” also in the framework of drought risk management. That means, that “additional water supply infrastructures should be considered as an option [only] when other [preventative] options have been exhausted” (EUC 2007: 4). Due to the high heterogeneity of landscape, socioeconomic factors and technological standards, it is not possible to give a consistent EU-wide recommendation of best additional water supply solutions (EUC 2010a).

5. **Fostering water efficient technologies and practices**: Within Europe, water saving standards are very heterogeneous. Leaking water supply networks (in irrigation as well as in public water supply) are no exceptional cases. Therefore, the potential for implementation of water efficient technologies is still high. As a study on water efficiency on the behalf of the Commission shows, the extended Eco-design directive may allow significant water savings in households [BIO INTELLIGENCE SERVICE & CRANFIELD UNIVERSITY 2009]. Beside the domestic sector, the EU Eco-Management and Audit Scheme (EMAS) as a management tool for companies and administrations is a tool for the implementation of water-saving technologies.

6. **Fostering the emergence of a water-saving culture in Europe**: awareness-raising is a very important process in policy development. As highlighted within the second. Follow-up reports of this communication (EUC 2010a: 3), “price increase may not necessarily lead to a decrease in consumption (…), additional measures are needed to encourage efficient use of water”. Several initiatives focus on awareness rising to encourage water saving measures. One important concept for awareness-raising is the water footprint (www.waterfootprint.org; HOEKSTRA et al. 2011). The Commission is aware about the influence of the water footprint on public awareness. However, whether the water footprint concept becomes part of EU awareness rising policy or not is not decided yet (EUC 2010a). Within the European Water Partnership (EWP), the “Aquawarness” strategy aims at an efficient and sustainable water culture (www.ewp.eu/aquawarness), based on the “Water Vision for Europe 2030”, which declares 10 principles for water use in Europe.

7. **Improve knowledge and data collection**: The improvement of knowledge is an essential base for effective policy and decision making. This is not only regarding knowledge about climate and ecology but also about the effects of financial instruments and awareness rising measures. Data have to be collected in order to evaluate weaknesses and progress. Therefore, the EU aims at the dissemination and facilitation of research results on water scarcity and drought issues. In the second Follow-up report, progress in establishing the European Water Scarcity and Drought Information System (VWSIS) was reported. To encourage the research in this sector, the Communication refers to the opportunities of the Seventh Community Research Framework Programme [2007-2013].

Setting water scarcity and droughts as a priority policy issue on the political agenda has led to an increasing number of projects funded by the EU and by national resources. Beyond many others, the LIFE-Program as “the financial instrument for the environment” - established in 1992 by the European Commission - funds an increasing number of projects which deal directly or indirectly with water scarcity and droughts. An overview is given on the webpage of the DG Environment (ec.europa.eu/environment/water/quantity/good_practices.html). Furthermore, a huge number of national and transnational projects were started, for instance within the context of transboundary water management (e.g. the GLOWA Danube Project; IHP/HWRP 2008) or development aid.
The European Commission stresses out the importance of the Water Framework Directive (2000/60/EC) as the main legal base for water management in the European Union. In the framework of the Common Implementation Strategy (CIS) of the WFD, several publications highlight the synergies between WFD implementation and the fight against water scarcity and droughts. The consideration of water scarcity and drought as well as climate change leads to several guidelines, e.g. the Guidance document “River basin management in a changing climate” (EUC 2009) and the water scarcity report “Water scarcity management in the context of the WFD” (EUC 2006, 2006a). For the CIS work program 2010-2012 (EUC 2009a), expert groups for both “climate change” and “water scarcity and droughts” exist to strengthen the link between science and policy.

3. WATER DEMAND-SIDE MANAGEMENT (GENERAL)

According to the definition of the EEA – European Environment Agency the concept of water demand management generally refers to initiatives, which have the objective of satisfying existing needs for water with a smaller amount of available resources, normally through increasing the efficiency of water use. Water demand management can be considered a part of water conservation policies, which tend to be a more general concept, describing initiatives with the aim of protecting the aquatic environment and making a more rational use of water resources (Sustainable water use in Europe – Part. 2: Demand management, 2001, Environmental issue report No. 19, EEA).

Similarly, the UK Water Industry Research points out that the water demand management must refer to the implementation of policies or measures which serve to control or influence the amount of water used [UKWIR/EA, 1996, Economics of demand management – Main report and practical guidelines, UK Water Industry Research Limited, London].

Traditionally, the water demand management is opposed to water supply management, where, in compliance with a definition of the United Nations, the primary strategy to meet the demand is by increasing the supply. On the other hand, the primary objectives of demand management are to rationalise and control water use, reduce waste and increase use efficiency and equity in view of limited supplies (concepts of economic efficiency, social development, social equity, environmental protection, sustainability of water supply and services and political acceptability).

More in detail, water demand-side management refers to any measure or initiative that will result in the reduction in the expected water usage or water demand; water supply-side management contrariwise refers to any measure or initiative that will increase the capacity of a water resource or water supply system to supply water.

Finally, it is important to underline that the water demand-side management is mainly based on technological approaches (e.g. water-saving devices, water metering and monitoring, leakage reduction, recycling and reuse, etc.) and economic approaches (e.g. incentives, tariff, price elasticity, etc.).

Also education and information approaches (campaigns, user education, watersaving advices, etc.) have a relevant role.

4. WATER DEMAND-SIDE MANAGEMENT (TECHNICAL)

4.1 INTRODUCTION TO THE THEME

The management of water demand is a key issue in Europe. The common characteristic of water demand in urban areas is its relentless rise at the present moment and the projections of continuous growth over the next decades. The chief influencing factors are: population growth, the higher standards of livings, demographic structure and the possible effects of climate change.

With awareness of having limited resources, it is understood that the key towards sustainability lies in the sound management of the existing water supplies.

According to the definition of the EEA – European Environment Agency, sustainability must seek to balance the water available at any particular point in time and space with the demand for water for various ‘uses’, and the need for enough water to safeguard human health and the aquatic ecosystem. Underpinning this, the water available must be of sufficient quality to satisfy the different users of water including again safeguarding human and other life. Measures may be used to increase availability of water (e.g. construction of reservoirs and leakage control) and/or control and decrease the demand for water (e.g. charging for water and metering).

In water demand-side management, measures are developed so that the existing water resources and infrastructure can be optimised, and also to encourage customers to use water efficiently. This double approach leads to economic, environmental and social benefits.
The technological measures of water demand-side management can be ranked into different typologies. Generally they focus on alternative sources to freshwater, recycling treated wastewater, efficiency of distribution network, leakage reduction, water saving equipment, consumption metering and reuse systems.

The main solutions achieved by the water demand-side management technological approach are shown in synthesis in the following table.

### 4.2 SELECTION OF CONCEPTS

According to the Environment European Agency, the appropriateness of measures is very much dependent on the kind of water use and the specific conditions of the water supply system. Normally, demand-side management programs are a combination of various measures, comprising, for example, structural and non-structural measures or targeting various entities within the water supply system simultaneously (e.g. supply agency and end-users).

One type of general measure and five types of technological measures can be distinguished:

**GENERAL TYPE**

- **MANAGEMENT AND PLANNING**

  Management and planning are key aspects of a successful water demand-side management strategy. This means understanding if there are restrictions, analyzing how much water is used, when, by whom, for what purpose and at what level of efficiency; determining the potential reduction in water use that can occur through improvements to water-using equipment and behavior and developing programs to achieve these improvements.

**TECHNOLOGICAL TYPES**

- **WATER SAVING**

  Water saving in urban areas and in the industry sector is considered a focal point in Member States policies to avoid water scarcity. The use of modern water saving devices can smoothly improve water consumption above all in the domestic sector.

- **EFFICIENT AND SUSTAINABLE IRRIGATION**

  Significant savings can be expected in the agricultural sector as a result of technological improvements, changes in farm practices, use of more drought-resistant crops or reuse of treated effluent.

- **LEAKAGE REDUCTION**

  Losses of water in the distribution network can reach high percentages of the volume introduced. On this basis leakage reduction can significantly contribute to the efficiency of any water management policy.
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1. Management and Planning

   - Recycling for a variety of uses
   - Reduction of production requirements

2. Water Saving

   - Localisation and repair of leaks
   - Pressure reduction

3. Water Reuse

   - Encouraging use of water-saving devices
   - Efficient irrigation systems
   - Alternative industrial processes
   - Metering and/or measuring water use/consumption
   - Recycling of used water for other uses

4. Leakage Reduction

5. Efficient Irrigation

6. Metering

These five technological themes fit very well with the main technological measures indicated by the water demand-side management principles. Moreover, the wide management and planning topic enhances the meaning of these measures.

4.3 DESCRIPTION OF CONCEPTS

4.3.1 MANAGEMENT AND PLANNING

According to the Environment European Agency (Fig. 4.1), the past efforts to satisfy the increasing demand have often been expended principally on increasing the supply of resources, which were available abundantly and at relatively low cost. However, the relationship between water consumption and water availability has turned into a major stress factor in the exploitation of water resources in Europe. Therefore, it is logical that the investigation of sustainable water use concentrates increasingly on the possibilities of influencing water demand in a way which is favourable for the environment.

Many pressures afflict water resources: from agriculture, industry, urban areas, households and tourism, and sometimes from natural variability in water availability (rainfall) and climate changes. Moreover, recent history demonstrated that extreme hydrological events, such as floods and drought, can create additional stress on water supplies essential for human and ecosystem health.

All these driving forces on the need for water are intimately linked with local, regional, national and international water management policies. The prudent and efficient use of water is thus an important issue in Europe and so many management and planning policies are in use or formulated to ensure the sustainable use of water in the long term.

Figure 4.1: Water resources in Europe
(Source: EEA, Map 5.1 Europe’s Environment - The Dobris Assessment)
Some examples of planning and management tools are shown in the Handbook, such as: the implementation of action plans on the river basin level or the regional one (Hessen, A1-1; Lower Tisza, A1-28; REC, A1-31; Covasna, A1-33); the implementation and the application of specific guidelines (Hessen, A1-2); the development of management and operational programs (Lower Tisza, A1-29) and the support to the public regional service companies (REC, A1-30).

The purpose of the Groundwater Management Plan Hessian Reed (A1) is to ensure the regional water supply and to avoid ecological damages in South Hesse. User specific requirements for the groundwater level pertaining to forestry, nature conservation, agriculture and residential areas are given. The standards of the management plan are implemented in all proceedings dealing with groundwater abstractions.

The Guidelines for the Vogelsberg Area, an area of volcanic origin (A 2) have the same goal as the groundwater management plan. It focuses particularly on the preservation of wetlands.

The constitution of specific regional and/or national apparatus (Aragonese Institute of Water, A1-5) can help in the decision making linked to the water management. Also the planning of sustainable development actions (Lower Tisza, A1-27) represents a general measure to the water resources management.

4.3.2 WATER SAVING

With regard to the urban sector, the Environment European Agency states that higher standards of living are changing water demand patterns. This is reflected mainly in increased domestic water use, especially for personal hygiene. Most of the European population have indoor toilets, showers and/or baths for daily use. The result is that most of the urban water consumption is for domestic use. The water used in households is mostly for toilet flushing (33%) and bathing/showering (20-32%). The lowest percentage of domestic use is for drinking and cooking (3%).

The use of water-saving devices, such as reduced volume toilet flushes in households (Fig. 4.2), can achieve savings of around 50% (see Handbook - Emilia-Romagna, A1-6, A1-7, A1-9, A1-12). The overall savings of water would depend on the proportion of household water demand in total urban demand and on how widespread is the use of such devices.

In order to have a reduction of domestic water consumption, many projects foresaw for example the free delivery of a domestic water saving kit composed of faucet aerators for house taps and showers. These are the smallest devices which, by raising the percentage of oxygen present in the running water, reduce its flow, increasing at the same time the hygienic-sanitary return.

![Faucet aerators](image)

Figure 4.2: Faucet aerators (© Regione Emilia-Romagna A.I.U.S.G. - Iviana Banzi)

In the industrial sector, the best strategies concern the modernisation and/or the substitution of industrial processes through e.g. the reduction of the water introduced and successively re-emitted in the surface water bodies, in addition to the reduction in quantities of wastewaters both organic and watery produced. (Emilia-Romagna, A1-8).

The industrial water demand management policy should include the use of economic instruments for pollution control and technological changes. The policy should also recommend using public education as a way to increase understanding about water scarcity.
4.3.3 EFFICIENT AND SUSTAINABLE IRRIGATION

The main agricultural water use is linked to irrigation, with minor use by livestock-farming and fish-farming. In the Mediterranean countries, there are often national and regional policies to encourage the modernisation or substitution of traditional irrigation methods.

The research on irrigation water saving has been devoted to crops, such as: response to irrigation, deficit irrigation, regulated deficit irrigation and partial rootzone drying, irrigation scheduling, sustainable irrigation management, assessment of the plant growth parameters, impact of irrigation regimes on product quality, development of models and Decision Support Systems, development of Crop Water Stress Index (infrared thermometry), studies on the sustainability of water reuse, test of irrigation technologies and design of irrigation systems, water treatments in constructed wetland at the farm scale. These activities brought to the identification and validation of the crucial parameters needed to calculate the optimal crop water requirements. (Emilia-Romagna, A1-19).

These strategies include plans to increase the size of properties to allow not only the introduction of modern irrigation techniques, but also the adoption of new, and sometimes experimental and/or pilot irrigation systems and specific technological tools, as irrigation software and internet facilities.

Software like EMR (Aragonese Institute of Water, A1-4, A1-37), created specifically to evaluate the environmental and agricultural needs in irrigation, enable to run daily water balances and quantify pollutants in the drainage (salts, nitrates and major ions). Depending on the results, it is possible to assess the irrigation quality and its agri-environmental impact in the time period defined by the user. Through this simple water balance in the soil, the software quantifies the water needs and evaluates the irrigation quality. The agri-environmental impact is quantified for all irrigation from water usage rates and salt and nitrate pollution.

Other software, like IRRINET, (Emilia-Romagna, A1-17) provides an irrigation advice for the main water demanding crops, combining several data sources: meteorological data, soil data, crop parameters including the application of the most effective irrigation strategy for every crop considered. The crop water balance is calculated at daily step and at field scale according to the geographical position (GIS) and to the crop characteristic, simulated or inputted by the farmer. The service provides the users with the optimal irrigation volume and timing, via web or mobile phone text message (Emilia-Romagna, A1-16, A1-21, A1-22, A1-23, A1-24).

It’s also important to combine the irrigation topics with the climate factor, through software tools, research systems and other innovative facilities (ARPA, A1-25, A1-26; Romania, A1-32; Noord-Brabant, A1-34).

4.3.4 LEAKAGE REDUCTION

Utilities can no longer tolerate inefficiencies in water distribution systems (Fig. 4.3) and the resulting loss of revenue associated with underground water system leakage. Increases in pumping, treatment and operational costs make these losses prohibitive.

Losses in water distribution networks can reach high percentages of the volume introduced. Real losses consist of leakage and overflows from transmission and distribution systems up to the point of customer metering or consumption. Thus leakage reduction through preventive maintenance and network renewal is one of the main elements of any efficient water management policies.

Reduction of non-revenue water and water loss is of critical importance. This can be achieved through investment in leak detection and repair programs and replacement of old transmission and distribution pipelines.

The implementation of modern leakage control and pipes rapier systems, like pressure control systems, can be a support to control and to manage this kind of problem.

To combat water loss, many researches are under development to detect, locate and correct leaks.

The projects: “Active leakage control and pipes repair” (Emilia-Romagna, A1-10), “District Meter Areas” (Emilia-Romagna, A1-13) and “Pressure control” (Emilia-Romagna, A1-14) are examples for combining efficient water management with leaks detection.

The aim of these projects is water losses reduction by active leak control and pipes repair in water distribution system. In fact, some of the factors contributing to leakage are old and poorly constructed pipelines, inadequate corrosion protection, poorly maintained valves and mechanical damage.
4.3.5 NETWORKING, METERING AND MONITORING

For effective planning, allocation and management of water resources for urban, irrigation, commercial and environmental purposes, it is necessary to have a clear picture of water use patterns.

Every action on networking, metering and monitoring of water use is crucial for an efficient water use and to promote a general water saving policy in all sectors.

In the following examples for the implementation of the network, meter and monitor parameters of water use in different sectors are given.

The area in the south of Hessen [the region between the RIVERS Rhine, Main and Neckar] and especially the Hessian Reed is a region where different stakeholders have an interest in the use of groundwater.

Main sectors that are competing for the limited groundwater resources are public water supply, industrial water demand and agricultural irrigation.

Whereas in the public and industrial sector the water consumption is precisely known because of measuring by water meters, there is a large uncertainty about the exact amount of water used for agricultural irrigation. This is due to the fact that usually the groundwater consumption for irrigation is not measured by water meters but other methods which are less precise and reliable. In the Hessian Reed exist nearly 2000 of such wells spread over the whole area. In this context the Regierungspräsidium Darmstadt as the granting and supervisory authority of the water rights and certain farmer-organisations discussed for some years to establish an objective, easy to verify, sufficiently accurate and easily accessible method for recording the amount of extracted groundwater used for irrigation. As a result it was clarified that besides water meters only one alternative recording method can at present potentially fulfil all these conditions: recording the water amounts by means of using the counters of the pump units that supply the irrigation devices and that indicate the operating-hours (Hessen, A1-3).

The “X-water Project Automatic Meter Reading” (Emilia-Romagna, A1-1) is a project which aims to provide guidance on the support offered by Automatic Meter Reading systems in the control of water losses. In order to water demand-side management, the AMR systems allow the application of incentives/disincentives to the water tariff based on knowledge of the actual bands of water consumption.
The project aims to provide indications regarding the applicability of distance reading for the identification of physical leaks in the network. Through continuous control of the district’s water balance (synchronous detection of volumes introduced into the system and supplied to customers) it is possible to detect water losses in a timely manner and launch research and repair activity, thus reducing lost volume.

The water, gas and district heating “Regional Network and Plant Remote Control Centre” (Emilia-Romagna A1-15) situated in Forlì, represents a new frontier in remote control and is an example of excellent resource at the service of the local area and the general public with the emphasis on security.

Hera Group serves a population of 1.2 million of users and a water volume supplied of 257*106 m³ [2009] by means 319 treatment plants and 30.849 km of pipeline. The Regional Network and Plant Remote Control Centre is the largest centre in Italy in terms of number of services and remote controlled points, and one of the largest in Europe.

Capillary rise from shallow water table is an important input to the crop water balance. To assess the crop water requirement satisfied daily by capillary rise, a Shallow Water Table Monitoring Network has been set up. (Emilia-Romagna A1-20). In this case the network has been composed by 142 stations located in key areas representative of an irrigation district, identified by means of pedologic studies and analysis. The collected data are organised in a regional data base, analysed, processed and provided daily to the Extension Services in order to calculate the capillary rise contribution to the crop water balance at field scale. The fast and effective use of the collected data, the wide diffusion and the strong link with the irrigation web services are the main success factors.

The savings from the introduction of revenue-neutral metering are estimated to be about 10%-25% of consumption. The introduction of metering is usually accompanied by a revised charging system and regulations on leakage.

4.3.6 WATER REUSE

To meet the growing industrial water demands, industries are encouraged to recycle water within the industrial facility. They should reuse treated wastewater in the industrial process wherever possible and adopt technology that uses less quantities of water for the same industrial product.

Water reuse mainly means the direct supply of treated effluent from the treatment plant to the user, e.g. industry and agriculture. It can be also applied to the recharge of an aquifer.

The EU Commission estimates that water reuse can contribute to reduce up to 13% of the irrigation ground and surface water withdrawal. Direct or indirect water reuse involves several aspects: contamination by faecal, inorganic and xenobiotic pollutants; high levels of suspended solids and salinity; rational use of the dissolved nutrients (particularly nitrogen). The challenge is to apply new strategies and technologies which allow to use the lowest irrigation water quality without harming either food safety, or yield and fruit or derivatives quality.

The EU project SAFIR was aimed to help farmers solve problems with low quality water and decreased access to water. New water treatment devices were developed to allow a safe use of waste water produced by small communities/industries (≤10,000 EI) or of treated water discharged into irrigation canals. Water treatment technologies are coupled with irrigation strategies and technologies to obtain a flexible, easy to use, integrated management.

The innovative technologies were found able to produce safe, high quality water for irrigation treating primary waste water or tomato derivatives. Applying the proposed treatment pathways both faecal and heavy metal contamination can be controlled avoiding accumulation of pollutants in soils or along the food chain. (Emilia-Romagna, A1-18)
The project “Cascade delivery of waste water” (Noord-Brabant, A1-35) on the other hand shows that innovative combinations between factories can be made, in using the residuals (i.e. energy, water) of the others in a cost effective way.

Under the general “water reuse” meaning, also the rainwater harvesting can be included (Fig. 4.4 and 4.5). The experience “Investigation program on opportunity for the recovering of rain water under the Mediterranean climate” (Hérault, A1-36) is a demonstration for an economic and technical survey which consists in supplying operational and detailed information on rain water recovering under the Mediterranean climate.

4.4 CONNECTION WITH OTHER THEMES

The application of technological measures and its “success” is strongly related to the simultaneous application of economic and financial instruments (chapter 5) and communication tools (chapter 8).

A huge number of international experiences on water demand-side management demonstrates that durable and stable results can be obtained only applying technological, economic and communication measures simultaneously, while the application of only one of them can give short-lived and uncertain results.

In this sense, the connection of technological measures to the climate change topic is unavoidable, because of its involvement in all sectors, such as agriculture, industry, urban and civil systems, and so on.

5 WATER DEMAND-SIDE MANAGEMENT (ECONOMIC)

5.1 INTRODUCTION TO THE THEME

Economic and financial instruments focus on water demand-side management through monetary mechanisms. By applying instruments, actions of stakeholders may result in either profit or loss.

As with all other products, the ‘economy of water’ is based on a balance between supply and demand (Fig 5.1). On a free market - without intervention - a disturbed balance should lead to a rise (more demand than supply) or fall (more supply than demand) of prices. In practice however, the ‘water market’ is strictly regulated, locking these economic mechanisms. This of course is a sensible thing to do, as access to good quality water is a primary necessity of life. In situation of severe drought – when demand is much higher than the actual availability of water – this regulation works contra productive as the price of water is no incentive for water saving. By using economic and financial instruments an incentive like this can be created.

Figure 5.1: The economy of water is all about balancing supply and demand
Key issue is to get people acting. To get people acting, drivers must be mobilised. These drivers can be either external or internal (see Fig. 5.2).

External drivers are imposed by the (regional) government. They can either take the shape of laws or taxes. The perception of people of this type of measures will generally be negative. To be effective some form of enforcement is needed. External drivers are very effective and easy to implement. The effects are more or less the same for all people. They require however constant attention from the competent authorities.

Internal drivers work from a positive perspective. They offer either material (money) or immaterial rewards. The effect of this reward however is highly individual, depending on entrepreneurship or ideals. Internal drivers are more difficult to implement and require a lot of communication. In long term perspective however they are self supporting and more or less ‘maintenance free’

![Figure 5.2: Drivers for water demand-side management](image)

From an economic perspective there are two drivers that can be used for developing instruments:

- Taxing and pricing;
- Return on investment.

### 5.2 SELECTION OF CONCEPTS

Based on the two economic drivers, two types of instruments (or concepts) can be distinguished (Fig 5.3):

- Stimulating better use of water (improving return on investment);
- Steering of water demand by taxing and pricing.

A third type of instrument may be added, which focuses on increasing the value of water, thus strengthening the effect of stimulating and steering:

- Strengthening the economic value of water.

For all concepts, good practices are available from (one of) the partner regions. References to these practices refer to the factsheets in the annex.

![Figure 5.3: Economic concepts for water demand-side management](image)
5.3 DESCRIPTION OF CONCEPTS

5.3.1 STIMULATING WATER EFFICIENCY

Stimulating water efficiency may lead to lower production costs for enterprises and lower invoices for water consumers. In essence there are three types of action that can support this: disseminating knowledge, optimizing processes and (financial) support. Needless to say, a mix of these actions often provides the best results.

An effective way of using knowledge to improve efficiency is benchmarking (Hessen, A2-1). Screening industries and plants, using (economic) models may be another option for using knowledge for stimulating efficiency (Romania, A2-6). On a regional scale, evaluation of water consumption data can be used for integrated planning of water supply (Hérault, A2-11).

(Financial) support may come in the shape of investment programmes (REC, A2-5) or subsidies for process optimization (Emilia-Romagna, A2-4).

5.3.2 TAXING AND PRICING

Taxing and pricing is perhaps the most classic of economic instruments. The principle is simple, but effective. The use of water - albeit groundwater, surface water or drinking water from the tap – or the purification of waste water comes at a certain price. In a straightforward system, the price level may be linked to the coverage of expenses for investments, operation and maintenance of the water infrastructure (Aragon, A2-2). More complex systems introduce regional and variable pricing (Emilia-Romagna, A2-3 and Romania, A2-7). Another option may be to introduce taxes for specific groups of users (e.g., farmers) to encourage wise use of water resources (Noord-Brabant, A2-10).

5.3.3 STRENGTHENING ECONOMIC VALUES

It is a strange paradox that water is crucial for life while it comes at a price next to nothing. For example in the Region of Noord-Brabant (the Netherlands) the use of groundwater resources for industry and agriculture – although limited by legislation – is virtually free. A cubic metre of drinking water costs less than 1 Euro. This means there is no real incentive for water saving or optimising the use of resources. There is no great profit or loss - in terms of money - in stimulating wise use of water or taxing and pricing.

A solution to this dilemma may be to increase the value of water. In monetary term this could be raising the price of water. An artificially high price however conflicts with optimal access to water as a primary necessity of life. To raise the value as a ‘scarce good’ or ‘production factor’ may be more effective. If the availability of good quality water is the cornerstone of highly profitable enterprises (albeit agro-food industry or recreation and tourism), stakeholders become more concerned about the preservation of their valuable water resources.

One approach to this concept may be the creation of new water based enterprises, using a ‘new markets’ approach (Noord-Brabant, A2-8). In another case, the water itself becomes a valuable product (Noord-Brabant, A2-9).

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European Union
European Regional Development Fund
5.4 CONNECTION WITH OTHER THEMES

Stimulating water efficiency strongly depends on the availability of tools and techniques. Many of these instruments are described in chapter 4. The economic action of these techniques can be unlocked by temporary financial support, but also by providing knowledge (which is basically communication, see chapter 8) or governmental actions (like policies and plans).

Strengthening economic values can be an autonomous process. In practice however governmental support in the form of policies, regional development programmes or plan is necessary for initiating and upscaling initiatives.

Taxing and pricing are classic financial instruments. Their justification however should be rooted in long term (regional) ambitions and plan and supported by effective communication (chapter 8).

As for the relationship with climate change (chapter 7), all concepts should work towards a long term ambition. Coping with climate change – or in a broader sense: environmental change – therefore is part of their implementation strategy.

6. DROUGHT MANAGEMENT

6.1 INTRODUCTION TO THE THEME

Drought is a normal and usual characteristic of climate, although people tend to consider it as an unexpected and exceptional event. Drought is a temporary abnormality within the natural variability. In fact, drought by definition is a temporary and abnormal phenomenon, and not a permanent phenomenon.

Drought is notable for a temporary water deficit in relation to the normal situation. This deficit may last for an extended period of time (a season, a year, various years…). It is a relative concept, in the sense that droughts differ in extension, duration and intensity.

Droughts are generally the result of the combination of various natural factors, which for their part may be as well influenced by human activities. The principal cause of every drought is the lack of rainfall, and more specifically, the periodicity, distribution and intensity of the lack of rainfall regarding water use, demand and storage.

Figure 6.1: Evolution of quarterly total rainfalls in Spain (mm).

SECOND TRIMESTER REPORT OF THE HYDROLOGIC YEAR 2010 - 2011
(JANUARY 2011 - MARCH 2011)

Source: National Drought Observatory

Four basic concepts related to water availability must be distinguished: drought, aridity, water scarcity and desertification. These concepts overlap and are sometimes incorrectly interpreted:

- Drought: Natural, fortuitous and temporal condition that severely reduces rainfall and water availability regarding normal quantities, spanning a significant period of time and affecting a wide region;
- Aridity: Natural and permanent climatic condition that is characterized by a very low rainfall;
- Water deficit: Temporal imbalance of water resources provoked by human action;
- Water scarcity: Related to a permanent condition of imbalance between water resources and water demands in a region.
In accordance to the type of consequences, different definitions of drought exist:

- Meteorological drought. It appears when there is a continuous scarcity of rainfalls. This drought is responsible for causing the other type of droughts and it normally affects to large areas. The concept of meteorological drought is linked to a specific region, as the atmospheric conditions that produce the rainfall deficit are very variable between regions;

- Agriculture drought. It is a humidity deficit in the root area that makes it impossible to fulfill the crop’s needs in a specific moment and place. Taking into account that each crop needs a different quantity of water and that this need can vary in the same plant during it’s growing it is impossible to establish a valid threshold of agriculture scarcity even for a same geographic area;

- Water Drought. It is the diminution of superficial and ground water availabilities in a management system. It happens during a specific temporal term and regarding the average figures. It may make it impossible to satisfy all water demands.

The next graphic shows the large variability of natural regime contributions in the Ebro valley. More specifically, it shows rainfalls below the average during a large number of years.

![Figure 6.2: ANNUAL NATURAL REGIME CONTRIBUTIONS TO THE Ebro BASIN 1940-2006](source: Ebro River Hydrographic Confederation)

To tackle drought, a suitable management of water resources is needed, being the absence or the minimization of drought a consequence of a successful drought management.

The aim of drought management is to minimize environmental, economical and social impacts in eventual drought situations.
Gauge systems to monitor drought are used to manage drought. The SPI (Standardized Precipitation Index) is a type of gauge system that works by accumulating rainfall. Dry periods are those in which the SPI has values below zero.

To obtain gauge’s values in Spain there are different control points across the diverse river basins. By means of these gauge’s values, representative average values of each area can be obtained.

Methods to tackle drought may be classified into reactive and preventive.

Reactive methods consist of the implementation of measures and actions right after the beginning of drought and once drought has been perceived.

This method is normally used in emergency situations and it often offers insufficient economic and technical solutions, due to that the actions are implemented immediately and there is no time to assess optimum actions or for social participation. Some examples of these measures are the following: water restrictions for users, allowances for new ground water collection, creation of public water banks, centers to exchange water rights, taxing, improving the efficiency of existing systems, overexploitation of aquifers, use of ground water reserves, public aids to compensate for economic losses, tax benefits, etc.

Preventive methods are those measures designed in advance, counting with appropriate planning tools as well as stakeholders’ participation. This method consists of short term and long term measures, as well as monitoring measures that warn on drought conditions. A preventive method plans the necessary measures to minimize drought impacts.

Some preventive measures are: the use of new agronomic techniques to reduce water consumption, crop planning, the establishment of economic incentives for water saving, water recycling in industries, treated waste water re-use, construction of new water stocks or enlargement of existing ones, water desalinization, training activities for water saving, development of early alarm systems, implementation of a drought management plan, assurance programmes, public campaigns for water saving, etc.

According to the WFD, drought prevention strategies should include:

- First and foremost, the retrieve of the good status of aquifers in quantity and quality terms, as well as the good ecological status of rivers, lakes, wetlands; paying special attention to sensitive areas. The aim is to preserve, and even increase, the resilience of ecosystems and aquifers by maximizing their capacity on regulating and regenerating water quality;

- As second priority level, strategies on water saving, efficiency and demand management. These promote water meters installation, the implementation of taxing systems by consumption – not by hectares, building volume etc. based on cost recovery criteria (including environment and opportunity costs);

- As third priority level, strategies for the creation of new flows in drought periods. Assessment and selection of the best available technologies must be done by assuming environmental, economical and social sustainability.
6.2 SELECTION OF CONCEPTS

With the aim to ensure an efficient drought management, we could establish 3 categories of instruments or tools depending on the type of measures to carry out.

- Communication and information.
- Technological and infrastructural measures.
- Planning and management.

For all concepts, good practices are available for the partner regions. References to these practices refer to the factsheets in the annex.

6.3 DESCRIPTION OF CONCEPTS

COMMUNICATION AND INFORMATION

Information on what drought is, its effects, its monitoring, the forecast of its development and management measures for drought’s forecasting and mitigation are issues of great importance for the authorities and for the civil society in general. Knowledge of these issues enables citizens’ participation and responsibility to combat drought.

In this sense, the Drought observatories (ARPA Emilia-Romagna, B-7 and Aragon, B-11) may be framed within this concept of information and communication on drought monitoring. These observatories develop this communication to those stakeholders (governments, watershed organizations, technical experts and civil society) through web pages.

TECHNOLOGICAL AND INFRASTRUCTURAL MEASURES

For a proper water resources management, it is essential to take measures to improve the area infrastructure and to have the technological tools and techniques to cope with drought situations.

This type of technological and infrastructural measures make it possible to get a greater control and monitor the available resources and water balance, which is essential to determine: what is the suitable cultivation depending on the circumstances of each area (Emilia-Romagna, B-6), the identification of critical situations in the basin (ARPA Emilia-Romagna, B-8), at the same time, establishing a series of actions to prevent, mitigate and adapt drought conditions (Emilia-Romagna, B-5, Noord Brabant, B-11): actions with the aim of guaranteeing water supply to the population in emergency situations (Aragon, B-2), actions focused on drought mitigation at river basin level (Aragon, B-3) and actions to ensure water quality (Aragon, B-4).

PLANNING AND MANAGEMENT

A good planning and water management is the essential tool for the regulation of resources and water demands, and it could be the most effective system to prevent droughts, by means of demands control. To get this aim, it is very important to be able to anticipate the drought conditions before they happen and not overestimate the available resources.

This planning may refer to give priority to the water utilization (Noord Brabant, B-12 and B-13).

Planning can also be done with the purpose of saving water and preventing drought effects in the agricultural environment (Romania and Noord Brabant B-9, B-10).

6.4 CONNECTION WITH OTHER THEMES

Drought is a climate dependent phenomenon, therefore, its relation to climate change (chapter 7) is obvious. Along with the floods, they are two of the occasional extreme events that, due to the climate change, will become more and more frequent. This is why, water resources management during drought periods is a key part of the strategy to adapt, prevent and mitigate the climate change and its effects.

Communication and participation (see chapter 8) of drought effects on society, for both Public Service Organizations and citizens, are essential to gain an understanding of the necessary measures to mitigate the consequences of the climate change and prevent it, and thus, make the population aware of the need of water saving.

This water saving and the improved efficiency of water systems can be achieved through technological tools (see chapter 4) or through economic mechanisms such as taxes and fees (see chapter 5).
7 ADAPTATION TO CLIMATE CHANGE

7.1 INTRODUCTION TO THE THEME

Water resources and how they are managed affect almost all aspects of human society and ecosystems, such as biodiversity, agriculture and food security, human health, water supply and sanitation, settlements and infrastructure, energy, industry and economy.

Observational records and climate projections provide abundant evidence that the water resources are vulnerable and have the potential to be strongly affected by climate change, with wider-ranging consequences. Under present natural climate variability, water stress is already high in many European regions. Climate change is expected to further intensify current stresses on water resources and to magnify regional differences of Europe’s water resources. Drivers of climate change are changes in the atmospheric concentrations of greenhouse gases and aerosols, land cover and solar radiation. Most of the observed global warming since the mid-20th century is most likely due to the observed increase of anthropogenic greenhouse gas concentrations (IPPC AR4).

A wide range of water-related climate change impacts have already been observed in Europe.

Projected changes in precipitation and temperature lead to changes in runoff, water availability, water quality and water temperature. Climate change will vary regionally and will affect Europe’s regions very differently.

Climate change will pose two major water management challenges in Europe:

1. Due to the combined effects of higher temperatures and reduced mean summer precipitation, water stress and drought risk are projected to increase in southern and south-eastern Europe;
2. Due to extreme precipitation events, which are very likely to increase in frequency and intensity, flood risk is projected to increase throughout the continent.

Societies can respond to climate change by adapting to its impacts and by mitigating greenhouse gas emission. Within the WATER CoRe project the main focus is on adapting to climate change which is mainly about improving water management.

The challenge for decision- and policy-makers is to understand the projected climate change impacts and to develop and implement policies to ensure an optimal level of adaptation. Adapting to climate change through better water management requires policy shifts and significant investments. All relevant water-related sectors must contribute to adapting to climate change. This relates to participation on all levels, whether administrative, institutional, private or from the civil society. Only an integrated approach will provide successful win-win solutions and avoid negative cross-sectoral feedbacks of measures.

A schematic framework representing anthropogenic drivers, impacts and responses to climate change, and their linkages is shown in figure 7.1a.

The Fourth Assessment Report (AR4) released by the Intergovernmental Panel on Climate Change (IPPC) in 2007 is the most comprehensive and up-to-date standard scientific reference of the causes, impacts and possible response strategies to climate change.

Adaptation is defined by the IPCC as the “adjustment of natural or human systems to actual or expected climate change or its effects in order to moderate harm or exploit beneficial opportunities”

Figure 7.1a: Schematic framework representing anthropogenic drivers, impacts of and responses to climate change, and their linkages (IPCC, Fourth Assessment Report, Climate Change, 2007)
(IPCC, 2007). Even if atmospheric GHG concentrations remained at 2000 levels, the temperature increase would be about a further 0.6 °C by the end of this century relative to 1980-1999 (IPCC, 2007).

Climate change increases the vulnerability of European society to a wide range of impacts on human and natural systems, and dedicated adaptation is therefore necessary to address these unavoidable consequences by both reducing vulnerabilities and strengthening resilience. The EU has adopted a Green Paper on Adaptation (EC, 2007a) followed by a White Paper (EC, 2009a). The Adaptation White Paper supports the preparation of a comprehensive adaptation strategy at the EU level in Phase 1, 2009-2012, which then shall be implemented as of 2013 in Phase 2.

7.2 PROJECTIONS OF FUTURE CHANGES IN TEMPERATURE AND PRECIPITATION OVER EUROPE

Climate change projections of mean surface air temperature, obtained using a high number of coupled AOGCMs and different emission scenarios, show an increase in mean air temperature over Europe during the period 2011-2100, respective to 1980-1999, more intense to the end of century.

Seasonally, the largest warming is projected in northern Europe in winter and in the Mediterranean area in summer. As concern the projections of minimum and maximum temperature, minimum winter temperatures are likely to increase more than the average in northern Europe, while the maximum summer temperatures are likely to increase more than the average in southern and central Europe (IPCC, AR4, 2007). The results obtained by regional climate models (RCM) and statistical downscaling techniques (SDs) sustain these pattern of changes, with some differences concerning the magnitude.
Analysing the outputs produced by the RCM from the ENSEMBLES project, the seasonal changes projected in mean air temperature over Europe (A1B scenario), vary between 0.5 and 2.8°C, for the period 2021-2050 respective to 1961-1990. In the period 2071-2099, an increase in mean air temperature is projected in all seasons, more intense in summer when the changes could reach 5°C (Van der Linden and Mitchell, 2009).

Figure 7.2 presents the projected pattern of changes in summer mean surface air temperature over Europe under the A1B scenario, multi-model ensemble mean of RCM simulations for two periods: 2021-2050 (a) and 2071-2099 (b) respective to 1961-1990.

An increase in the 10th, 50th and 90th percentile of mean air temperature has been projected over Europe, more intense in 90th and to the end of this century (2080-2099), when the projected values of changes are between 5-11°C (www. ensembles-eu.org/).

Climate change scenarios of annual precipitation over Europe produced by the current generation of models emphasise a pattern of changes that divide Europe in two “regimes” with an increased precipitation in the north and decreased precipitation in the south, more pronounced in the Mediterranean area, during the period 2021-2050 respective to 1961-1990, scenario A1B (www.ensembles-eu.org/). As it could be noted from figure 7.3a, the projected changes in annual precipitation vary between -15% and 15%. A similar pattern of changes in annual precipitation, but more intense (between -20% and 20%), is projected for the period 2071-2099 respective to 1961-1990, scenario A1B.

Going into details at seasonal level, the largest increases in northern Europe are simulated in winter, while the largest decreases in southern Europe are simulated in summer when, to the end of the century the projections show a reducing up to 40% (Fig. 7.3b). Concerning the extreme precipitation, the outputs of climate models show that the risk of drought during summer is likely to increase in central Europe and in the Mediterranean area (IPCC, AR4, 2007).

7.3 SELECTION OF CONCEPTS

Addressing climate change requires two types of response. Firstly, we must reduce our greenhouse gas emissions by taking mitigation actions and secondly we must take adaptation action to deal with the unavoidable impacts. Both strategies are interrelated but there are differences in temporal and spatial scales. A prerequisite for the development of adaptation and mitigation measures and strategies is projecting the potential future impacts of climate change on water resources and other water-related sectors.

Scientific knowledge regarding the expected future climate change impacts can be obtained through climate change impact modelling by applying and combining assumed greenhouse gas emission scenarios, general circulation models, regional climate models or downsampling techniques as well as (e.g. water balance) impact models.
For the implementation of adaptation and mitigation strategies, existing policy frameworks on different levels of governance relating to different sectors must be taken into account. The adaptation and mitigation strategies should be integrated into broader development strategies and policies.

For all concepts, shown in Fig. 7.4, good practices are available from the partner regions. References to these practices refer to the factsheets in the annex.

Table 1 shows the allocation of the WATER CoRe good practices within the four concepts.
For modelling and determining the potential regional impacts of climate change on the water-sector, high resolution regional climate projections are required. At the beginning of the modelling chain [Fig. 7.5] general circulation models (GCM) are driven by emission scenarios [SRES] which are based on assumptions about the future development of greenhouse gas emissions. Because the spatial resolution of the resulting global climate projections are too coarse for application in regional impact models, the global climate projections are downscaled by regional climate models or statistical downscaling methods generating regional climate projections.

In the project “Local climate change scenarios and impacts” (ARPA, C-12) statistical downscaling techniques have been developed and high resolution climate change scenarios have been generated.

The project MODMET-2 (ARPA, C-13) generated a multi-model ensemble of calibrated seasonal climate predictions for Italy, based on the correlation between large-scale inter-annual variability and local climate variability.

The main objective of the EU CECILIA project (Romania, C-20) was to deliver a climate change impacts and vulnerability assessment in targeted areas of Central and Eastern Europe. Emphasis is given to applications of regional climate modelling studies at a resolution of 10 km for local impact studies in key sectors of the region, respectively forestry, agriculture, hydrology and air quality. The results of the crop yield growth changes influenced by climate change (especially drought conditions) and management crop systems were achieved.

The regional climate projections are used as input for regional impact modelling in order to “forecast” the potential future effects of climate change on various water-related sectors and issues, such as:

- Hydrology (Romania, C-20);
- Water-management (HMUELV, C-1; Romania, C-20);
- Runoff (HLUG, C-6, C-7);
- River hydrodynamics (HMUELV, C-1);
- Electricity production by hydro-power plants (REC, C-14);
- Groundwater (HLUG, C-3, C-4);
- Water supply in Municipalities (REC, C-15);
- Agriculture (HLUG, C-5; Romania, C-20, C-21);
- Irrigation (HLUG, C-5; ARPA, C-12);
- Forestry (Romania, C-20);
• Food production (REC, C-17; Romania, C-18);
• Air quality (Romania, C-19);
• Health (ARPA, C-13; Romania, C-20).

In the project MODMET-2 (ARPA, C-13) impacts of extreme climate events on population, environment [e.g. water resources, forests] and energy production have been evaluated.

Because of the cascade of uncertainties (Fig. 7.5) related to the modelling chain the term “forecasting” should not be understood as a precise prediction. One specific modelling chain describes only one possible future state of the world. Therefore, multi-model approaches, which take different modelling chains into account, are preferable to using the output of only one single modelling chain (HLUG, C-3). However, these multi-model approaches produce bandwidths of results which are not easy to interpret.

Whereas many research projects are dealing with the impacts of climate change on one specific field, more complex projects are realised as integrated approaches, also considering the conflicts and inter-relations between competing water-related sectors (HLUG, C-3, N-Brabant, C-25). The scale of water-related impact studies range from local to regional trans-boundary investigations (REC, C-17, Romania, C-20).

Assessing the potential regional impacts on the basis of regional impact modelling is a prerequisite for the development of adaptation strategies.

7.4.2 ADAPTATION STRATEGIES

Adaptation means anticipating the adverse effects of climate change and taking appropriate action to prevent or minimise the damage they can cause. The issue of adaptation is addressed in the IPPC WGII AR4. Adaptation strategies are needed at all levels of administration, from the local up to the international level.

Even if the world would stop emitting greenhouse gases completely, climate change will continue for decades because of the delayed effect of past emissions. The prevailing uncertainties are no excuse for not acting and waiting, early action will save on damage costs later. Therefore, there is the urgent need to start responding now. Adapting to climate change has become an indispensable complement to reducing greenhouse gas emissions (mitigation).

Because of the immanent uncertainties of climate projections, adaptation strategies should be developed as flexible or no-regret strategies. Undertaking of no-regret actions reduces adverse impacts of climate change but would also not be ill-advised if projected impacts are not materialising.

Examples of adaptation measures with regard to the water sector include using scarce water resources more efficiently, developing drought-tolerant crops, increasing irrigation efficiency, rainwater harvesting, water storage measures and water reuse [grey water recycling].

In the following, examples for the development of adaptation strategies in water-related fields are given. Issues related to the implementation of adaptation strategies and their incorporation into existing policies are discussed in section 5.3.4.

The project “AnKlG” (HLUG, C-3) aimed at the development of adaptation measures and strategies for a sustainable and integrated groundwater management addressing the already existing conflicts between agriculture, forestry, biotopes, residential areas and water supply in the Southern part of Hessen. Beside climate change there are other changes and factors, such as changes in land use (N-Brabant, C-25), the market situation for agricultural products (HLUG, C-5) and demographic development (HLUG, C-3), which affect the water sector. These factors may intensify or mitigate the situation when water-stress occurs.

Both these climate-independent factors and the prevailing uncertainties and bandwidths of the regional impact modelling results (HLUG, C-3) have to be considered for the development of adaptation strategies.

The international project “CLIVAGRI” (Romania, C-21) in which 30 partners and 28 countries were involved, aimed at the development of
adaptation strategies, recommendations and warning systems for agriculture. The project had a strong focus on exchanging information, disseminating the results and developing synergies and collaboration by establishing links with important stakeholders, the European Union, existing European networks and bodies as well as with the WMO and FAO.

“The water machine” (N-Brabant, C-23) is a sophisticated example for how spatial planning and water management can be utilised to create an attractive living environment and to increase resilience to climate change threats in suburban areas (similar to REC, C-16).

The project “Multifunctional Land Use” (N-Brabant, C-25) demonstrates how multifunctional land use (spatial planning) can be utilised as an adaptation strategy for areas with high spatial pressure by developing innovative land use combinations and increasing land use efficiency. The main objective is to analyse the competing spatial claims associated with climate relating to water, agriculture, nature and housing.

In addition to the above mentioned examples the WATER CoRe project comprises further good practices for the development of adaptation measures and strategies regarding the following water-related fields:

- Water management (N-Brabant, C-24, Romania C-20);
- Hydro-energy sector (REC, C-14);
- Urban water management (REC, C-15);
- Spatial planning (N-Brabant, C-24) and development of urban areas (REC, C-16);
- Agricultural food production (REC, C-17; Romania C-18; N-Brabant, C-24);
- Agricultural irrigation (HLUG, C-5; Aragon, C-9; C-11; N-Brabant, C-24).

Examples of adaptation measures of the good practices portfolio of the WATER CoRe project are:

- Stabilisation of groundwater levels by artificial recharge (HLUG, C-3);
- Optimising water-saving and efficient irrigation techniques (HLUG, C-3);
- Cultivation of heat resistant crops with less irrigation demand (HLUG, C-3; N-Brabant, C-24, Romania C-20);
- Redistributing and dynamic steering of groundwater-orientated abstraction rates by means of a regional water supply network (HLUG, C-3);
- Adapting (dimensioning) and expanding the regional water supply network (HLUG, C-3);
- Water saving through monitoring devices (leakage reduction) (Aragon, C-9);
- Water saving in the agricultural sector through the creation of an information platform that offers farmers daily recommendations for irrigation (Aragon, C-11);
- Adapting agricultural production by cultivating tree species with increased resistance to drought and high temperature in dry summer or cold winter (Romania, C-18);
- Stimulating self-support in fresh water supply (buffering and infiltration) and re-allocation of land use (N-Brabant, C-24).

7.4.3 MITIGATION STRATEGIES

Mitigation is defined by the IPCC as human intervention to reduce the sources or enhance the sinks of greenhouse gases. Many impacts of climate change can be reduced, delayed or avoided by mitigation.

However, the relationship between climate change mitigation measures and water is a reciprocal one. Mitigation measures can influence water resources and their management, and it is important to realise this when developing and evaluating mitigation options. On the other hand, water management policies and measures may have an influence on greenhouse gas emissions and, thus, on the sectoral mitigation measures. Interventions in the water system might be counter-productive when evaluated in terms of climate change mitigation (IPPC, Technical paper IV). For example, implementing important mitigations options such as afforestation, hydropower and bio-fuels may have positive and negative impacts on freshwater resources. The issue of mitigation is addressed in the IPCC WGIII AR4.
A wide variety of mitigation options which can be applied in different sectors are available. As mentioned earlier, the WATER CoRe project mainly focuses on adaptation to climate change. However, the WATER CoRe project comprises mitigation examples, ranging from regional programmes [HLUG, C-2] to national strategies [Aragon, C-10], [Covasna, C-22].

The “Project for Optimisation of Water & Emissions Reduction” [Aragon, C-9] is an example for combining efficient water management with mitigation. The reduction of greenhouse gas emissions is achieved through the implementation of renewable energy-based pumping devices for irrigation purposes.

The overall aim of the project “LIFE AIRAWARE” (Romania, C-19) is to build a pilot air quality monitoring and forecasting system in order to assist spatial planning decision-making, traffic management and pollution control in the Bucharest metropolitan area by predicting the environmental impact of air pollution.

Further good practices of the WATER CoRe project dealing with or comprising mitigation options are related to the following topics:

- Utilisation of hydropower (Hessen, C-1, REC, C-14);
- Utilisation of biogas (Aragon, C-8);
- Installation of heating systems using renewable energy (Romania, C-22).

### 7.4.4 IMPLEMENTATION AND GOVERNANCE

The development and implementation of successful adaptation and mitigation strategies is a complex cross-cutting issue and is often hampered by different kinds of obstacles and barriers, such as costs, uncertainties and resulting lack of commitment. Adapting to climate change requires policy shifts, institutional reforms as well as significant investments.

At the beginning there will be significant short term costs which we have to invest in limiting climate change. This will be a challenge for democratic governance; political systems will have to agree to pay the early costs to reap the long term gains.

Decision on adaptation and mitigation are taken at different governance levels and inter-relationships exist within and across each of these levels. The levels range from individual households, farmers and private firms, to national planning agencies and international agreements. Effective mitigation requires the participation of major greenhouse gas emitters globally, whereas most adaptation takes place from local to national levels [IPPC WGIII AR4].
For an adaptation strategy to be effective, it must result in climate risk being considered as a normal part of decision-making. In this context, adaptation strategies will fail if they continue in the long run to be seen separate from other aspects of strategic planning and risk management.

Adaptation strategies must be linked to and integrated with existing policies, economic plans and national strategies. Multi-sectoral [holistic] or integrated approaches addressing conflicting water interests of agriculture, industry, urban water supply, energy production and nature conservation are required. Both spatial planning and Integrated Water Resource Management (IWRM) could provide integrated frameworks for planning cost-effective and well coordinated and targeted adaptation measures.

Direct participation of stakeholders at local, regional, national and international levels and of all affected and relevant sectors is crucial, e.g. local and national government, private sector, civil society (Fig. 7.8). In particular the local level plays an important role because the local level is where concrete adaptation will take place. Adaptation strategies will only work on the ground if they fit local conditions [bottom-up approach]. On the other hand adaptation needs to be mainstreamed into EU water policies and legislation. The EU has the appropriate level to facilitate coordination and the exchange of good practices between Member States. European legislation influences decisions right down to the local level (top down-approach).

In the following, examples for the implementation of adaptation strategies and adaptive governance in water-related field are given.

- The sub-project “Impacts of climate change and adaptation strategies for the water resources management of the rivers Eder and Fulda” (Hessen, C-1) is part of the transdisciplinary regional, national and international networks of the Klimzug-project through which developed adaptation measures will be transferred into local authorities, between the regions and internationally; the successful implementation of the adaptation strategies within the region will be obtained by close cooperation between researchers, local enterprises, political decision-makers, administrations and the civil society as well as the introduction of several governance-innovations (climate change-adaptation officers, -managers and the –academy).

- The Integrated Climate Protection Programme of Hessen “INKLIM 2012” (Hessen, C-2) has been designed as an integrated approach taking into consideration both greenhouse gas reduction [mitigation] and adaptation to climate change. Further, the programme comprises both capacity building through investigating the effects of climate change on various interrelated sectors [multi-sectoral approach] and the subsequent utilisation of the gained knowledge for policy development. In this context the assessment of the costs for implementing the developed instruments and measures for climate protection is an important issue. The results of INKLIM 2012 has been considered as scientific basis for several regional climate protection policies.

- “The Aragonese Climate Change and Clean Energies Strategy - EACCEL” (Aragon, C-10) is also an integrated strategic approach which combines mitigation and adaptation options. This regional strategy contributes to the national and international commitments to reduce greenhouse gas emissions in Aragon and is the regional framework for the development of action plans.

- The “Project for Optimisation of Water & Emissions Reduction” (Aragon, C-9) is a demonstration project for integrating mitigation and water saving measures into good water governance policies of 10 irrigation communities, 10 regions and 10 EU cities.

- The project “Enhance regional SEE cooperation in the field of climate policy, adaptation to climate change in urban areas in Turkey” (REC, C-15) illustrates the development and implementation of adaptation strategies for urban water management in the framework of IWRM and a national integrated strategy for adaptation.

- The project “Green and Blue Space Adaptation for Urban Areas and Eco Towns” (REC, C-16) aims to improve the regional and policy making process related to the planning and development of urban areas in the context of climate change. Spatial planning and urban design provide adaptive options by means of green and blue infrastructure in order to reduce vulnerability of urban areas to increased temperatures and flooding. The project facilitates exchange of knowledge and experience and the actual transfer of good practices on climate change adaptation strategies to local and regional authorities. Through stakeholder and community engagement, as well as the development of regional policy networks, partners will produce high level policy statements and climate change adaptation action plans.

- The project “Deltaplan Dry Rural Areas” (N-Brabant, C-24) aims at defining regional adaptation strategies in order to cope with seasonal water scarcity in rural areas in the South of the Netherlands. Because many sectors are affected, the cooperation of all relevant regional stakeholders is essential in this multi-sectoral approach. Being the policy counterpart of the national scientific research programme “Knowledge for Climate” (N-Brabant, C-26), the project gives an example for the process of developing and implementing of adaptation strategies and policy development.
“Hotspot Dry Rural Areas” is part of the national programme for climate change adaptation “Knowledge for Climate” [N-Brabant, C.26] and aims at the development of knowledge regarding the effect of climate change on regional development as well as the development of adaptation strategies for dry rural areas. The main issues are water storage, water stress and the incorporation of climate-related risks into the planning and regional decision-making process.

“Knowledge for Climate” is a research programme that aims to develop applied knowledge, through cooperation between the Dutch government, the business community and scientific research institutes, in order to ensure that long term decision making takes into account the impacts of climate change.

The project “Central and Eastern European Climate Change Impact and Vulnerability Assessment — CECIIA” (Romania, C-20) developed recommendations for adaptation options based on the case study results in the South-East Romanian agricultural area. A number of agronomic adaptation strategies were recommended to avoid or reduce negative climate change effects and exploit possible beneficial options:

1. Measures to improve management, use and protection of water resources in irrigated agriculture;
2. Adaptation measures to improve management efficiency and use of existing irrigation systems and elaboration of technological and technical means for irrigation.

Based on these results, in 2008 the Ministry of Environment and Forests developed the “Guide on the adaptation to the climate change effects” approved by Ministerial Order (no 1170/2008). This guide provides recommendations on measures which aim to reduce the risk of the negative effects of climate change in 13 key sectors as follows: agriculture, biodiversity, water resources, forests, infrastructure, construction and urban planning, transportation, tourism, energy, industry, health, recreational activities and insurance.

7.5 CONNECTION WITH OTHER THEMES

Improving the efficiency of water use and water demand-side management is key for adaptation. Therefore, most of the technical and economic instruments related to demand side management, which are described in chapter 4 and 5, are potential adaptation measures.

There are also many links with chapter 6. Communication and dissemination of constantly evolving scientific evidence, knowledge and new data to all involved stakeholders is very important for the development of adaptation strategies in the water sector. Research results and scientific information need to be translated to water managers, decision- and policy makers and operational practitioners, and uncertainties need to be communicated in a transparent way. It was also pointed out that the participation of all relevant stakeholders is crucial for the process of developing effective adaptation strategies.

Table 2 summarises connections between good practices of chapter 5 with other themes.
8 COMMUNICATION AND PARTICIPATION

8.1 INTRODUCTION TO THE THEME

“Communication” and “Participation” are two different kinds of social interactions which help decision-makers (authorities) and the public to enter into dialogue of a proposed activity, measure, plan, programme or policy in the field of environment, water management, water scarcity, or in other related fields. Through communication and participation, citizens and communities can learn about the effect of planned activities or measures, they can gain information or get involved and try to influence decision-making. Authorities use these instruments to provide the public information, to raise attention and awareness of people, to educate them on crucial and important issues, and to involve the citizens in the decision-making process.

Communication and participation may differ from the perspective of what citizens need and want to achieve, or what they need to know to take action, and what the authorities need to know and to do to communicate with the public and proactively engage the citizens.

With the help of communication decision-makers (or authorities) can:

- Make clear what their plans or planned activities and measures are about and how they intend to carry them out;
- Explain the reasons behind decisions or activities, initiatives to people in a way which can be understood by all;
- Deliver messages in a simple and understandable way to the broad public or the affected stakeholders;
- Give the necessary information and also collect feedback from people.

Through the multiple tools of communication and sources of information, citizens can ask for information of their interest or concern, learn about the upcoming decisions or measures, and provide also their feedback.

Participation should not be a one time opportunity and confined to one public consultation meeting or a hearing but should be provided during the whole decision-making process. Participation should ensure that:

- Opportunity is provided for citizens to know in due time about what is planned or what is being implemented so they could get information and be prepared;
- The public is informed about all details of an upcoming decision-making process, know where to find the needed information, be able to find out when and how they can be involved;
- There is opportunity for people to express opinions, comments, views, make proposals in public hearing or via submitting written comments, in public hearings, consultations, in meetings or via electronic commenting;
- Comments made by the public are taken into account, authorities respond to the concerns raised by citizens and show how they have dealt with them, etc.

Communication and participation are related. Communication - and within this information - helps to build up participation. Without proper communication and in lack of information, participation may be difficult.

During the interaction with the public or during the different stages of decision-making process, different levels of information and participation may be applied. The figure 8.1 below illustrates the levels of information and participation during the different stages of the decision-making, indicating also some examples of interactive or reactive methods.

Different levels of public participation allow for different levels of involvement of the public in the decision-making process and different numbers of persons. Generally, as the level of involvement increases, the numbers of individuals involved may decrease. As we proceed to the higher levels, the public or stakeholders have more and more influence over the outcome of the decision-making. The role of the decision-makers changes as well, from the level where the authorities inform and ask for feedback from the public or give feedback to them [Information, Citizen feedback], to the level where the decision is made taking into account the comments by the public [Consultation], to the level where they agree to a process of a joint or shared decision-making [Joint planning or decision-making], up to the level where the control over the decision-making is fully in the hands of the public [Citizen Control].

2 Awakening Participation. Building Capacity for Public Participation in Environmental Decisionmaking. REC, 1996. See more at archive.rec.org/REC/Publications/PPTraining/cover.html
Communication and participation are two-way processes. They are not only about communicating the viewpoint that the authorities prefer or the alternative they support but also about being open and listen to what citizens need, what concerns they have, what information they want to know or learn about, etc. These all need to be taken into account during communication or when authorities are making the decisions.

Communication and participation need to be planned and tailored to the specific issue, process, decision, or to conveying a specific message. A planned process will make participation and communication efforts more efficient, effective, and lasting. As soon as the authority or an institution begins planning its objectives and activities, it has also to begin planning ways to communicate and involve the public or the intended audience.

The legal requirements for communication and participation are always the baseline to follow as minimum requirements. These are provided for in national laws, EU legislation of each country and in international agreements. However, good practice can easily go beyond these requirements.

The Aarhus Convention\(^4\) has been the first international agreement which provides for a legal framework guaranteeing the rights of the public:

- To receive environmental information upon request or by active dissemination of information through different mechanisms, such as information centers, public registers, databases, web sites, etc. at the initiative of the authorities;
- To participate in decision-making on specific activities, or during the preparation of plans, programmes, policies relating to the environment and legislation that may have significant effect on the environment;
- To access to justice when the citizens’ rights are infringed upon access to information and public participation in specific (project-type) decision making or when national law related to the environment is breached.

### Planning the Communication and Participation Process

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![Figure 8.1: “The Participation Ladder”: Different levels of information and participation](image)

![Figure 8.2: Planning the communication and participation process](image)

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3. More information on planning public participation in the training materials published at the following REC webpage: themis.rec.org/files/enforcement_and_pp_magda_toth_nagy_updated2.pdf

themis.rec.org/files/template_training_session_outline_magdi_updated.pdf

8.2 SELECTION OF CONCEPTS

Within the terms “communication” and “participation” we can distinguish several different aspects and tools.

Two aspects of communication are:

- Awareness raising and education;
- Information dissemination.

Regarding “Participation” we focus on:

- Public participation or stakeholder involvement.

8.3 DESCRIPTION OF CONCEPTS

8.3.1 AWARENESS RAISING AND EDUCATION

Awareness raising is used as the first measure to broadly disseminate knowledge or information for a targeted audience when we want to call attention to a certain concern or achieve change in behaviour and mentality, create engagement, raise consciousness and ultimately mobilize people to take action themselves.

Awareness raising can be carried out through well organized events, campaigns, brochures or publications, etc. The awareness raising events should be attractive, energizing and memorable. An interesting example for awareness raising is organizing plays for children and families in public places such as a shopping malls on the importance of water consumption habits in their home (Aragon, D-2). The play was using amusing characters, games and songs and a language understandable for children and adults, and performed sessions in the Christmas period when the influx of public was very high. The children also received a “good citizen handbook”, a brochure with advice for saving and good practices of water consumption at home.

Distribution of free water saving pack in the street for the broad public (Aragon, D-4) to promote ecological consumption habits, or launching regional communication campaign “Water, vital saving” targeting households using a brochure with useful suggestions and coloured images and kits for domestic water savings (Emilia-Romagna, D-6) or the advertising campaign comic strip drawings that consume water in a responsible way (Aragon, D-3) are examples of another approach. Awareness campaign can also target schools as it happened in Herault, where water saving was promoted and small water saving kits were distributed to encourage school children in understanding the impact of water shortage and learn how to use water saver devices (Herault, D-16).

Private and public actors of the agricultural sector were made aware of the possible consequences of climate change and agricultural production (National Meteorological Administration, Romania, D-12) through a project including a study, transnational exchange of experiences, observation, awareness campaign and dissemination through code of attitude for farmers, declaration and DVDs.
Multiple other tools can be used to support the awareness raising campaigns as mentioned in the above cases, such as media, local radio and television, websites, posters, external advertising (e.g. urban bus), marquee, etc. Interactive communication tools should be used not only to inform but also to involve and make the key stakeholders and the public interested.

During education, accumulated knowledge, skills and values are brought and transmitted to the children through the kindergarten and elementary or secondary schools system. The interactive multimedia environmental education kits, such as the Green Pack programme, for secondary schools and the Green Pack Junior for primary schools, grades 2-6 as well as for their teachers, are effective ways of education. The educational programme covers 22 topics including water, water saving and climate change and has been produced in 14 national and regional editions. (REC, D-10)

Using story books for children is another way of education. The story book for children on the travelling water drops distributed to the age group from 3 to 10 in kindergartens and elementary schools (Hessen, -1) sensitizes children about water saving attitudes and on water pollution. It has been used for 15 years and has been distributed in German, Polish and Czech.

Educational institutions, such as for example museums, can reach out to a broad circle of public. The Eco-museum on Water (Emilia-Romagna, D-9) is an institution educating universities, associations, farmers, technicians and students on the technical, cultural, social and environmental aspects of water. It communicates technical concepts in an easy and understandable way using also conferences, seminars, training courses, as well as educational activities for schools.

8.3.2 DISSEMINATION OF INFORMATION

Information is power and influence. It enables people to know more about their environment or community and is based on the obtained information to decide whether they want to take an action or want to be involved in a particular decision-making procedure.

Information should be timely and should be provided in an understandable and user-friendly format.

Information can be obtained upon request from authorities or by own initiative from available sources. Authorities should also proactively disseminate all information necessary for the citizens to know about the state of the environment and about the planned or implemented activities of the authorities. People can participate more effectively if information is presented visually rather than in words. Graphics, maps, illustrations, cartoons, drawings, photomontages and models, etc. should be used wherever possible.

In water management, climate change and water scarcity issues, the information can be disseminated through many different channels. A more advanced form of dissemination is the platform for dialogue established to share knowledge among stakeholders, diffuse news, data and experiences among the researchers, water services managers, national and local institutions, non-governmental organizations, environmental and other associations. The National Forum on water saving and conservation (Emilia Romagna, D-7), a network between stakeholders and institutions facilitates the dissemination and access to information. The platform and its thematic working groups, which used newsletters and conferences, workshops, seminars, have also contributed to public and stakeholder involvement.

Other examples include publications and exhibitions as information dissemination tools. A publication about the importance of water, the Book of Water (Aragon, D-5) was published in high quality with attractive photographs. Famous artists, politicians, social figures, representatives of businesses and associations and the general public offered their reflections on water. Guides can be useful to enlighten decision-makers on the advantages of alternative resources and large range water recovery options to the operational phases. A Handbook was prepared on these issues offering useful tips (Hearult, D-1.5). The permanent exhibition on irrigation technologies (Emilia Romagna, D-8) is aimed at providing clear, up to date information on this subject to farmers and technicians. The use of the guide was combined with training sessions and e-learning program.

8.3.3 PUBLIC AND STAKEHOLDER INVOLVEMENT

During stakeholder dialogue a collaborative approach should be taken. This means engaging stakeholders at an early stage when options are open, all needed information is provided and they still can influence the outcome. Everyone shares knowledge and insights. Possible actions and ideas are explored and discussed before decisions are finalized. Using the knowledge, views and ideas of a wider group social capital is built, discussion is enriched and it leads to better informed, better understood and better supported outcomes.
Old versus new approach

Experts Decide - stakeholders react

<table>
<thead>
<tr>
<th>Start</th>
<th>Decide</th>
<th>Announce</th>
<th>Defend</th>
<th>Try to secure agreement</th>
<th>If there is no agreement impose or abandon</th>
</tr>
</thead>
</table>

Collaborative/consensus building processes

<table>
<thead>
<tr>
<th>Prepare</th>
<th>Decide together</th>
<th>Secure agreement</th>
<th>Implement</th>
<th>Better future for wildlife and people</th>
</tr>
</thead>
</table>

The opportunities to bring together different stakeholders, including the most affected, the authorities as well as different institutions, and to provide a forum or platform for discussion, may result in facilitation of a dialogue where problems and the best alternatives can be identified for policies and implementation activities on water saving and conservation (Emilia-Romagna, D-77). There are internet based or electronic tools used increasingly for promoting public involvement in decision-making. An example is the People-Planet-Profit Scan (Noord-Brabant, D-13) for assessing and promoting development which can be used in the early planning stage of decision-making. The outcome of the scan can be used for further discussion among a wide array of stakeholders leading to consensus on improvement of the assessed project.

<table>
<thead>
<tr>
<th>Traditional consultation tends to:</th>
<th>Stakeholder dialogue tends to:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assume win/lose outcomes</td>
<td>Search actively for win/win results and ways to add value for all parties</td>
</tr>
<tr>
<td>Focus on differences and polarise rival position</td>
<td>Explore shared and different interests, values, needs and fears and build on common ground while trying to resolve specific disputes</td>
</tr>
<tr>
<td>Focus on issues and results</td>
<td>Focus on processes, as well as issues and results, in order to build long-term ownership of, and commitment to, mutually agreed solutions</td>
</tr>
<tr>
<td>Produce results perceived to reflect inequities of power and resources</td>
<td>Produce results which can be judged on their merits and which seem fair and reasonable to a broad spectrum of stakeholders</td>
</tr>
<tr>
<td>Try to deal only in facts</td>
<td>Also take into account feelings, values, perceptions and vulnerabilities</td>
</tr>
<tr>
<td>Ignore importance of building relationships across differences</td>
<td>Strengthen existing relationships and build new ones where they are most needed</td>
</tr>
<tr>
<td>Offers no learning</td>
<td>Invest in mutual learning as a starting point for future processes and projects</td>
</tr>
</tbody>
</table>

Figure 8.6: The differences between the traditional consultation and the stakeholder dialogue

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8.4 CONNECTION WITH OTHER THEMES

Communication and participation play a significant role supporting water demand-side management, climate change adaptation and mitigation as well as drought management and therefore should be an integral part of these fields.

Communication from the side of authorities, using education and awareness approaches, as well providing information upon request and proactively, are equally as essential as involving the public and the affected stakeholders during the different stages of decision-making, implementation, monitoring and enforcement of decisions.

Information and communication on what is drought and what is climate change, what are the effects, what measures are necessary to mitigate and to adapt to these, what the population can and should do are crucial. This should include dissemination of constantly evolving scientific evidence, knowledge and new data also to all involved stakeholders for the development of mitigation measures and adaptation strategies in the water sector. Research results and scientific information needs to be translated to water managers, decision and policy makers and operational practitioners, and the key stakeholders, and uncertainties need to be communicated in a transparent way. At the same time such information should be also made available in a user-friendly, easily understandable language for the general public. [See chapter 7]

Education and awareness raising of the population targeting children, schools, families, farmers, etc. are fundamental in understanding the needs for and resulting ultimately in positive changes in behaviour, mentality and attitude. They are also helping in mobilizing the different target groups and stakeholders to take actions and play their part in society to achieve the necessary short- and long-term effects in preventing the negative consequences or adapting to climate change [e.g. water saving, sustainable water use, etc.]. (See chapter 4).

Decisions on developing mitigation measures and adaptation strategies, implementing policies and measures are taken at different governance levels and therefore the involvement and participation of all stakeholders at local, regional, national and international levels and of all affected and relevant sectors is needed, e.g. local and national government, private sector, civil society. Communication and public participation techniques should be tailored to the relevant affected stakeholders and the level of decision-making. As it is the local level where the concrete adaptation will take place, the most affected local level stakeholders should be especially involved. A bottom-up approach should be followed to make sure that adaptation strategies will work on the ground and they fit to local conditions. These efforts should be harmonized with the involvement of key stakeholders in the decision-making process on developing, adopting and implementing adaptation strategies at the European and national level (top-down approach). [See chapter 6, and chapter 7].

9 FURTHER INFORMATION

9.1 WEBSITE

The www.watercore.eu website is the focal point for WATER CoRe project communication development.

Communication in a European project should be developed, necessarily, from two different perspectives: the internal communication, which aims project partners to take fully part in the project as well as to make them aware of their obligations and benefits; and, the external communication and dissemination, which aims to disseminate the project activities and bring them closer to final beneficiaries, to enhance the project, to make visible the added value of projects offered by the project and to increase the project’s external visibility, prestige and image.

The project’s website aims to offer two solutions for the two different communication fields. Therefore, it is structured in two different sections: on the one hand, the private section, which is only accessible to project partners; on the other hand, the public section, which is open to the public in general.

It is necessary to recall that the main objective of WATER CoRe project is to create a platform with information on water scarcity and drought and make it available for all European regions that may need this information to solve related matters in their territories. In this sense, the public section of our website is an excellent showcase to communicate to stakeholders the updated products of WATER CoRe project. Therefore, stakeholders may download the “Good Practice Handbook” as well as the “Survey on Water Scarcity and Drought in Europe”, which are currently available at the main page of the website. Moreover, the web main page offers the latest news of the project, a link to the project’s FACEBOOK profile and the opportunity to check out the most recent newsletter.

The public section is structured in seven subsections:

• “The Project” that provides information on most relevant data of the project together with a support letter to the project signed by all the maximum political representatives on water issues from each project partner region;
• “Partners” contains detailed information on the institutions and organizations that take part in the project;

• “Documents” provides all the newsletters ever published in the project as well as all the public documents of the project such as the “Guide for Corporative Identity” or the “Project Handbook”;

• “Events” holds information on the events where the project is to be present;

• “Contact” to our leader partner: Hessen and our Project Partner: Blue!

• “Media” holds over 50 related news and articles on the project;

• “Links” are divided into “Relevant official EU website”, “Other EU projects and Networks” and “Other scarcity and drought related website”;

• “Site map” makes it easy for the user to use the website as it provides a constant global view on the user’s situation in the system.

The private section offers to members complete information of the startup of the project. Moreover, it provides tools to make team-working easy. Access is restricted to members, who accede to this section by introducing their name and password.

### 9.2 HANDBOOK AND E-LEARNING MODULES

Two of the main products, the Handbook of Good Practices and the E-learning modules are available on the WATER Core website. The Handbook describes examples of good practices from all the partner regions. The E-learning modules offer a structured way to access the information from the WATER Core project for the development of regional plans and actions in both partner regions and elsewhere in Europe.

### 9.3 EU POLICY CONTRIBUTIONS

Currently the European Commission intends to mainstream adaptation into all climate policies together with developing until 2013 the EU Adaptation Strategy with general recommendations for all member states. While mitigation is tackled in compliance with global reduction targets, adaptation requires a local response to the consequences of the impact of climate change on the natural and human systems. Due to the regional-related aspect of the climate change impact, adaptation policy and measures are efficiently set through cross-border cooperation and open exchange of knowledge and experience. However, all measures for adapting to climate change must be developed with national objectives in mind, and based on specific national needs and resources.

The European Climate Adaptation Platform, CLIMATE-ADAPT (formerly known as the EU Clearinghouse on Adaptation) was launched on March 23, 2012 ([climate-adapt.eea.europa.eu/web/guest/home](http://climate-adapt.eea.europa.eu/web/guest/home)). The EU Clearinghouse mechanism is a good example that, in order to act as a facilitator for collecting and disseminating information, intends to use data and case studies in the field of climate change and drought as good practices/lesson learned, and also to have a view regarding the level of coordination among sectoral/regional policies.

The WATER CoRe project offers the opportunity to exchange experiences on water management in the context of climate change, vulnerability and adaptation and provides new tools to strengthen the European expert networks. The recent adaptation policy development in Europe requires a major research effort to timely provide a sound and policy-relevant knowledge base.

**Next steps – A Blueprint for Europe’s Waters**

The Blueprint will:

• Look into gaps and shortcomings of the current policy and ways to address them;

• Look at the evolving vulnerability of the water environment to identify measures and tools in several EU policy areas;

• Examine the balance between water demand and supply, taking into account the needs of both human activities and natural ecosystems;

• Support data collection, scientific and technological development.
Chapter 2


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Chapter 7

