7. Water quantity

7.1 Storyline for indicators

Water availability problems occur when the demand for water exceeds the amount available during a certain period. They occur frequently in areas with low rainfall and high population density, and in areas with intensive agricultural or industrial activity. Apart from causing problems providing water to users, over-exploitation of water has led to the drying-out of natural areas in western and southern Europe, and to salt-water intrusion in aquifers.

The overall abstraction and consumption of water resources is currently sustainable in the long-term perspective. However, some areas may be facing unsustainable trends, especially in southern Europe where much improved efficiency of water use, especially in agriculture, is needed to prevent seasonal water shortages. In addition, the expected climate change may affect water resources and demand. The three main consumptive users of water are agriculture, industry and the domestic sector.[1]

The main policy objectives are:

- *To ensure the rates of abstraction from our water resources are sustainable over the long term[2] and to promote sustainable water use based on a long-term protection of available water resources[3];*
- *To ensure a balance between abstraction and recharge of groundwater, with the aim of achieving good groundwater status by 2015[4].*

The Water Framework Directive obliges Member States to use pricing for water-related services as an effective tool for promoting water conservation. This would also allow the environmental costs of water to be reflected in the price of water. National, regional and local authorities need, amongst other things, to introduce measures to improve the efficiency of water use and to encourage changes in agricultural practices necessary to protect water resources (and quality). Leakage remains a major source of inefficiency of water use and in several countries objectives have been set to achieve major reductions in leakage.

EU Member States shall ensure by 2010:

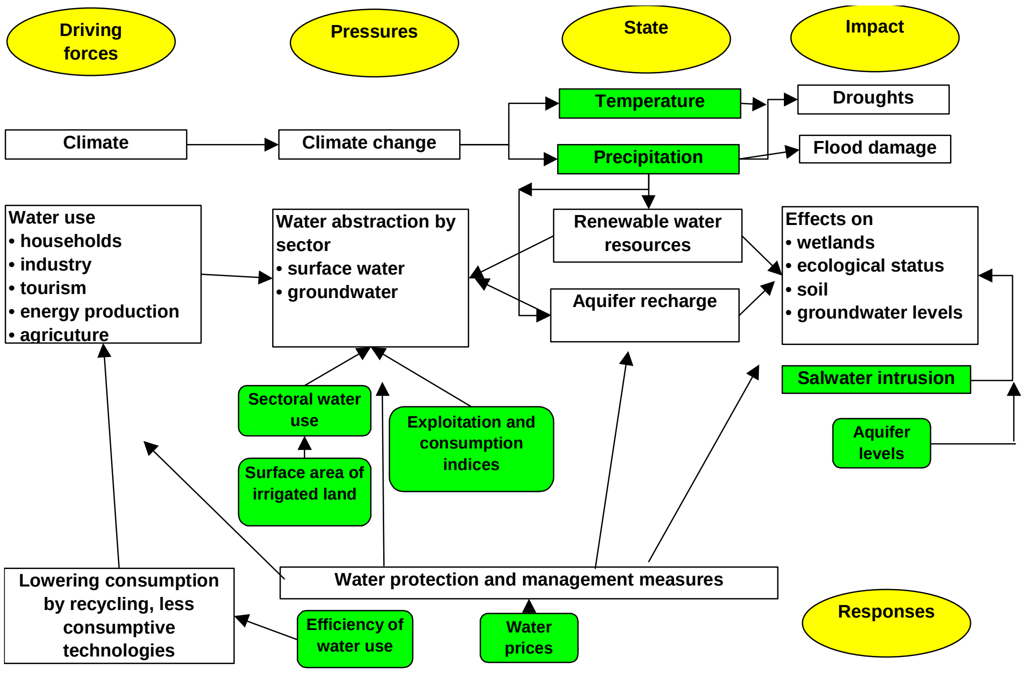
- that water-pricing policies provide adequate incentives for users to use water resources efficiently, and thereby contribute to the environmental objectives of this Directive;
- an adequate contribution of the different water uses, disaggregated into at least industry, households and agriculture, to the recovery of the costs of water services.

[1] 6th Environmental Action Programme, 5.6 Ensuring the Sustainable Use and High Quality of Our Water Resources (p.45-46)
[2] 6th Environmental Action Programme 5.6 Ensuring the Sustainable Use and High Quality of Our Water Resources (p.45-46)
[3] Water Framework Directive Article 1
[4] Water Framework Directive Article 4

7.2 Indicators used

The DPSIR framework for assessing water quantity resources is shown in Figure 7.1. The rectangles in green are those indicators used in this report.

Figure 7.1 DPSIR conceptual framework for assessing water quantity resources



Indicators used in this report and for which factsheets are available on the EEA's web page <URL to be added>.

Table 7.1 summarises the assessments that are made in terms of the policy questions using relevant indicators. More detailed information and assessments then follow in the subsequent pages and indicator factsheets. An '✖' in the assessment column indicates that there is at this point no indicator developed or formulated to answer the specific policy question.

Table 7.1 Overall assessment of progress in meeting policy objectives in terms of water quantity

Policy question	Indicators	Assessment
Question 1 Are the abstractions of water resources sustainable over the long term?		
• How does climate impact on water resources?	*Available water*	☺ Twelve countries have less than 4 000 m^3/capita/year while the northern countries and Bulgaria have the highest water resources per capita. ☹ Most climate models project decreasing precipitation rates for Southern Europe and more temporally intense rainfall events. ☺ Most climate models project increasing precipitation rates for Central and Northern Europe.
	Climate change indicators	✖
• Which areas in Europe are at higher risk of water stress?	*Water exploitation index*	☹ Eighteen percent of Europe's population live in countries that are water stressed.
• Are we using less water?	*Trends in total abstraction*	☺ Total water abstraction has decreased over the last decade in most regions of Europe with the exception of Western Southern Europe where it has been constant.
Question 2 Is the use of water by socio-economic sectors sustainable?		
• How socio-economic structures affect water resources sustainability?	*Water consumption index*	☹ The countries that have the highest agricultural water use have the highest consumption indices, consuming in some cases over 10% of their annual available resource.
• In which sector is water use increasing/decreasing?	*Trends in sectoral use of water*	During the 1990s: ☺ There were decreases in water abstracted for agriculture, industry and urban use in Central Accession and Central Western countries, and in water used for energy production in Southern Western and Central Western countries; ☺ Water abstracted for urban use and industry remained relatively constant in Southern Western; ☹ There was a slight increasing trend in agricultural water use in Southern Western countries and in water abstracted for energy production in Central Accession countries.

• Is agricultural production becoming less water intensive?	*Agricultural water use*	☹ Southern European countries have the largest area of irrigated land in Europe, and use around three times more water per unit of irrigated land than other parts of Europe. ☹ The amount of water used for irrigation has increased in southern Europe and some Western Central countries in the 1990's, and in some countries it is likely to continue to increase. 😐 In the Northern Accession countries the amount of water used for irrigation has decreased over the same period largely because of the deterioration of, and non-use of, irrigation systems in these countries.
• Are the households reducing the water use?	*Water use by households*	☺ Urban water use has decreased in the 1990s in many European countries as result of measures to reduce demand and because of economic re-organisation. 😐 Urban water use is highest in Western Southern countries largely reflecting the warmer climate in this part of Europe.
• Is tourism affecting long-term water resource sustainability?	*Tourism water demand*	☹ Increased tourism is placing greater stress on water resources in the Mediterranean region.
Question 3 Is water stress due to water abstractions being reduced?		
• Are there indications of low water availability/reduced water quality?	*Overall reservoir stocks*	😐 Southern European countries retain the highest proportion of their annual freshwater resources in storage reservoirs, often to safeguard supplies when other water resources are stressed. These countries use the highest proportion of their water resources for irrigation. 😐 Hydropower generation is also a major use of storage reservoirs particularly in Nordic countries.
	Saltwater intrusion	☹ Salt water intrusion as a result of groundwater over-exploitation is a major concern in many aquifers throughout Europe
• Are impacts on wetlands and aquatic biota decreasing?	*Groundwater levels*	☺ Groundwater levels have increased in some European aquifers in response to decreases in groundwater abstraction.
• Is the number of locations with less than good ecological status due to water abstraction decreasing?		✖

Question 4 Are we using water prices and water saving technologies to improve water conservation?		
• Is water pricing used as a tool for promoting water conservation?	*Water prices*	☺ Significant progress has been made towards more effective water pricing policies in many countries that should reduce water demand. ☹ However far less progress has been made in the agricultural sector compared to the domestic and industrial sectors.
• Are we changing to more efficient uses of water?	*Water use efficiency*	☺ Water use efficiency can be improved using various water-saving devices in households, public places and industry. ☹ Nevertheless, such devices are not very widespread in households.
	Water Leakage	☹ Leakage losses are still significant in many urban areas. ☺ Progress is being made in some countries to reduce water leakage from urban distribution systems.

✖ Indicator to be developed

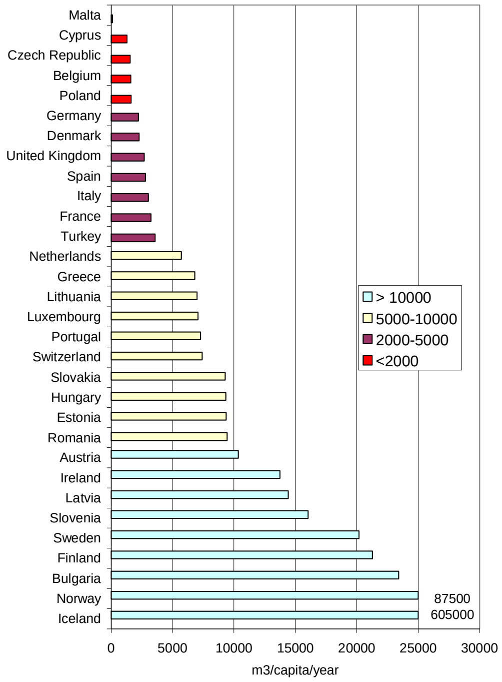
Policy Question 1: *Are the abstractions of water resources sustainable over the long term?*

Available water

Precipitation is the source of all freshwater resources. Precipitation is unevenly distributed in Europe being highest in the western part and in regions with mountains (Map 7.1). Temperature has a major influence on the water needs of plants and the evaporation from surface waters. Annual average run-off from rain varies from over 3 000 mm in western Norway to less than 25 mm in southern and central Spain, and is about 100 mm over large areas of Eastern Europe.

The total freshwater resource of a country is defined as the internal flow plus the actual external flow. The internal flow is the total volume of river run-off and groundwater generated exclusively by precipitation into a territory. The actual external flow into a country is the total volume of actual flow of rivers and groundwater, coming from neighbouring territories. In absolute terms, the total freshwater resource in Europe is around 3 500 km^3/year. Twelve countries have less than 4 000 m^3/capita/year while the northern countries and Bulgaria have the highest water resources per capita (Figure 7.1).

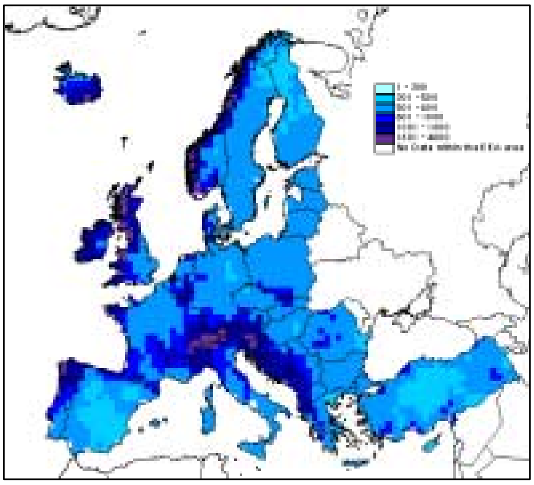
Figure 7.1 Water availability per capita and country



Source: Eurostat, New Cronos database

Key messages:
☺ Twelve countries have less than 4 000 m^3/capita/year while the northern countries and Bulgaria have the highest water resources per capita.
☹ Most climate models project decreasing precipitation rates for Southern Europe and more temporally intense rainfall events.
☺ Most climate models project increasing precipitation rates for Central and Northern Europe.

Map 7.1 Mean annual precipitation between 1940-1995 in the EEA area (mm)

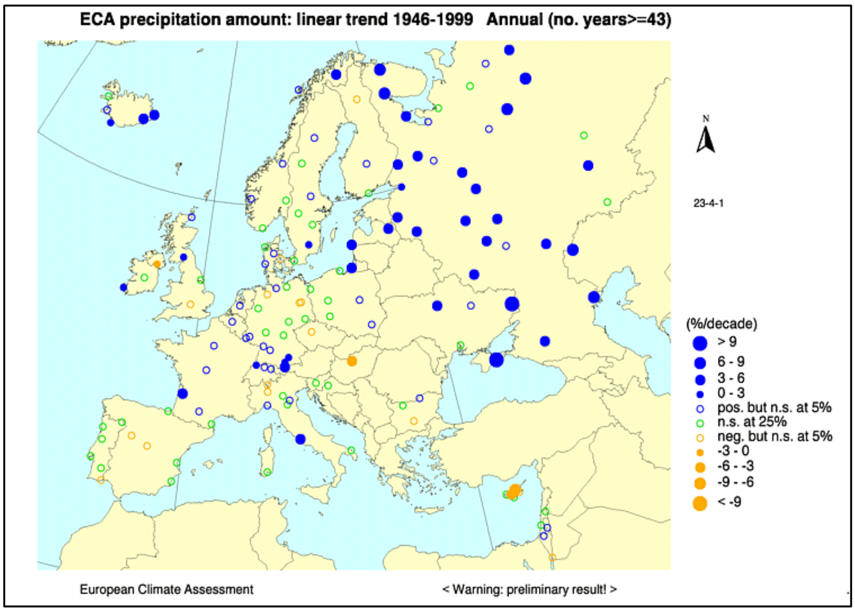


Source: CRU, 1998

Inflows from transboundary watersheds can be a significant percentage of freshwater resources in countries, either as surface flow or as groundwater flow. The Accession countries of the Danube basin have the highest dependency on external resources (above 70 % of their total resources). In Western Europe, the Netherlands has the highest dependency (88 %), followed by Luxembourg and Portugal.

Climate changes are affecting precipitation patterns in Europe. In some parts of Northern countries there has been more than a 9 % increase of the annual precipitation per decade between 1946 and 1999 (IPCC 2001 and Klein Tank *et al.* 2001). Decreasing trends in precipitation have also been observed in parts of Southern and Central Europe. Most climate models project increasing precipitation rates for Central and Northern Europe and decreasing rates for Southern Europe. The increasing rates are mainly due to more precipitation during the winter months, while Southern Europe will experience more summer droughts.

Map 7.2 Trends in precipitation, 1946-1999



Source: European Climate Assessment

Policy Question 1: *Are the abstractions of water resources sustainable over the long term?*

Water exploitation index

Abstractions for different uses exert the most significant pressure on the quantity of freshwater resources. The total water abstraction in Europe is about 353 km^3/year, which means that 10 % of Europe's total freshwater resources is abstracted. The water exploitation index in a country is the mean annual total demand for fresh water divided by the long-term average freshwater resources. It gives an indication of how the total water demand puts pressure on water resource. It also identifies those countries that have high demand in relation to their resources and therefore are prone to suffer problems of water stress.

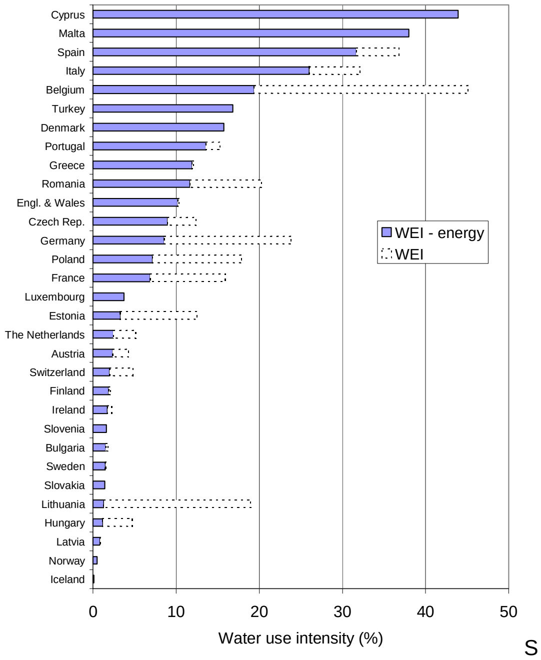
For this assessment, the following threshold values/ranges for the water exploitation index have been used to indicate levels of water stress: a) non-stressed countries <10 %; b) low stress 10 % to < 20 %; c) stressed 20 % to <40 %; and d) severe water stress ≥40 %. The threshold values/ ranges above are averages and it would be expected that areas for which the water exploitation index is above 20 % would also be expected to experience severe water stress during drought or low river flow periods.

A total of 20 countries (50 % of Europe's population) can be considered as non-stressed (Figure 7.2), lying mainly in Central and Northern Europe. Nine countries can be considered as having low water stress (32 % of Europe's population). These include Romania, Belgium and Denmark and southern countries (Greece, Turkey and Portugal). Finally, there are four countries (Cyprus, Malta, Italy and Spain) which are considered to be water stressed (18 % of Europe's population). Water stressed countries can face the problem of groundwater over-abstractions and the consequent water table depletion and salt water intrusion in coastal aquifers.

Total water abstraction decreased during the 1990s by 30 % in the northern Accession countries and by 14 % in the Western Central countries while in the Western Southern European countries it has been constant.

Key messages:
☹ Eighteen percent of Europe's population live in countries that are water stressed
☺ Total water abstraction has decreased over the last decade in most regions of Europe with the exception of Western Southern Europe where it has been constant.

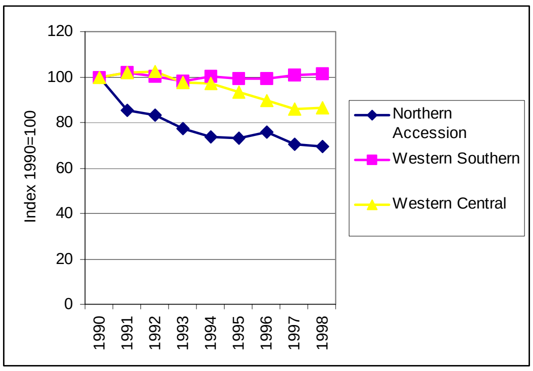
Figure 7.2 Water exploitation index across Europe



S

Note : Solid bar Water Exploitation Index without water abstraction for energy cooling; dotted bar WEI based on total water abstraction.
Source: Eurostat, New Cronos database

Figure 7.3 Trends in water abstraction in different regions of Europe



Western Central: Austria, Belgium, Denmark, Germany, France, Luxembourg, Netherlands, UK
Western Southern: France, Greece, Italy Portugal, Spain
Northern Accession: Bulgaria, Czech Rep., Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovak Rep., Slovenia.
Nordic: Iceland, Finland, Sweden and Norway: insufficient data for trend assessment.
Source: Eurostat, New Cronos database

Policy Question 2: *Is the use of water by socio-economic sectors sustainable?*

Water consumption index

The water consumption index is computed as the total consumption divided by the long term freshwater resources of a country. This index highlights those regions where higher consumptive uses are predominant such as in the Western Southern countries.

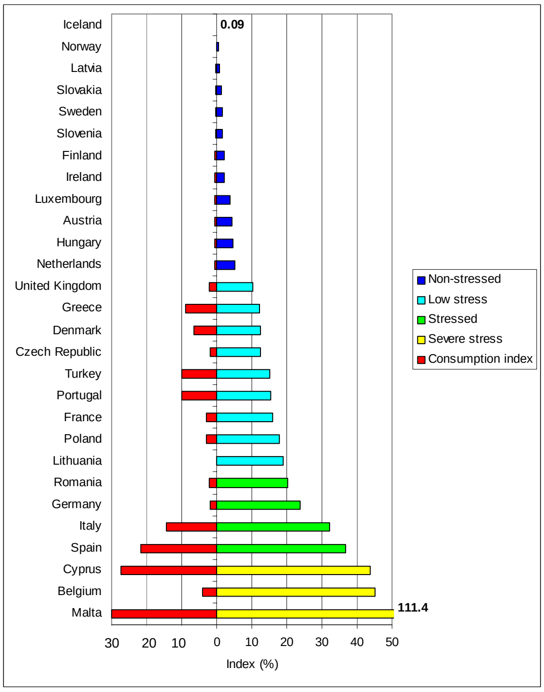
For the purposes of this assessment it has been assumed that 80 % of total water abstracted for agriculture, 20 % for urban use, 20 % for industry and 5 % for energy production is consumed, that is not returned to the water bodies from where it was abstracted. These figures are averages of the water consumed by the sectors as there are no data at national level on the water returned from the different water using sectors. These figures have been widely accepted, though they may vary by about five to 10 % depending on the sectors and other factors. For example, agriculture is the largest water-consuming sector and actual consumption depends on climatic conditions, crop composition and irrigation techniques. Energy is the least consuming sector, returning 95-97 % of the total abstracted water.

The average water consumption index in Europe is 3 %. This index falls to 1 % for some Central Western and Accession countries, and in Nordic countries. The highest consumption indices are found in those countries where agricultural water use predominates such as Cyprus, Malta, Spain, Italy, Portugal and Greece. Even though countries such as Germany and Belgium have high exploitation indices, their consumption indices are relatively low, reflecting the predominant water uses in those countries i.e. water for energy production.

Key message

☹ The countries that have the highest agricultural water use have the highest consumption indices, consuming in some cases over 10 % of their annual available resource.

Figure 7.3 Consumption and exploitation index in European countries



Notes:
Malta has an exploitation index of over 100 indicating that it uses a volume of water that exceeds its annual freshwater resources. This is because more than half of Malta's water supply comes from desalinated brackish water which is not included in the calculation of its freshwater resources.
Source: Eurostat, New Cronos database

Policy Question 2: *Is the use of water by socio-economic sectors sustainable?*

Trends in sectoral use of water

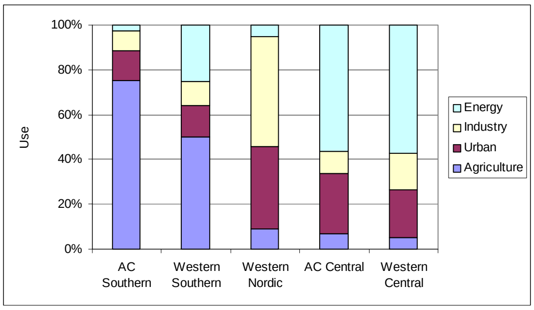
Socio-economic sectors have different demands for water. There are also differences across Europe in relation to the main national socio-economic activities. On average, 33 % of total water abstraction in countries is used for agriculture, 16 % for urban use, 11 % for industry (excluding cooling), and 40 % for energy production.

Figure 7.4 shows the sectoral use of water per region in Europe. The Southern Accession Countries and Western Southern countries use the largest percentages of abstracted water for agriculture (75 %, and 50 %, respectively). Irrigation is the most significant use of water in agriculture in Southern countries, being almost 100 %. Western Central and Western Accession countries are the largest users of water for energy production (including cooling water) (57 %), followed by urban use. In particular, Belgium, Germany and Estonia, use more than half of the abstracted water for energy production.

The decrease of agricultural and industrial activities in Central Accession countries during the transition process led to decreases of about 70 % in water abstracted for agricultural and industrial uses in most of the countries (Figure 7.5). Agricultural activities reached their minima around mid-1990s but more recently countries are increasing crop and livestock production (EC, 2002). Data show a 30 % decrease in abstractions for public water supply (urban use) in Central Accession countries. In most of these countries the new economic conditions led to water supply companies increasing the price of water and installing water meters in houses. This resulted in people using less water. Industries connected to the public systems also declined their industrial production and hence water use. Nevertheless in most countries the supply network is still obsolete and losses in distribution systems require high abstraction volumes to maintain supply.

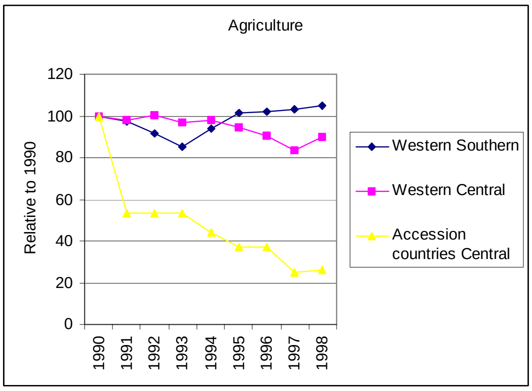
Key messages:
During the 1990s:
☺ There were decreases in water abstracted for agriculture, industry and urban use in Central Accession and Central Western countries, and in water used for energy production in Southern Western and Central Western countries;
😐 Water abstracted for urban use and industry remained relatively constant in Southern Western;
☹ There was a slight increasing trend in agricultural water use in Southern Western countries and in water abstracted for energy production in Central Accession countries.

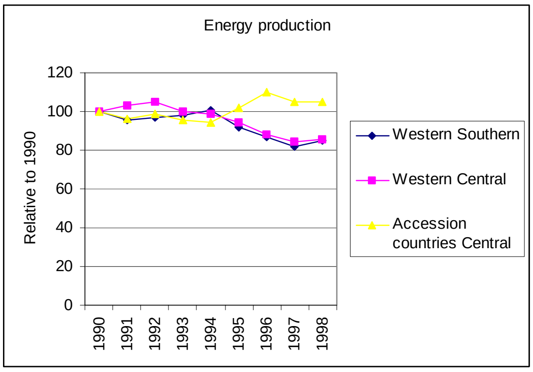
Figure 7.4 Sectoral use of water in regions of Europe

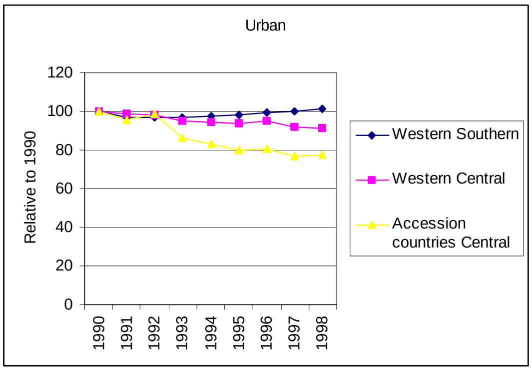


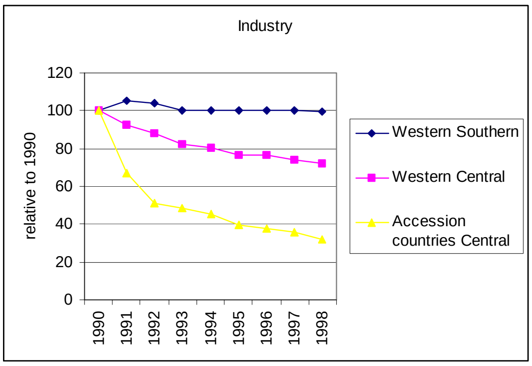
Notes:
Southern Accession countries (AC): Malta, Cyprus, Turkey.
Western Southern: France, Greece, Italy, Portugal, Spain.
Nordic: Iceland, Finland, Norway, Sweden.
Central Accession countries (AC): Bulgaria, Czech Rep., Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovak Rep., Slovenia.
Western Central: Austria, Belgium, Denmark, Germany, Netherlands, UK.
Source: Eurostat, New Cronos database

Figure 7.5 Trends in the sectoral use of water in three regions of Europe









Notes:
Western Southern: France, Greece, Italy, Portugal, Spain.
Western Central: Austria, Belgium, Denmark, France, Germany, The Netherlands, UK,
Accession Countries Central: Bulgaria, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia, Slovenia.
Nordic: Iceland, Finland, Sweden and Norway: insufficient data for trend assessment.
Source: Eurostat, New Cronos database

Policy Question 2: *Is the use of water by socio-economic sectors sustainable?*

Agricultural water use

Agriculture is the largest water consuming socio-economic sector in particular for irrigation. The role of irrigation differs between countries and regions because of climatic conditions. In southern Europe, it is an essential element of agricultural production, whereas in central and northern Europe, irrigation is generally used to improve production in dry summers. A major influence on the amount of irrigated land in the EU has been the Common Agricultural Policy which controls the type and quantity of crops grown.

The area of irrigated land in Western Southern and Southern Accession countries steadily increased between 1993 and 1999, whereas in Western Europe it remained relatively constant, and in the Northern Accession countries it steadily decreased. Southern European countries (Western and Accession) account for 74 % of the total irrigated area in Europe. In countries such as Turkey, it is expected to further increase in the near future following new irrigation developments. Changes in the economic structure and land ownership, and the consequent collapse of the large scale irrigation and drainage systems and agriculture production have been the main drivers for the agriculture changes in the past ten years in the Northern Accession countries.

In Europe, the mean water allocation for agriculture increased from around 4 735 to 5 619 m^3/ha/year between 1993 and1999. There were, however, large differences between regions and countries. In southern countries it is 3-4 times higher than anywhere else and an increase from around 6 100 to 7 200 m^3/ha/year was observed over this period largely due to the increase in Cyprus, Spain and Turkey. Portugal had the largest per unit consumption in these countries in 1999. France showed a 50 % reduction over this period even though irrigated area increased thus implying some increase in irrigation water efficiency and/or changes in the crops being irrigated. In most Western (Central and Nordic) countries, the mean water allocation has decreased with the exception of Denmark and UK where water used per irrigated area has increased steadily from 1993 to 1999. The mean per unit water consumption in Northern Accession countries decreased steadily from 1 250 in 1993 to 488 m^3/ha/year in 1999. This is because even though large areas may be equipped for irrigation, they are not necessarily irrigated. This is because of the economic changes and difficulties in these countries.

Key messages

☹ Southern European countries have the largest area of irrigated land in Europe, and use around three times more water per unit of irrigated land than other parts of Europe.

☹ The amount of water used for irrigation has increased in southern Europe and some Western Central countries in the 1990's, and in some countries is likely to continue to increase.

☺ In the Northern Accession countries the amount of water used for irrigation has decreased over the same period largely because of the deterioration of, and non-use of, irrigation systems in these countries.

Figure 7.6 Development of irrigated land in Europe

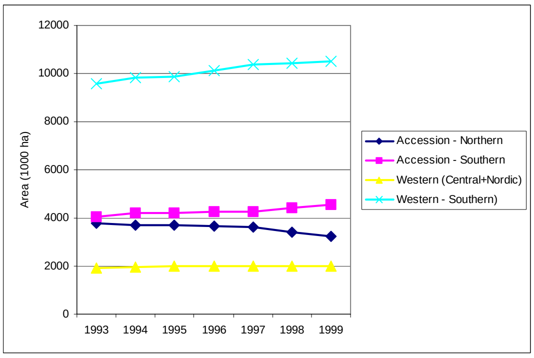
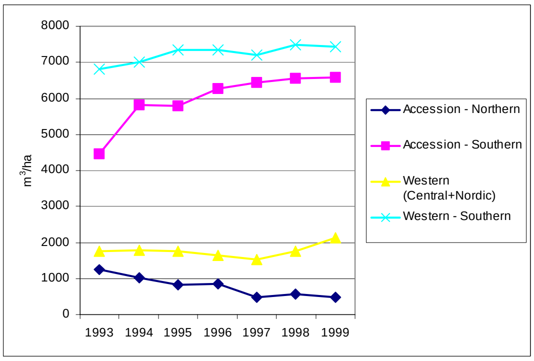


Figure 7.7 Development of water use for irrigation



Notes to Figures 7.6 and 7.7
It has been assumed that the main use of water for agriculture is for irrigation.
Northern Accession countries: Bulgaria, Czech Rep., Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovenia, Slovak Rep.
Western (Central and Nordic) Austria, Belgium, Denmark, Germany, UK, Ireland, Luxembourg, Netherlands, Finland, Iceland, Norway, Sweden.
Western Southern: France, Greece, Italy, Portugal, Spain,
Southern Accession: Turkey, Cyprus, Malta
Data sources:
Faostat and Aquastat (FAO), Eurostat, New Cronos Database (Eurostat-OECD JQ2000), from EEA. Data warehouse SoE national reports.

Policy Question 2: *Is the use of water by socio-economic sectors sustainable?*

Water use by households

Increased urbanisation, population growth and living standards have been major drivers in the increase of urban water use in the past century. The amount of urban water use depends on climate, level and efficiency of public supply services, patterns and habits of water use by the population, technological changes (e.g. water saving technologies and use of alternative sources) and socio-economic instruments. The connection of populations to water supply systems has also increased over recent decades, especially in southern countries. Urban water use is not evenly distributed over time as households and services tend to demand more water in hot and dry periods. There are also seasonal variations in population, such as tourists, that influence the amount of water used at a particular time. At the same time, population density varies over regions and countries. Yearly country aggregated figures do not reflect these seasonal and regional variations.

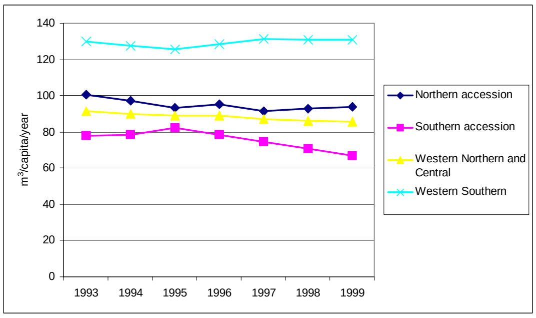
In Western and Accession countries, urban use (households and industries connected to public water supply) of water is around 100 m^3/capita/year. In general, Western Southern countries have the highest urban water use per capita and Southern accession countries the lowest (Figure 7.8). Urban water use has shown a small decrease in all country groupings between 1993 and 1999 except for Western Southern countries where it has remained relatively steady. The relative high use in Western Southern countries reflects their hot climate (increase in water for showering, garden use, public services etc.), and the changes in lifestyle associated with increasing urbanisation.

In some western countries, water use fell during the 1990s as a result of focus on water saving, increasing metering, and the use of economic instruments (water charges and tariffs). In other western countries, urban water use has continued to increase as a result of more people being connected to water supply systems, more households and changes to more water-consuming lifestyles (more washing machines, baths, swimming pools, etc.) The decreasing trend during the 1990s, in Northern Accession Countries is mainly due to the general socio-economic and institutional framework changes. For

Key messages

☺ Urban water use has decreased in the 1990s in many European countries as result of measures to reduce demand and because of economic re-organisation.

Figure 7.8 Trends in urban water use



Notes

The urban water use per capita per year is based on the total population of a country rather than the population that is connected to the urban water supply. The latter is not generally available. Urban water is water abstracted for urban purposes which include domestic uses (households), small industries, municipal services, and public gardening. Thus urban water use per capita is higher than the household water consumption because it includes these other uses and water losses in the distribution system.

Northern Accession: Bulgaria, Czech Rep., Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovenia, Slovak Rep.

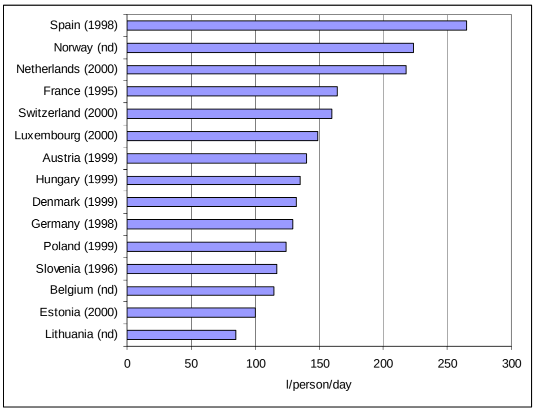
Southern Accession: Turkey, Cyprus, Malta.

Western Central and Northern: Austria, Belgium, Denmark, Germany, UK, Ireland, Luxembourg, Netherlands, Finland, Iceland, Norway, Sweden.

Western Southern: France, Greece, Italy, Portugal, Spain.

Source: Eurostat, New Cronos Database (Eurostat-OECD JQ2000), from EEA Data warehouse; World Bank.

Figure 7.9 Household water consumption



Notes

Domestic water consumption is generally calculated from the estimated or measured total public water supply and can either include or exclude leakage losses in the distribution system. It is usually expressed on a per household or per capita basis. Year of data in brackets, example, in Hungary some of the water supply companies have been privatised leading to relatively high water prices and a decrease in urban water use. Similarly in the Czech Republic, the water industry has been transferred from the state to municipalities with different forms of ownership, and water charges applied. In the Baltic States meters were installed in private houses, higher water tariffs applied and renovation of old pipe systems carried out; all these measures have reduced the urban water use. Bulgaria and Romania have relatively high urban water use per capita because of breakdowns in water-supply networks, lack of water metering, water losses and water wastage.

nd = no information.
Source: European Water Association 2002.

The largest amount of household water consumed is found in Spain with 265 l/capita/day (Figure 7.9), followed by Norway (224 l/capita/day), Netherlands (218 l/capita/day and France (164 l/capita/day). Lithuania, Estonia and Belgium with 85, 100 and 115 l/capita/day, respectively, have the lowest household water consumption in those European countries with available information.

Policy Question 2: *Is the use of water by socio-economic sectors sustainable?*

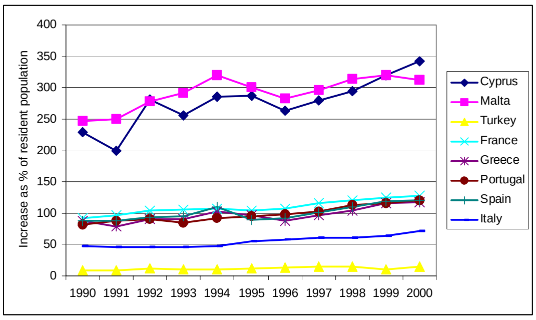
Tourism water demand

Tourism places severe, often seasonal, pressures on water resources at the regional and/or local level across parts of Europe, and is one of the fastest increasing socio-economic activities in Europe. The increase in water demand is often associated with recreational uses such as swimming pools, golf courses, and aquatic parks as well as consumption by a much increased population during holiday seasons. For example, the resident population of Cyprus and Malta increases over three-fold and in Spain, Portugal, Greece and France it doubles (Figure 7.10).

Different measures to cope with peak water demand are in place in the Mediterranean region. These range from transporting water by tankers (Aegean Islands) to the use of non conventional resources as desalination plants and the re-use of treated wastewater for irrigation purposes, specially for golf courses (Spain, Malta and Cyprus) and the development of sewerage and sewage treatment works supporting tourism facilities (Portugal, Spain). In addition water saving campaigns and economic instruments have been introduced to reduce tourist water demand. For example, an eco-tourist tax has been introduced in the Balearic islands to help fund projects related to the efficient use and saving of water.

Key message
☹ Increased tourism is placing greater stress on water resources in the Mediterranean region.

Figure 7.10 Trend in tourist arrivals in Mediterranean countries



Source: EEA from World Tourism Organisation

Policy Question 3: *Is water stress due to water abstractions being reduced?*

Overall reservoir stocks

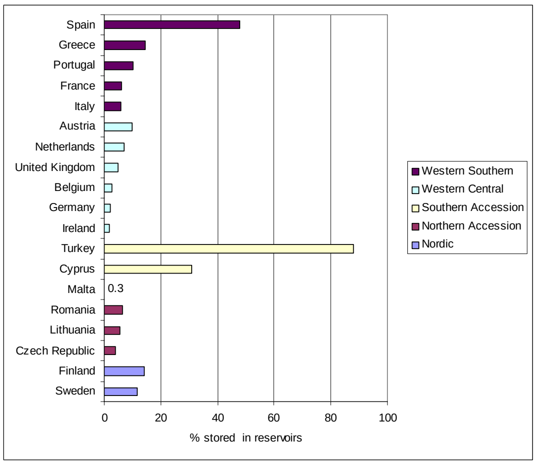
The use of storage reservoirs helps overcome the uneven distribution of natural water resources with time (see indicator on precipitation). Run-off in the wet season can be held back and used in the dry season (seasonal regulation), while water available in wet years can be stored and used in dry years (inter-annual regulation). The beneficial aspects of reservoirs in safeguarding water resources and supplies have to be balanced against the significant impacts that their construction and subsequent operation have on natural landscapes and ecosystems.

The primary functions of reservoirs in Europe are hydroelectric power production, storage for public water supply and irrigation. Water is not always available to meet demands. In particular, water for urban use must be guaranteed and irrigation demands often need to be met during the dry season, when river discharges are at their annual lowest levels. Water storage by reservoirs helps to overcome this temporal unavailability of freshwater resources. In Europe, approximately 13 % of mean annual runoff is stored behind dams. It represents a significant increase in the standing stock of natural river water, with residence times for individual reservoirs spanning less than one day to several years.

The countries with the highest percentage volume of stored water in relation to their annual renewable freshwater resources (over 20 %) are Turkey, Spain and Cyprus (see Figure 7.1). These countries also use the highest percentage of their resources for irrigation. This activity demands the largest water volumes in the driest seasons, requiring winter storage. Spain and Cyprus are considered to be water stressed whilst Turkey has low water stress (see indicator on the Water Exploitation Index). In many countries (such as Austria, Finland, France, Greece, Ireland, Italy, Norway, Portugal and Sweden) the majority of major reservoirs are used for hydropower production. In particular, the primary purpose of major reservoirs in Sweden and Norway is almost exclusively for hydroelectricity (EEA, 1991).

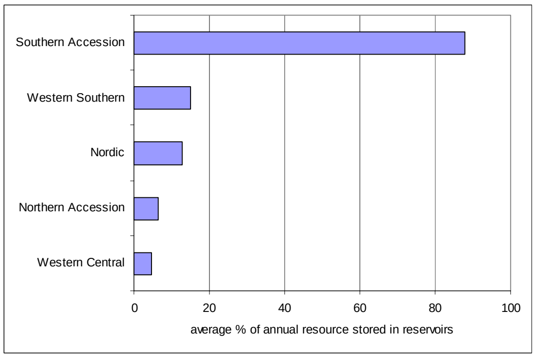
Key message
☺ Southern European countries retain the highest proportion of their annual freshwater resources in storage reservoirs, often to safeguard supplies when other water resources are stressed. These countries use the highest proportion of their water resources for irrigation.
☺ Hydropower generation is also a major use of storage reservoirs particularly in Nordic countries.

Figure 7.1 Proportion of annual renewable freshwater resources stored in reservoirs in European countries



Source: EEA, 1999 FAO AQUASTAT , UNECE, 2001. Environmental Performance Reviews: Romania.

Figure 7.2 Proportion of annual renewable freshwater resources stored in reservoirs in European regions



Countries included in each regional grouping are as defined in Figure 7.1.
Source: EEA, 1999 FAO AQUASTAT.

Policy Question 3: *Is water stress due to water abstractions being reduced?*

Saltwater intrusion

Key message
☹ Salt water intrusion as a result of groundwater over-exploitation is a major concern in many aquifers throughout Europe.

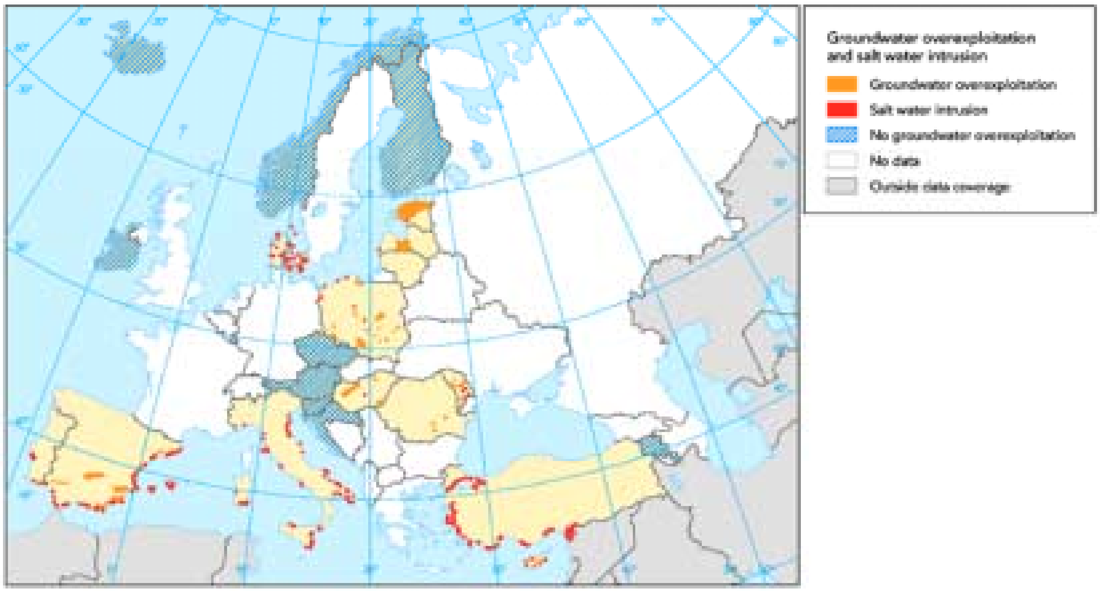
Groundwater over-exploitation occurs when groundwater abstraction exceeds its recharge and leads to a lowering of the groundwater table. The rapid expansion in groundwater abstraction over the past 30-40 years has supported new agricultural and socio-economic development in regions where alternative surface water resources are insufficient, uncertain or too costly (EU, 2000). Over-abstraction leads to groundwater depletion, loss of habitats and deteriorating water quality. It is a significant problem in many European countries. One of its impacts is the intrusion of saltwater into aquifers.

In nine of 11 countries where coastal over-exploitation was reported to exist, saltwater intrusion is the consequence.

Large areas of the Mediterranean coastline in Italy, Spain and Turkey have been reported to be affected by saltwater intrusion. The main cause is groundwater over-abstraction for public water supply.

Irrigation is the main cause of the groundwater over-exploitation in agricultural areas, some examples are the Greek Argolid plain of eastern Peloponnesos, where it is common to find boreholes 400 m deep contaminated by salt water intrusion.

Map 7.4 Groundwater overexploitation and saltwater intrusion in Europe



Source: EC (2000)

Policy Question 3: *Is water stress due to water abstractions being reduced?*

Note: Demonstration indicator

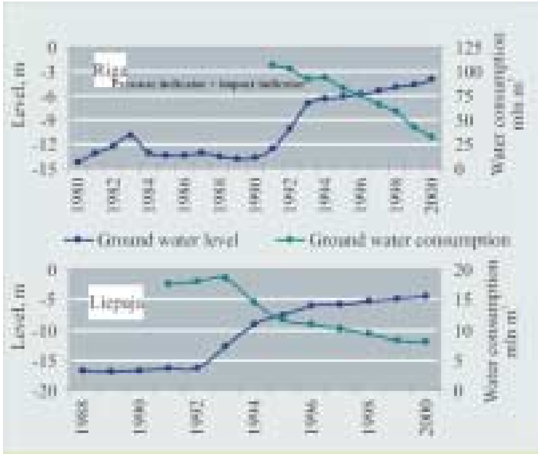
Groundwater levels

Key message:
☺ Groundwater levels have increased in some European aquifers in response to decreases in groundwater abstraction.

Over-abstraction of groundwater can lead to decreases in water levels in aquifers. In turn these can lead to impacts on groundwater dependent terrestrial and aquatic ecosystems such as wetlands. However there are examples of how water resources can recover once over-abstraction has ceased.

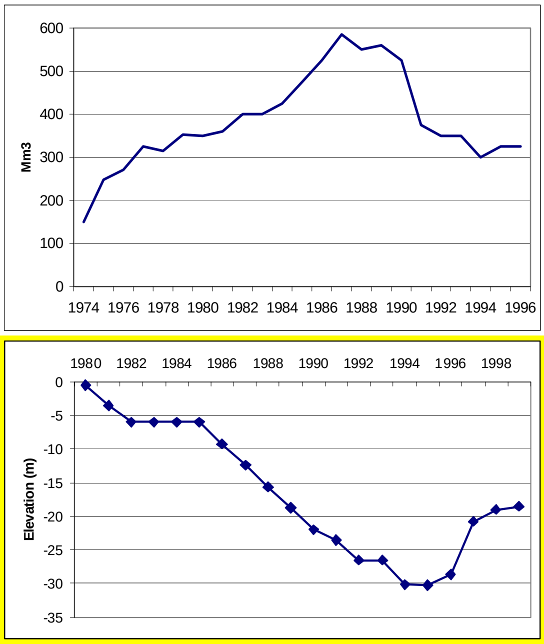
For example, in Hungary (OECD EPR 2000) the intensity of groundwater use has fallen by one-third since the mid-1980s. In Transdanubia, after over-abstraction of karstic groundwater by mining operations was halted in the early 1990s, the water table, which had fallen an average of 30 m, recovered. Intensive and non-balanced use of groundwater caused large underground depression fields, at Liepaja (1 000 km^2) and Riga (7 000 km^2) in Latvia, but decreased water consumption during the 1990s led to a gradual rise in the water level (SoE, 2002) (Figure 7.11). In the Amsterdam Dunes, a large-scale artificial recharge scheme made possible a large restoration of the freshwater store (EU, 2000a). The Spanish La Mancha Occidental in the Upper Guadiana basin was declared as over-exploited, since when abstractions have fallen from 600 million m^3 per year at the end of the 1980s to the current 300 million m^3, and there has been a marked recovery of the water stored in the aquifer, which also means a recovery of the valuable associated ecosystems (see Figure 7.12).

Figure 7.11 Changes in the groundwater level and water abstraction in Riga and Liepaja, 1980-2000



Source: Latvia SoE report, 2002

Figure 7.12 Annual abstractions from the aquifer (top) and water-level recovery (bottom) at representative borehole in La Mancha Occidental



Source MMA2000

Policy Question 4: *Are we using water prices and water saving technologies to improve water conservation?*

Water prices

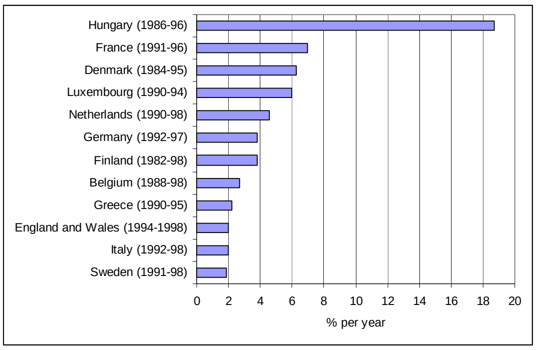
Water pricing is an example of one of the measures that are used to control or reduce water demand by different users. The Water Framework Directive requires Member States to ensure, by 2010, that water-pricing policies provide adequate incentives to use water resources efficiently and to recover the true costs of water services in an equitable manner. Most countries are progressing towards water pricing systems. Nonetheless, quantifying the effects of water pricing at the European scale is complex due to the lack of reliable and comparable data, and the combined effects of other water demand measures.

There has been a general trend towards higher water prices in real terms for the domestic sector throughout Europe in the 1990s (Figure 7.13). There are wide variations in water charges within individual countries and between different countries in Europe. This is because of the wide range of factors that determine local water prices, and whether there is a full recovery of costs including those for water treatment and supply, for sewage treatment and for environmental damage. Water charges usually represent a very small percentage of household income or of GDP per capita (range 0.2 % Oslo to 3.5 % in Bucharest in 1996). In many Accession countries, water prices were heavily subsidised before 1990 but there was a marked increase in prices during transition, resulting in lower water use. In Hungary, for example, water prices increased 15-fold after subsidies were removed which led to a reduction in water use during the 1990s of about 50 % (Figure 7.14).

Industry also tends to be price sensitive to water supply and treatment costs. Consequently, higher water prices are leading to reduced water use through water-saving technology and re-use. Agriculture, which is still widely subsidised, pays much lower prices than the other main sectors, particularly in Southern Europe (Figure 7.15). Increased prices are likely to produce a more marked effect on domestic water use where supplies are metered, water prices are high in relation to income, exploitation is high and where public supply is a high percentage of total supply. Domestic and industrial supplies are now metered in most countries, whilst irrigation supplies are metered only in a few.

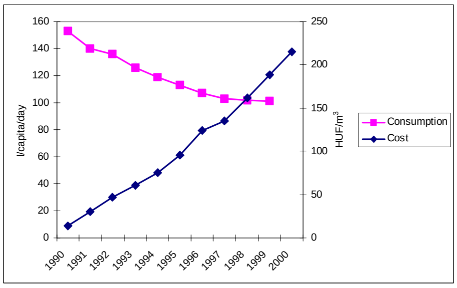
Key messages:
☺ Significant progress has been made towards more effective water pricing policies in many countries that should reduce water demand.
☹ However far less progress has been made in the agricultural sector compared to the domestic and industrial sectors.

Figure 7.13 Domestic water use price: average increases in some European countries



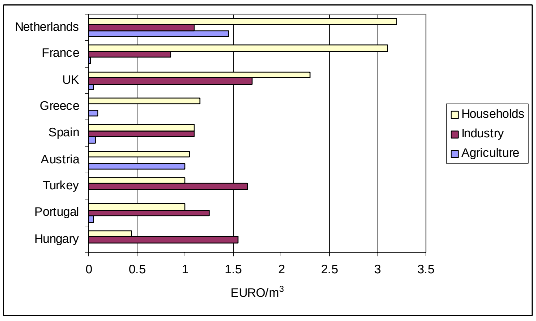
Notes: Average household combined sewage and water bills, except for Germany and Luxembourg where data are only to public water supply. The period over which the average price increase was calculated for each country is given in brackets.
Source: OECD 2001

Figure 7.14 Changes in household water use and price of water in Hungary



Source: OECD, 2001

Figure 7.15 Comparison of agricultural, industrial and household water prices in late 1990s



Notes: Median values for range of prices are shown in each category and should be considered as indicative only.
Source: OECD 1999, 2000, 2001.

Policy Question 4: *Are we using water prices and water saving technologies to improve water conservation?*

Water use efficiency

Water demand management measures are being introduced to promote water use efficiency in the major water sectors. Improved water efficiency is being reinforced by water prices and European and national legislation.

Higher standards of living are changing water demand patterns. This is reflected mainly in increased domestic water use, especially form personal hygiene. Most of the European population has indoor toilets, showers and/or baths for daily use. The result is that most of the urban water consumption is for domestic use. Most of the water use in households is for toilet flushing (33 %), bathing and showering (20-32 %), and for washing machines and dishwashers (15 %). The proportion of water used for cooking and drinking (3 %) is minimal compared to the other uses. Statistics and experience has shown that there is a potential to improve the water efficiency of common household appliances such as toilets, taps and washing machines. For example new technologies have reduced the amount of water used by domestic appliances such as washing machines and dishwashers over the last 30 years (Figure 7.16).

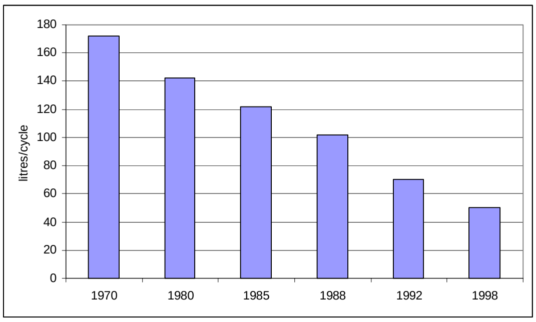
Data at the European scale are insufficient to undertake a thorough and quantitative assessment of the water savings achieved, whether these are being introduced equally and with sufficient speed to meet policy requirements to improve the environment or to meet sustainability targets. Improvements in water use efficiency in the agricultural sector generally lag behind those in the urban and industrial sectors.

The impact of the use of household water–saving devices on total urban demand will be different depending on the proportion of household demand in total urban demand. For some countries savings of up to 40 % of total urban demand might be achievable. In addition to maximise potential savings it would be necessary to encourage market penetration of technological devices by increasing information for users and seeking the co-operation of producers.

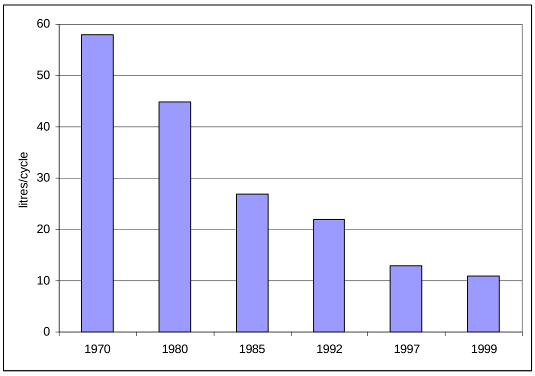
Key messages:
☺ Water use efficiency can be improved using various water-saving devices in households, public places and industry.

Figure 7.16 Evolution of water used for a) washing machines and b) dishwashers

a)



b)



Source: Water efficiency in cities, International Conference, 1999.

Policy Question 4: *Are we using water prices and water saving technologies to improve water conservation?*

Water leakage

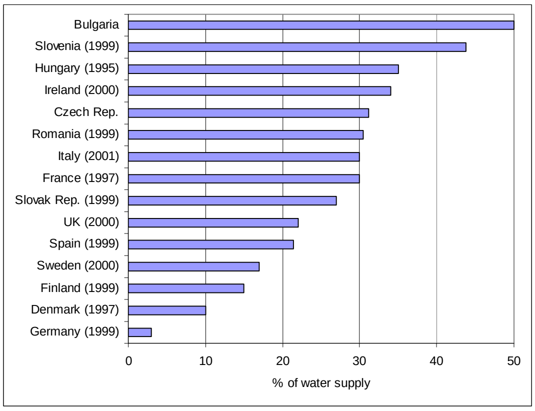
Losses of water in the distribution network can reach high percentages of the volume introduced. The problems with leakage are not only related to the efficiency of the network but also to water quality (contamination of drinking water if the pressure in the distribution network is very low). Leakage reduction applies to both distribution and customer supply networks.

Leakage losses are still significant in many urban areas (Figure 7.17). Commonly, this is due to the poor condition of water mains. Germany has a low leakage levels due to a combination of favourable soil conditions, treatment to reduce the aggressiveness of the water supplied, easy access to repair mains and a high level of mains replacement. In Accession countries losses are significant and large parts of the distribution networks are made from asbestos cement pipes that are more than 25 to 30 years old. Maintenance of the existing infrastructure is also neglected in most countries. Network losses in Slovenia in 1985 and 1990 were 31.7 and 30.4 % of total water urban supply, respectively, but increased to an average of 43.8 % during the period 1994-1998 (Figure 7.18). In Slovenia reconstruction of the water supply network started in 1995 by changing asbestos pipes.

Nonetheless, progress is being made to reduce leakage losses in some countries. In England and Wales, an active programme of leakage reduction reduced network losses from 29 to 22 % of the total distribution input between 1992/3 and 2000/1 (Figure 7.18). In Spain average water losses in the distribution network increased from 20.0 to 21.4 % between 1996 and 1999, with only 4 regions recording a reduction in water losses over this period. In Malta, leakage control policies have been introduced to reduce leakage rates by 55 % from 1995 to 2001.

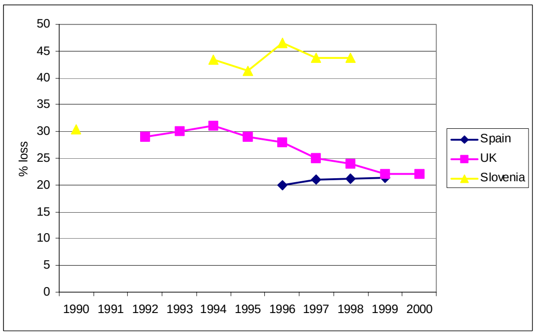
Key messages:
☹ Leakage losses are still significant in many urban areas.
☺ Progress is being made in some countries to reduce water leakage from urban distribution systems.

Figure 7.17 Estimated losses from urban water networks



Notes: Year of data given in brackets
Source: Compiled from various sources by ETC/WTR

Figure 7.18 Trends in urban leakage in Spain, UK and Slovenia



Notes: Loss as percentage of total public water supply.
Sources: Spain, INES; UK, OFWAT; Slovenia, Statistical Yearbook of Office of Republic of Slovenia, 2000

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