of »water services«. Water in households is mainly needed for cleaning and washing, for personal hygiene, and for toilet flushing (*Table 2.2-1*).

To satisfy the basic human needs like drinking, washing and cooking a minimum of about 5 litres water per day and person is estimated (GLEICK 1996). Of course this value varies due to regional climatic conditions and individual psychological features, the deviations in both directions are however comparatively low. The water demand increases, if an adequate quality of life and sanitary conditions shall be achieved. The World Health Organisation (WHO) and the US Agency for International Development published an estimated water requirement of about 20 to 40 litres *per capita* and day and, while the European Environmental Agency estimates a minimum requirement of about 80 litres *per capita* and day.

Taking these minimum requirements into account present studies and reports covering the world-wide water supply show that half of the current world population can not rely on water services which were already standard to the old Romans and Greeks (WOLFF & GLEICK 2002).

Compared to the total amount of water withdrawn from the groundwater and surface water reservoirs, the water use of the private household sector is only of minor importance, but there are large differences between countries and regions. The world-wide water demand of private households grows due to an increase in world population and the ongoing processes of urbanisation in the developing countries. On the other side, in the most developed countries domestic water demand varies strongly but all together the situation is characterised by a stagnant development or in some cases by a real decrease of the water use figures.

The water use of the private households is measured by the volume of water which is withdrawn from the central public water supply network. The specific water use figures per day and capita are then calculated under the consideration of the total population number within the respective regional or local supply area. International comparisons of water use figures have to take into account that in many countries only a part of the population is connected to a public water supply network. Therefore, the statistic figures published may be stated too low in those countries; on the other hand the specific water use rate may be too high in those countries or regions where tourism is of significant importance (WIELAND 2003, p. 3).

Water use in households varies enormously between different regions: while around 20 litres *per capita* and day are used in the rural arid regions in Africa, an US – American has in average a water demand of almost 300 litres per day.

The average *per capita* water use within the member states of the EU is currently around 150 litres per day, but even within this association of developed countries the figures vary between 113 litres *per capita* and day in Belgium and 214 litres in Finland.

The specific water use value in the new accession countries of the EU is 105 litres *per capita* and day on average. This below-average value is mostly a combined effect of a lower standard of living and a higher rate of self sufficiency. In Germany the specific water consumption in 2004 was 127 litres *per capita* and day, about 20 litres lower than the water use in the year 1990, shortly after reunification.

Table 2.2-1 represents the share of the water use categories of the domestic sector in Germany. The data are mainly based on estimations since the water use in households is not differentiated between the individual categories. Hence, international water use studies show comparable results.

Industrial water use

About 20 per cent of the world-wide water withdrawn is used in the commercial and industrial sector. The differences between different countries are considerable; the share of the industrial sector at the total water use is almost 60% in the developed countries whereby the role of the agricultural sector as water consumer plays a comparatively minor role in these countries.

According to different scenarios, an increase of the industrial water demand up to 1,170 km^3 per annum till the year 2025 is expected on the global level, this would correspond to a share of this sector at the total water use of about 24 per cent. The largest part of this projected increase in industrial water use will be realised in those developing countries with high economic growth rates, and especially by those which heavily rely on resource – intensive industries. Water demand projections show a rise in water use for electricity generation especially in the African, Asian and Latin American countries.

In the European countries water use in the industry is currently around 10% in average, not taking into account the water withdrawn for cooling purposes in the electricity generation process. If the water quantities needed for cooling purposes or used in hydroelectric power stations are included, then the share of the industrial sector at the total water withdrawals is up to 32% (see *Table 2.2-2*).

During the 1980s and the 1990s, the industrial water use considerably decreased in the most developed countries. This development is to a great extent caused by new production technologies with lower water input and in a broader sense a decoupling of economic growth and resource consumption. This can impressively be illustrated by the following examples: Before World War II the water quantity needed for the production of one ton of steel was

about 60 to 100 tons, today with improved technologies the water use has been reduced to less than 6 tons of water per one ton of steel. A further reduction of water use in this branch is due to a substitution of steel through aluminium for example in the automobile production (WOLF & GLEICK 2002, p 23; EUROPEAN ENVIRONMENTAL AGENCY 1999).

This development is expressed in the literature by different ratios. The concept of »water productivity« is for example a useful instrument to describe changes in the industrial water use. This indicator relates the quantity of goods and services to the quantity of water necessary to produce these goods. The quantity of produced industrial goods and services can be measured in physical units (number of the products, weight etc.) or in monetary units (gross domestic product, gross added value).

Table 2.2-1: Percentage composition of the private consumption (department of the environusement 2001, p. 34)

Boiling and drinking	3
Personal hygiene	6
Baden and showers	30
Toilet flush	32
Cleaning	3
Washing the dishes	6
Wäschewaschen	14
Garden sprinkle	4
Car laundry	2
Total	100

Table 2.2-2: Share of the industry in the complete water withdrawal (EUROPEAN ENVIRONMENT AGENCY 1999).

Country	**Industrial water consumption (without cooling water)**		**Cooling water for power stations and water power**	
	($\times 10^6$ m^3)	**(%)**	**($\times 10^6$ m^3)**	**(%)**
Belgium	210	3.0	5,149	73.4
Denmark	82	9.0	0	0.0
Germany	6,475	11.0	16,952	28.8
Finland	1,111	33.2	1,690	50.5
France	3,942	9.7	25,835	63.5
Greece	136	2.7	91	1.8
Großbritanien	848	7.0	1,721	14.2
Ireland	250	20.6	277	22.8
Italy	7,980	14.2	7,025	12.5
Luxe castle	14	24.5	0	0.0
Netherlands	507	4.0	11,028	87.0
Austria	489	20.7	885	37.5
Portugal	241	3.3	2,682	36.8
Sweden	1,479	54.6	70	2.6
Spain	1,647	4.6	4,915	13.9
Total	**25,411**	**10.4**	**111,612**	**31.8**
	Average value		Average value	

* water can be used repeatedly

Source: EEA, Environmental assessment report of No 1: Sustainable water use in Europe, share 1: Sectoral Use of Water

The term »water use efficiency« describes another concept and considers the potential of water savings in the industrial sector. Efficiency is the ratio between the minimum of water needed for a certain kind of production process and the quantity of water currently used in this process. Every reduction in the current water use leads to an improvement of the efficiency measure in direction of 1.0 (i.e. 100 per cent efficiency).

Although there is an improvement in the world-wide water productivity during the last decades, there are of course some considerable differences between the countries. This is a result of a very uneven access to new technologies, the various degrees of economic structural changes and the different emphasis of water – intensive branches. But also dissimilar water costs as well as specific environmental policies may be of importance in this context.

Water demand projections

Prerequisite for a long term sustainable management of water resources is a reliable estimation of future water supply and water demand in a region or in any country. Since the 1960s there has been numerous global water demand projections, mainly based on the analysis and the extrapolation of historical water use figures.

GLEICK (2000) evaluates altogether 26 global water demand projections published since 1967 which deal with projection periods between 20 years and half a century.

The results of his study are clear : The older studies are very simple trend extrapolations of water use and operate with ratios in the form of water use per person or per acre in the case of irrigation. More current studies use a larger number of demand categories and distinguish between domestic, industrial and agricultural water demand and the water needed to maintain ecological functions. Some studies also take into account water losses in the supply network as well as the potential effects of climate changes on water resources and water demand. The quality of the projections is improving since more developed projection methods are applied, and a broader data base and expanded information processing capacities are available.

Today water demand projections are based on the scenario method. This is not a forecast or projection in the narrower sense but a method to show possible future developments taking into account different circumstances and assumptions about the development of the main factors influencing water demand. Depending on those different conditions and sets of relevant factors, several future outlines can be distinguished.

The World Water Commission for example describes three scenarios to assess world-wide water supply and water demand till the year 2025. The »Business as usual«

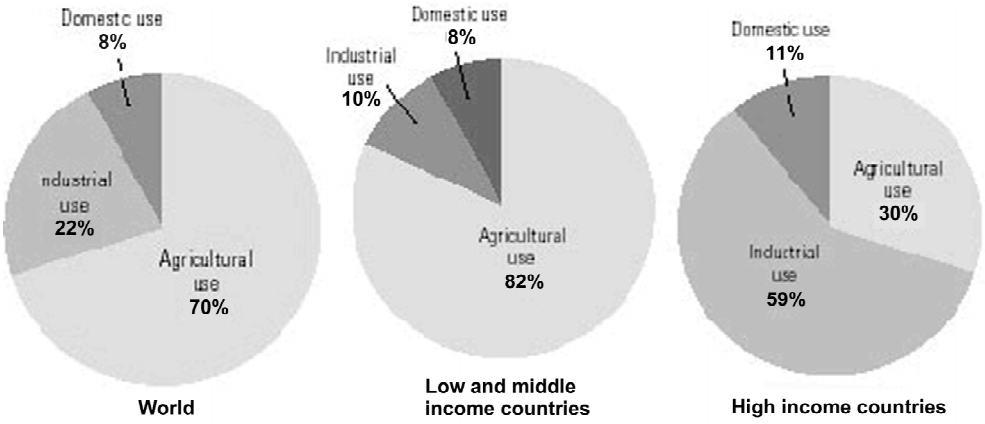

Fig. 2.2-2: Water use by states (UNITED NATIONS 2003, p.19).

scenarios describes the future water demand assuming that there is no change in the economic, social or political framework and relies therefore on the extrapolation of recent trends. The second scenario focuses on future water demand under the assumption that there is a decisive improvement in water use efficiency due to new technologies. The third scenario deals more with changing life styles, values and consumer behaviour and describes a picture of a more sustainable society.

A comparison of the predicted results with the actual results turned out the deficits of most forecast methods. The former projections have overestimated the current water use since they simply extrapolated historical trends without taking into account the changing economic conditions and the effects of new social, institutional or political frameworks. The lower growth of the water use resulted from considerable but maybe not predictable improvements in the water use efficiency. Of course water demand is also influenced by the very unfavourable economic developments in a lot of countries.

In the midst 1990s the actual water withdrawals were world-wide only half of those quantities predicted in the demand forecasts 30 years ago. SHIKLOMANOV (2000) assumes that in the year 2025 there will be less global water use than he himself has calculated 1974 in a demand forecast for the year 2000.

From this point of view it appears to become obvious that at least on the global scale there will probably be no problems with the availability of water resources in a foreseeable future. To illustrate this assessment: even if according to recent projections the world population should increase to about 9.4 billion people in 2050 and if one assumes an average *per capita* water use on the current (high) US level, a *per capita* water volume of 4,600 m³/year would still be available (SCHMANDT 2003).

Despite these good news at the global level there are however regional imbalances between water supply and water demand all over the world and there are clear signs that these problems will increase in the future.

For the implementation of an effective water management, regional water demand projections should be available which take into account all relevant factors and conditions influencing future water demand.

In the context of the UNESCO International Hydrological Programme IV a total of 26 regional water demand projections for so called »natural economic regions« were drawn up; these large scale regions are characterised by comparable economic and natural conditions. Such regional studies are useful to determine those areas which in future will be confronted with serious water problems due to an increase in water demand and/or a reduction of available water resources. The distinction between »water stress« and »water scarcity« regions is of relevance for policy implementation. »Water stress« means that in certain regions only between 1,000 and 1,600 m³ of water are available *per capita* and year, in a water scarce region the water availability is limited to only 1,000 m³ or less *per capita* and year.

Western European countries are altogether classified as water stress regions but according to recent demand studies this situation would not deteriorate however. Modern sewage treatment methods and water reuse techniques will probably reduce the future water demand in the developed countries. Nonetheless, under »business as usual« assumptions, the number of people living in water stressed regions will globally rise to about 3.4 billion world-wide until the year 2025, compared to 1995 this would be almost a doubling ♦