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Technology Foresight Summit 2007

27-29 September 2007, Budapest, Hungary

Organized by UNIDO in cooperation with the Government of Hungary

Main Report

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Technology Promotion Unit

Investment and Technology Promotion Branch

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

Vienna, 2007

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Introduction

The second Technology Foresight Summit, held in Budapest on 27-29 September 2007 was a flagship event of UNIDO's Regional Technology Foresight Programme for Central and Eastern Europe (CEE) and the New Independent States (NIS).

Its main objective was to facilitate exchanging experiences of foresight practitioners and to contribute to the discussions related to the protection of water resources through more rational and sustainable use of water by industry. The event also targeted to examine how foresight methodologies can be applied both by governments and by business for formulating strategies in order to move toward the internationally set target on zero discharge of effluents by industry.

The Summit combined four types of events:

- a symposium on water productivity in the industry
- a technology foresight panel
- a fair on water technologies of the future (with strong industrial participation), and
- a ministerial roundtable.

The Summit was partially dedicated to the highlight area of industrial water productivity. Participants exchanged views in order to identify actions that industry, governments and other stakeholders should do today in order to move toward preferable future to reach zero discharge of effluents by the industrial sector. The Summit discussed policy and methodology issues related to the application of foresight as a tool for support strategic decision-making.

Participants of the Summit represented a wide range of stakeholders, including high-ranking decision makers from governments, industrial experts and leaders, academy, international organizations and NGOs.

This report aims at summarizing the major findings of the Summit and the recommendations formulating by expert discussions to different stakeholders. The report discusses separately the main issues in relation to water productivity in industry and technology foresight, then shortly examines how foresight may be used effectively as a tool for industrial water productivity strategy setting. At the end recommendations are listed to different stakeholders.

The report is based on the papers presented at the meetings. All these papers are available in the Summit's documentation at the web page www.unido.org/foresight/summit/2007.

Industrial Water Productivity

Water on International Agenda

Since the 1970s the international community has recognised that much more attention should be given to water-related challenges. Water has become a high priority on all environment and sustainable development related international efforts. The number of high-level political meetings, declarations, action plans directed on water has grown significantly since 1977:

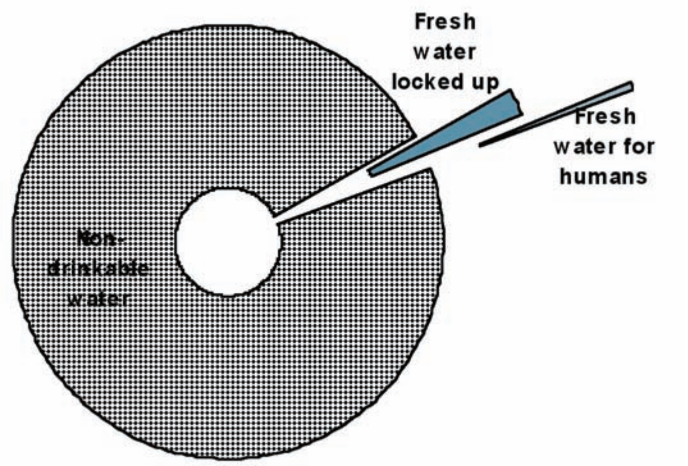
1977	Mar del Plata – UN Conference on Water
1981-1990	International Drinking Water Supply and Sanitation Decade (UN)
1994	Noordwijk – Ministerial Conference on Drinking Water Supply and Environmental Sanitation (Action plan "to assign high priority to programmes designed to provide basic sanitation and excreta disposal systems to urban and rural areas.")
1997	Marrakesh – 1st World Water Forum: World Water Vision
2000	La Hague – 2nd World Water Forum
2000	United Nation Millenium Declaration; Targets: "Halve, by 2015, the proportion of people who are unable to reach or to afford safe drinking water"
2001	Bonn – International Conference on Freshwater: Need for actions in governance, mobilising financial resources, capacity building and sharing knowledge.
2002	Johannesburg – World Summit on Sustainable Development; Sanitation is added into the Millenium Declaration targets – by 2015 halving the proportion of people with no access or can not afford basic sanitation.
2003	Kyoto – 3rd World Water Forum
2003	International Water Year
2005-2015	International Decade for Actions – Water for Life (UN)
2006	Mexico City – 4th World Water Forum

Why we have so much concern on the globe's water security?

Global situation

"*Water is not a commercial product like any other but, rather, a heritage which must be protected, defended and treated as such*."[1] There are alternative sources of energy, but there are no alternative to water.

Figure 1: Share of fresh water in world's total water resources

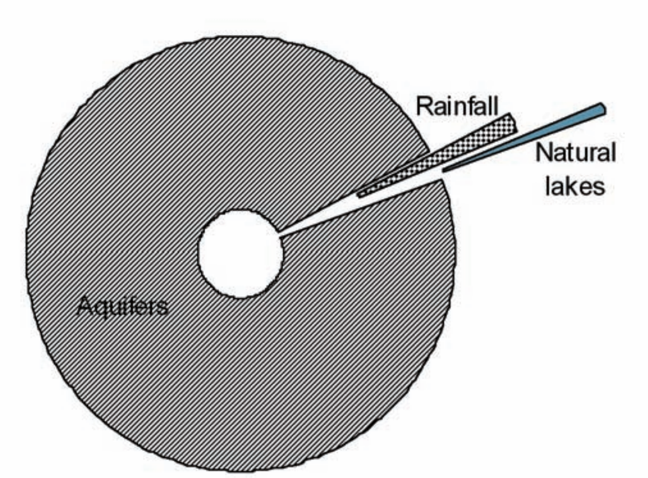


Source: Facts and trends – Water; World Business Council for Sustainable Development, ISBN 2-940240-70-1, August 2005

3% of the world's water is drinkable (the rest is mostly seawater and other non-drinkable water). Today's desalination technologies require a lot of energy, so the price at this moment both economically and environmentally is too high to use much more fresh water produced from seawater. Only a few regions can allow (and are forced) to apply these technologies.

More than 80% of fresh water is frozen (in Antarctica, the Artic and glaciers – at our present technological level in practice they are not available for humans), so only 0,5% of the earth's water is available to satisfy our fresh water demands.

Figure 2: Where fresh water resources are located?



Source: Facts and trends – Water; World Business Council for Sustainable Development, ISBN 2-940240-70-1, August 2005

1 Directive 2000/60/EC on establishing a framework for Community action in the field of water policy, October 23, 2000

10 million km^3 is stored in aquifers[2] (97,9% of total freshwater), 119 000 km^3 net of rainfall falling on lands (1,16%). The rest is considered as surface water: 91 000 km^3 in natural lakes (0,89%).[3], over 5 000 km^3 in man-made storage facilities (0,05%)[4], and 2 120 km^3 in rivers, constantly replaced from rainfall and melting snow (0,02%).

Water sources differ by quantity, quality and availability. For example groundwater and thermal water are usually good for most uses but can easily be contaminated. Their quantity is variable depending on location. Surface water, rivers and lakes are variable depending on human and biological impacts, and can play an important role locally. Lakes comprise 87% of surface water. The quality of water in ice caps and icebergs is excellent, and it represents 1,74% of global water and 69% of fresh water, but locally it does not play a significant role. Rain water's quality is good, its quantity is limited and its distribution both geographically and in time is very imbalanced. The municipal sources, especially sewage water is poor in quality and its quantity is very infrastructure-dependent.[5]

The literature makes difference between water based on its level of contamination. **Wastewater** is the portion of withdrawn water which has been polluted and must be treated to the regulatory levels before reaching other water sources. **Discharge** means the introduction of any substances into water. **Pollution** means the discharge by human activities (EU Directive 2006/11/EC).

2 Aquifer - An underground geological formation or group of formations containing usable amounts of groundwater that can supply wells and springs.

3 We are witnessing dramatic declines in the size of many lakes and inland seas. Examples: Aral Sea, Dead Sea and Lake Chad. The volume of water in the Aral Basin has been reduced by 75% since 1960. Lake Chad, a freshwater lake shared by four African countries declined to 10% of its size from 1963 upto now (source: Grobicki's paper to the Summit)

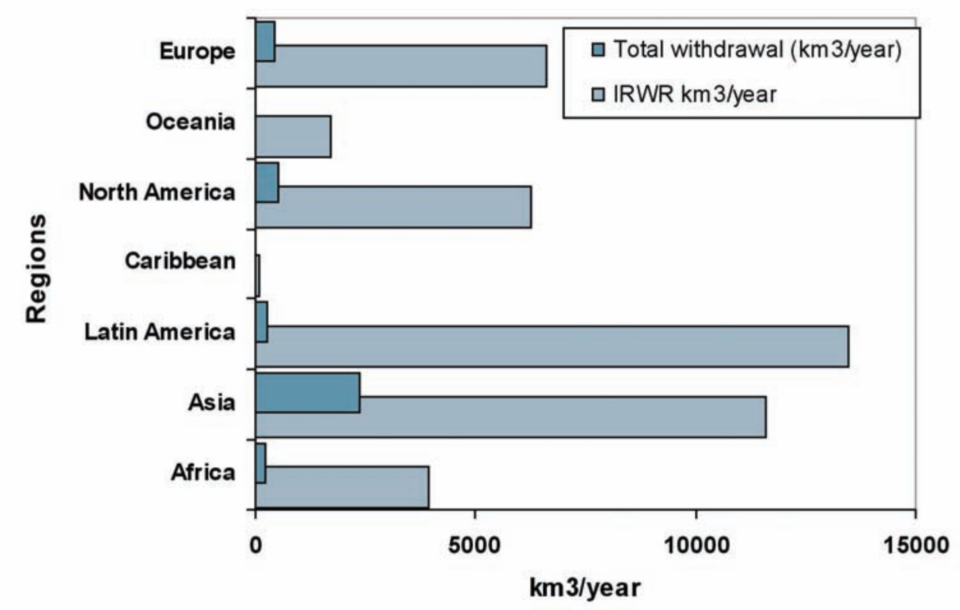
4 Since 1950 the global storage capacity has shown 7 fold increase

5 Payne (2007)

Do we have enough water?

The amount of water on earth is stable, but it is not available always where and when needed. Droughts, floods, climatic and usual seasonal variations may result in extreme local conditions.

Figure 3: Total IRWR and water withdrawal by regions, 2003



Source: Kopytowski (2007)

The available water resources (the IRWR[6]) and their actual use (withdrawal) show large variety among continents (see Figure 3). While Asia withdraw more than 20% of its resources for various purposes, Africa, Europe and North America perform only 5,5 to 8,4 %, and Latin America only 1,9%.

Main users of fresh water

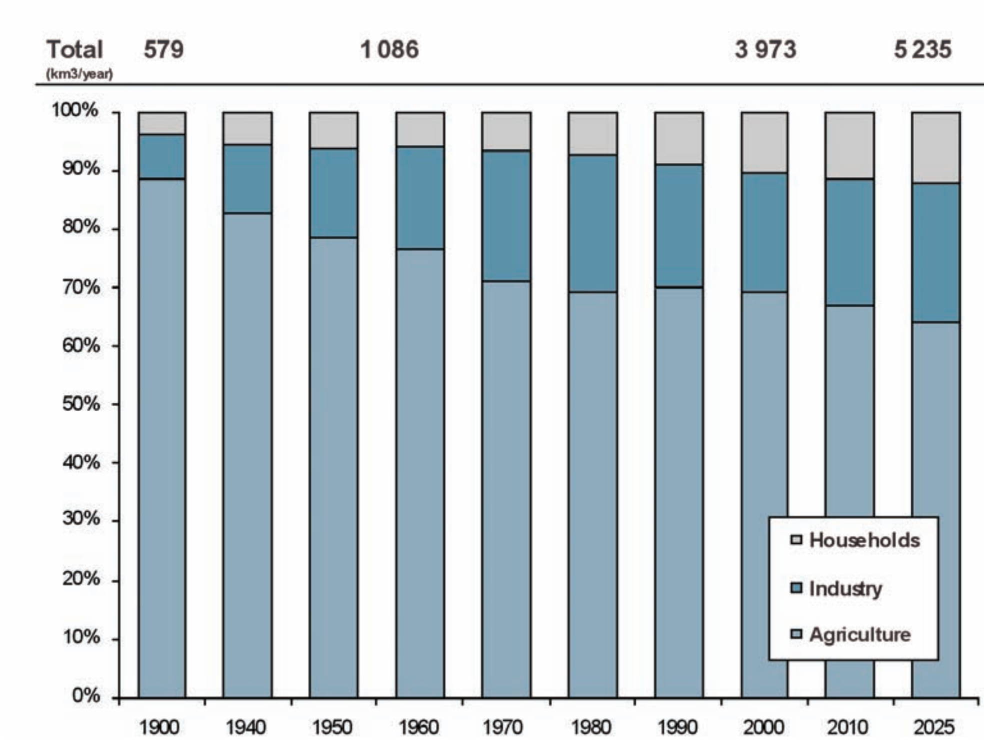
There are three major users of fresh water: households, industry and agriculture. Globally the most water is used for agriculture purposes (70% of total fresh water withdrawal), followed by industry (with 22%) and households (by 8%).

But in the past 100 years the share of agriculture in water use is diminishing, while the shares of industry and the households are growing. The total amount of water used in 2000 was about 7.5 times more than in 1900. (Figure 4)

6 The IRWR comprises the value of the average annual flow of rivers and recharge of groundwater generated from endogenous precipitation. Natural incoming flows originating from outside of a country are not included.

Irrigation is the key application in agriculture, which in several countries accounts for more than 90% of total fresh water use (India: over 90%, China and Egypt: over 80%). In other countries, like the rainy England it is very low (less than 1% of total consumption). In several countries and regions the locally available sources can not satisfy fully the demands. The situation is serious in the South-Western regions of the US, in Chile, in the Western regions of Mexico, in South and North Africa, in South-Eastern of Spain, in Eastern India, and in several smaller regions in Central Europe as well.

Figure 4: Share of total water withdrawal among major users (1900-2025)

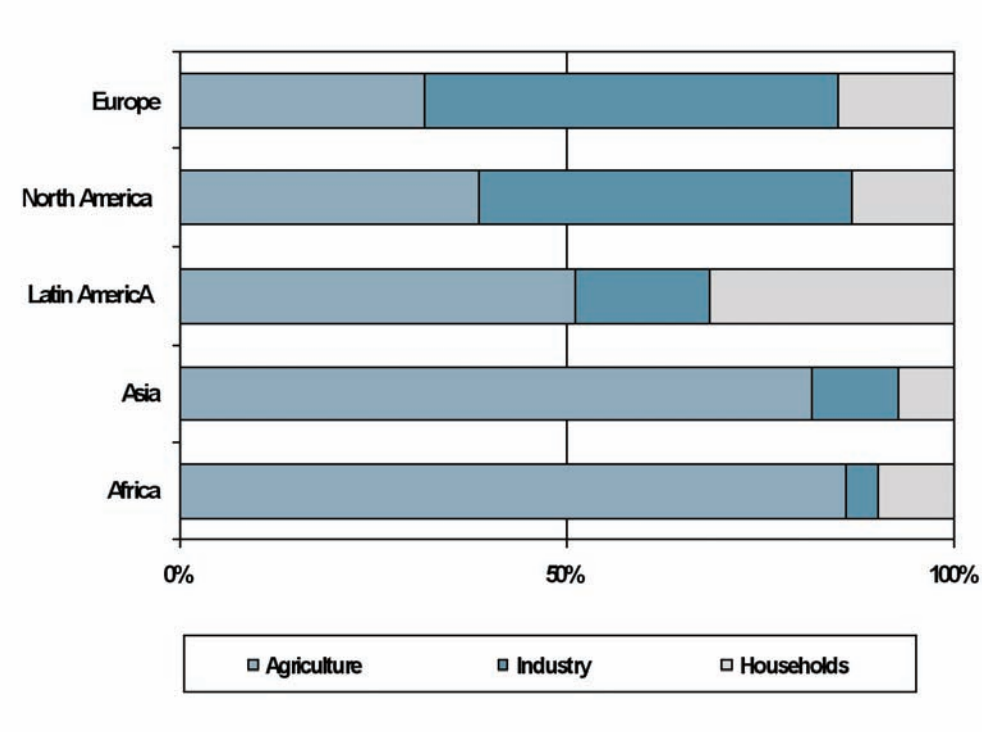


Source: Shiklomanov, http://webworld.unesco.org/water/ihp/db/shiklomanov/index.shtml

The households use different applications. People need clean water for drinking, cooking, washing and sanitation. Water is essential to health. Water consumption in households is growing, but differences among regions and countries are significant mostly based on the level of per capita income. Some shocking facts may highlight the seriousness of the problems and the need for urgent actions: 3 900 children die every day due to poor quality of water and hygiene[7], more than 1 billion people – mostly in Asia – has no access to improved drinking water sources, and 4 out of every 10 humans live in bad sanitation environment (Asia and the Sub-Saharan regions are mostly affected)[6].

7 „Water, Sanitation and Hygiene to Health, Facts and Figures", WHO, updated November 2004

Figure 5: Share of users by regions



Source: Kopytowski (2007), from FAO data (World Research Institute, 2006)

The large geographical regions show a large variety in this sense. Agriculture has less than 50% weight in Europe and in North America, and industry is the largest user of water in both regions. Households withdraw more water than industry in Latin-America and in Africa. (Figure 5)

The challenge: water stress

The distribution of water resources and its withdrawal are not necessarily in good balance, the demand-supply chain may be broken occasionally, periodically or in several cases permanently. The growing consumption and inappropriate applications have resulted in high environmental costs, like loss of biodiversity, and disappearing wetlands, rivers and lakes.

"*The optimum scenario for water supply and use is to have the right quality of water in the right quantity, in the right place, for the right use at the right time. However, it is the quality of water that frequently undermines the efficiency of this equation.*"[8]

In the 20th century the world's population tripled, while the use of renewable water resources grew six-fold. Just in the past 50 years water use has more than tripled. The consequence is clear: more water shortages, scarcities and growing stress in more regions.

We talk about water stress when the demand is higher than the resources available for local users. According to international experiences, when the annual per capita renewable fresh water availability is less than 1 700 m^3, countries face water stress. Below 1 000 m^3 water scarcity results in negative economic consequences and human health suffers as well.

8 Payne (2007)

About one third of world's population is living in countries suffering from high or moderate water stress.[9] According to estimations by 2020 this share is doubling.[10] At present, and definitely in the future, the nature-run environmental cleaning capacities are also being exhausted and it can not play its traditional role anymore.

As the stress is becoming more distributed geographically, tensions among local communities, regions and countries, stakeholders and different users may intensify. More than 260 river basins are shared by two or more countries, so only regional, cross-country collaborations, agreements and joint monitoring activities and other coordinated actions may manage successfully potential crisis situations originated by fighting for limited resources.

How humans contribute to the water stress

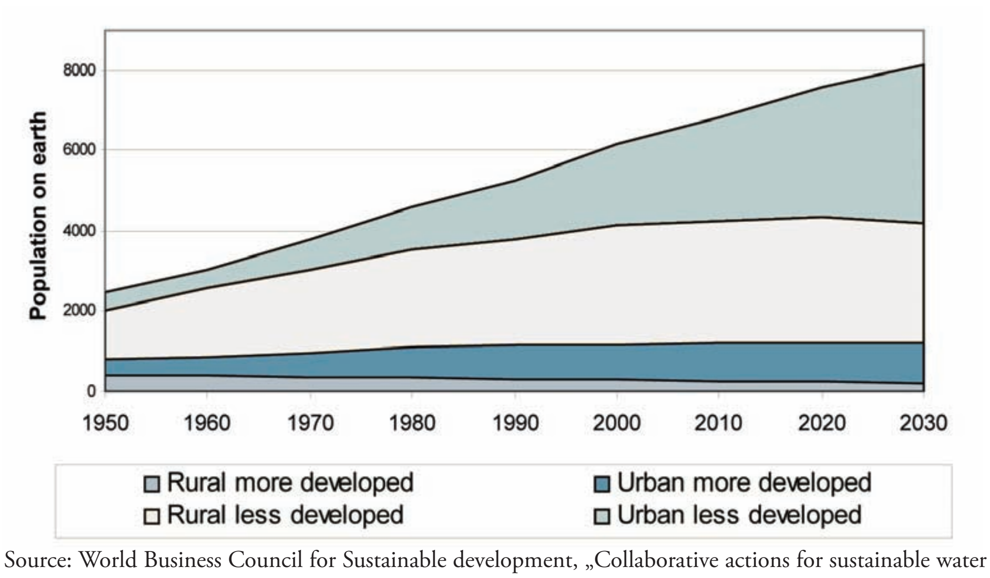
Human activities have a strong correlation with water stress; many human activities contribute both directly and indirectly, to challenging it. The process is driven by many factors.

Major drivers that determine the global water scenarios:[11]

Demographic

a. Growing population: The population has doubled since 1950, while the water consumption has tripled. According to UN estimates the present 6,2 billion population on earth will grow to 10 billion by 2050. Most of the growth is expected to happen in the developing regions, which already suffer water stress. More people will require more water.

Figure 6: Population on earth between 1950 and 2030 (forecasted) by the types and sizes of settlements



Source: World Business Council for Sustainable development, „Collaborative actions for sustainable water management", August 2005

9 „Water and wastewater reuse, An Environmentally Sound Approach for Sustainable Urban Water Management", UNEP, 2002

10 World Business Council for Sustainable development, „Collaborative actions for sustainable water management", August 2005

11 Gallopin, G.C & Rijsberman F., „Three Global Water Scenarios"

b. Rapid urbanization: 2007 is the first year in our history when more people live in cities than in rural areas[12]. According to forecasts the population in urban environment will grow much faster than in rural areas in the coming decades. (The rural population is expected to stabilise at around 3,2 billion level - only a slight increase from the present 3 billion). Water supply in high-density urban areas needs different approaches, solutions and investments than in villages. The huge production of waste water in big cities will seriously challenge the authorities, citizens and the environment. (see Figure 6)

Economic: The intensification of industrialisation in several developing countries and the transition of traditional business activities to services "can lead to more pressure on water resources and natural ecosystems."[13]

Climatic change: The climate change, as forecasted today, may have ambivalent impacts on the water stress challenges. On one side the rising temperature may result in higher rate of evaporation from the surface and from reservoirs. On the other side the annual precipitation could bring more fresh water to some locations. But the annual averages can come from more storms and floods, and the real impacts are hard to estimate. Locally they may be positive but seriously worsening as well. In time of droughts water would not be available, while in the periods of flooding huge amount of water is wasted due to limited access of storage capacities (the quality of flooded water is also different than in normal conditions).

Technology: The technological changes may also have mixed impacts on the water related challenges. First of all, modern new technologies can improve water withdrawal efficiency and water productivity. The expansion of high-tech industries may change significantly industrial structure, and new, less water-stressed agricultural products may also go into mass-production. But inefficient use of technologies by industry, poor irrigation activities, leakages in water delivery systems, moving high water-consumption industries to developing countries may cause stresses in water supply.

Social (lifestyles, poverty): Countries like India and China, have taken significant steps in the past decade to improve living standard and fighting successfully against poverty. This process results in a growing demand for fresh water.

Changes in eating habits may also contribute. For example growing 1 kg of potatoes requires 100 litres of water, while 1 kg beef needs 13 000 litres.

The evolution of these drivers can not be forecasted in many cases. For example it is hard to estimate now how the water use efficiency (productivity) will progress. It depends very much on new technologies applied in the market or the intensity of social and political sensitivities on the water stress challenges, and the effectiveness of reactions to these challenges by governments and other key stakeholders.

12 Grobicki (2007)

13 Facts and trends – Water; World Business Council for Sustainable Development, ISBN 2-940240-70-1, August 2005

The growing population will result in higher demand for food, which argues for more agriculture activities. But it is hard to estimate how this increase in demand will affect the water withdrawal by the agriculture sector. It is also unclear how the rain-fed areas will react to this economic opportunity. It can happen that their share in crop production will increase intensively in the coming years, which on the other side will have negative environmental consequences because of deforestration.

In scientific and technological development it is hard to forecast when and in which areas real breakthroughs will happen. At this moment it seems that the trend of using less material and energy intensive technologies in production and the transition from manufacturing to services will continue, but this process will have very different impacts on regions, which may result in a large variety of water stress situation locally.

But probably the biggest uncertainty is whether we are able to change our values and preferences in order to create better conditions for long-term sustainable life on earth. It seems to be obvious that "**to change the way we act, we must first change the way we think**!"[14]

Industrial Water Productivity

Industry is the second largest user of fresh water. But the actual demand largely depends on the type of industries and the purpose of water withdrawal. Industry uses water for the following types of applications:

Water for energy Large hydro projects are designed firstly to use water as a source of energy. But several other objectives (like flood control, irrigation applications, drinking water production and recreation) can also be realised by such mega-actions.

Cooling water Cooling in thermal power generation is the largest single use of water for industrial purposes.

Process water Industry uses water to make steam for direct drive power and for use in various process or chemical reactions.

Water for products Many industrial sectors, mostly the food, pharmaceutical and beverage industries are consuming water as an ingredient in their end products for human consumption. The term of "virtual water" describes the water embedded into such products. By exporting these products water is also exported. Virtual water corresponds to the volume of water required to produce a foodstuff or a given product.

Water as a medium for waste disposal "Water removes any raw material not used in the manufacturing process as waste. This washing and transport function is very obvious in galvanizing operations, the mechanical industry and the textile industry. It can also be seen in the use of cooling water to remove thermal energy (as heat) that can not be utilized."[15]
Rivers, lakes (Nature) can break down small quantity of waste waters disposed by industry, but by reaching its limits the general water quality declines and usually expensive water treatment procedures must be applied in order to clean it up.

14 World Business Council for Sustainable Development, „*Business in the world of water*", WBSC Water Scenarios to 2025

15 Genon (2007)

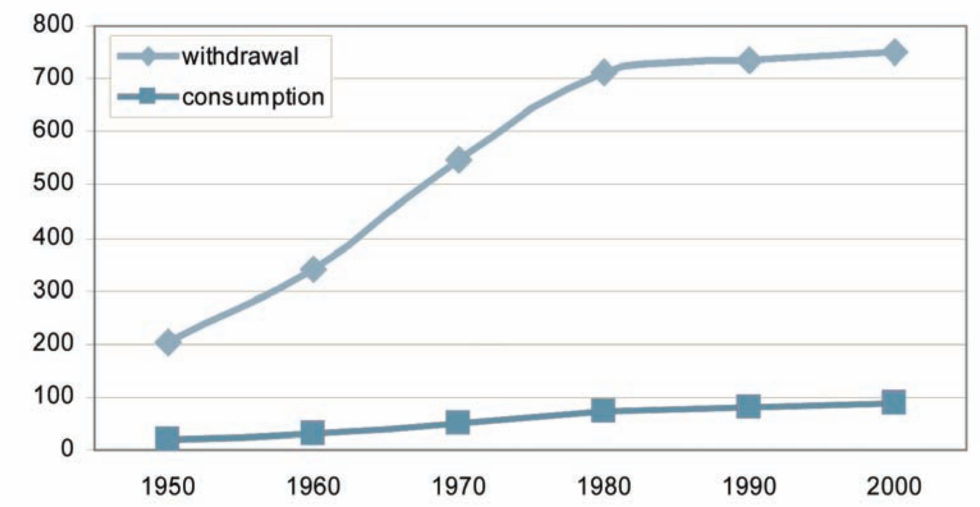
In industry "*withdrawal of water is made from a suitable source, maybe the water is pre-treated, then the product is manufactured, the process possibly cooled and the waste is washed away with or without treatment. This sequence of events, which obviously wastes water, also has the potential to magnify the problems of poor quality in primary water sources.*"[16]

Industrial Water Withdrawal and Consumption

Globally industry accounts for 20-22% of total water withdrawal, but this share is much higher in the more developed regions. Since industrial water demand is forecasted to increase by 1,5 times by 2025[17] the importance of wastewater reuse is growing.

The water withdrawal by industry is much higher than its consumption, since parts of the used water remains in the product, others are evaporating, and some are discharged as wastewater or effluent. The world industrial water withdrawal and consumption changed dynamically in the past 60 years, but the two processes did not run parallel. (Figure7)

Figure 7: Dynamics of global industrial water use between 1950 and 2000 (in km³)



Source: Shiklomanov, http://webworld.unesco.org/water/ihp/db/shiklomanov/index.shtml

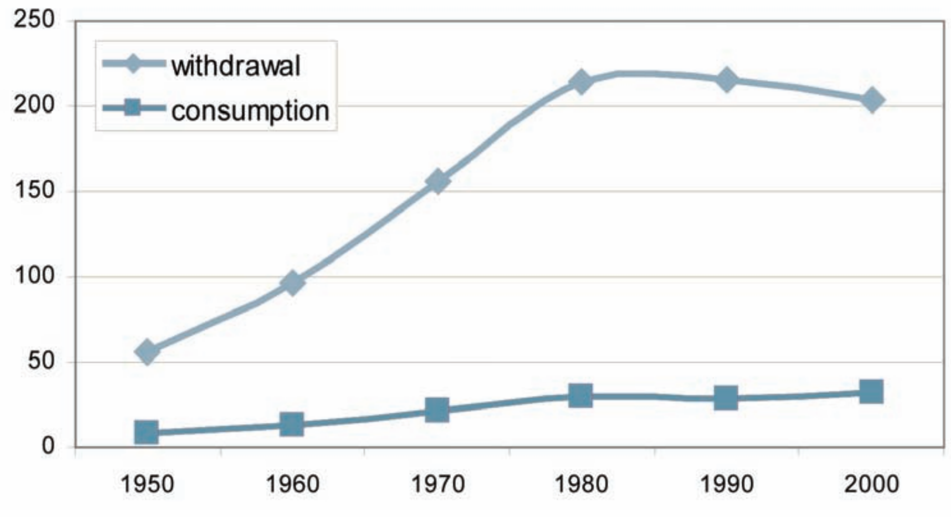
In the years from 1950 to 2000, the world water industrial withdrawal grew from 200 km^3/year to 800 km^3/year, while the water consumption went from 20 km^3/year to 100 km^3/year. The gradual increase in water consumption reflects the continuous growth in industrial production. But since the 1980s the water withdrawal stopped to follow this trend and based on the distribution of new water recycling and reuse technologies withdrawal is no longer growing as fast as before.[18]

Europe shows an even more dramatic success in this sense, probably thanks to measures that several countries have introduced in applying more systematically recycling and reuse in manufacturing and power generation. (Figure 8)

The target is that the withdrawal and consumption curves move to each other and at the end we may reach the status of zero discharge (the possible smallest gap between withdrawal and consumption).

16 Payne (2007)
17 Shiklomanov, „World water Resources and their Use", http://webworld.unesco.org/water/ihp/db/shiklomanov/index.shtml
18 Grobicki (2007)

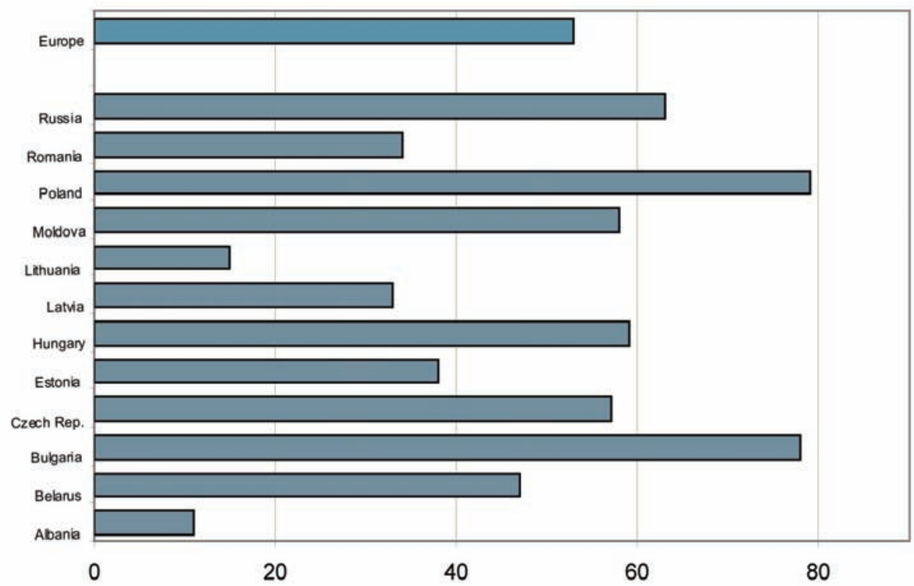
Figure 8: ***Dynamics of industrial water use in Europe between 1950 and 2000 (in km³)***



Source: Shiklomanov, http://webworld.unesco.org/water/ihp/db/shiklomanov/index.shtml

Different industries/sectors require different amount of water to produce marketable goods. 1m^3 of soft drinks need 1,3 to 3,8 m^3 water; in the case of beer this number is 5,5 to 7,1 m^3; 1 ton of brick production needs 15 to 30 m^3 water; textile industry is one of the most water consuming sectors (1 ton of textile require 600 to 800 m^3 water), followed by semiconductor wafer manufacturing (56 to 546 m^3 for producing 1 ton of wafers) and the leather industry (40 to 67 m^3).[19] A nation's industrial water consumption largely depends on the country's industrial structure and the technologies applied.

Figure 9: ***Share of industry in total withdrawal in the CEE region (%)***



Source: Kopytowsky (2007) (based on data from AQUASTAT FAO)

The share of industry in total withdrawal shows a large variety in the European countries in transition. (Figure 9) It would be dangerous to consider them as a unified group by any

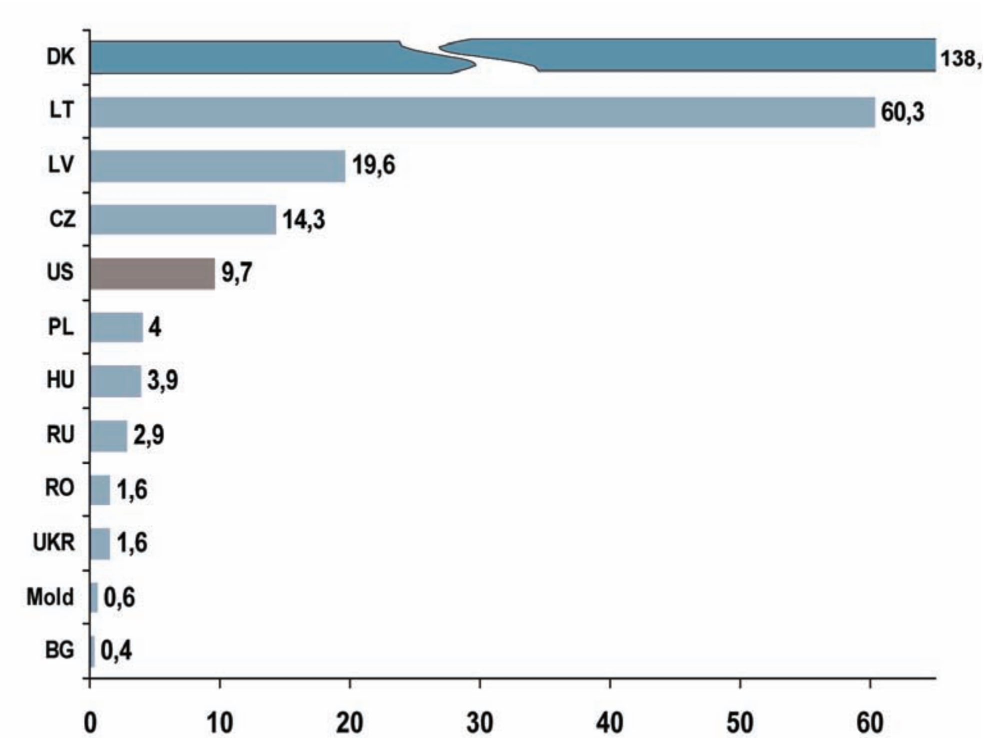
19 Kopytowski (2007)

means. The simple comparison with the European average does not say anything on the level of industrialisation or income in this group of countries. There is no strong correlation between income and industrial water withdrawal in the region. But the actual share in a country may highlight the political, economic and social importance of industrial water management issues.

Water Productivity

Water productivity is the ratio of value of the amount of water withdrawal (in m^3 or in m^3 per capita) to the value of output from the industrial activities using this water.[20]

Figure 10: Industrial Water Productivity (USD/km3)



Source: Grobicka (2007)

According to available statistics, Denmark has the world's highest industrial water productivity, but Japan's position is also very good. The US is much behind the European developed countries. (Figure 10) Industrial water productivity is just partly connected to the level of industrialisation. The level of water stress is a determining factor.

20 The value of output may be measured in industrial value added or in GDP per capita

The quality and quantity of wastewater depends on factors like the source of supply, population density, industrial activities, and the attitudes of the local community. Water quality can be improved by reducing pollution at the source, providing adequate treatment of wastewater or recycling and reuse of wastewater.[21] Generally speaking, industrial water management deals with water use and the wastes generated during industrial processes. The focus of water management may be put:

- to the input (decreasing the demand for fresh-water by reuse/recycling),
- at the end of the procedures (end-of-pipe approach, which aims at cleaning up the polluted water),
- on the industrial process (by applying more efficient and cleaner manufacturing technologies).

Any effective business strategy on water management should focus on two targets: minimize water withdraw and wastewater generation, and increase water productivity.

Water productivity can be increased by many measures. Some can be done individually by companies on site, others need collaboration of enterprises and/or municipalities/governments. Usually a combination of measures may result in successful reaction to the water stress challenge. The application of new technologies should meet effective incentives, fair and correct regulations, efficient management tools and committed leadership both at the business and the community sides. Matching quality to demand, recycling/reuse on site and water reclaim are considered as effective response to the water productivity challenge.

Matching quality to demand

In many cases industry uses much higher quality water than the process would require. Using potable water to water gardens or flushing toilets is a kind of wasting resources. But the opposite may also happen: industrial processes sometimes need extremely high quality water. A better matching to the quality needs may result in higher water productivity.

For the food processing industry typically the water quality requirements are far higher than drinking water. The same is true for pharmaceutical and several high-tech industries (like microchips manufacturing). Others do not require such pure water, but special environmental standards should be satisfied (like in the construction industry). The quality of water for most industries needs to be adjusted to account for the following typical problems: scaling, corrosion, biological growth, foaming (associated with detergents) and pathogenic organisms.[22]

The effect on the final products and on the plant equipments, and the health and safety of the workers should be taken seriously into consideration regarded water quality for industrial use.[23]

Matching use to quality assumes that suitable treatment is applied. Since the available technologies don't function as bottleneck for efficient quality matching, the most critical factors are policy planning to get these technologies into action and promoting regulation which motivates industry to react.

21 Gromiec (2007)
22 Source: "*Water, A Shared Responsibility*", The United Nations World Water Development Report 2, UN-WATER/WWAP/2006/3, UNESCO 2006
23 Genon (2007)

Water/wastewater recycling and reuse

Water reuse means a beneficial use of reclaimed or treated water for specific purposes such as irrigation, industrial or environmental uses. Water reuse can be done directly or indirectly. We talk of direct reuse, when the water goes directly from the treatment plant to the reuse site. Indirect reuse happens, when the water has been discharged from a treatment plant or as an effluent into a natural receiver, such as a surface water or groundwater body, from which further water is taken. Water reclamation is the treatment of wastewater to make it reusable, as reclaimed water. Water recycling involves one use or user.[24]

Water and wastewater reuse has many benefits, and of course several challenges as well. First, recycled wastewater is a much more stable source of water, its quality and quantity may be much better forecasted and designed than in the case of fresh water. "*Some wastewater streams contain useful materials, such as organic carbon and nutrients like nitrogen and phosphorous. The use of nutrient-rich water for agriculture and landscaping may lead to a reduction or elimination of fertilizer applications*."[25] Secondly, the wastewater reuse has a clear economic benefit, since it leads to reduced fresh water consumption and treatment needs, resulting in cost savings. Thirdly, water and wastewater reuse results in lower demand for freshwater, so it may free up resources to higher quality demand applications.

Reuse and recycling of water are very dependent on quality. If the quality for a certain use is not available, then the water is likely wasted. A good monitoring of quality is essential.

The cost of the treatment needs evaluation both from the company's business perspective and also the broader environmental benefits. These two aspects are not always compatible. From a company's point of view there are two costs that must be compared. The first is the cost of the connection to obtain primary source water plus the cost to discharge it. The second involves reuse where the cost of treatment should be taken into consideration. But companies must consider other financial implications as well, for example to quantify "*the performance value of water in the process, the savings or costs associated with discharge, and the difference in costs between open and closed circuits*".[26] Industrial water and wastewater reuse can have direct economic benefits to companies in the form of heat recovery, reduction of production costs (by the recovery of raw materials in the wastewater) and cost reduction associated with wastewater treatment.

The cost/benefit analysis should include all these factors and parameters. The financial comparison is easily done and provides a preliminary indication of the possible cost advantages, but additional elements should also be taken into consideration. The recycling and reuse of wastewater makes the process more reliable and less dependent on freshwater availability. In several industrial processes this lower level risk has huge value in financial terms as well.

Water reuse and recycling for industrial applications have several applications. Examples selected according to the source of wastewater used by industry[27]:

24 Payne (2007)
25 „Water and wastewater reuse, An Environmentally Sound Approach for Sustainable Urban Water Management", UNEP
26 Genon (2007)
27 „Water and wastewater reuse, An Environmentally Sound Approach for Sustainable Urban Water Management", UNEP

Source of water reuse	Applications
Reuse of municipal wastewater	Cooling tower make-up water Once-through cooling Process applications
Internal recycling and cascading use of process water	Cooling tower make-up water Once-through cooling and its reuse Laundry reuse (water, heat and detergent recovery) Reuse of rinse water
Non-industrial use of effluent	Heating water for pools and spas Agricultural applications

In Europe, modified industrial practices, progressive policies and regulations have been widely applied in water reuse. There are many examples of the gradual adoption of recycling and reuse and also of industrial areas where reuse has been achieved by installing redistribution networks for treated industrial water. In some industries the reuse of water is widespread. For example, the galvanizing industry reuses process and washing water. The iron and steel industry and metallurgical sectors reuse cooling water from evaporation towers. However, in some industries, such as textiles and food, only limited adoption has been carried out because of the potential accumulation of deleterious substances that may come from reuse. In fact, the high quality necessary in the final products may limit the major reuse of water.

The energy sector has also witnessed an important increase in water reuse because of increased power demands and the consequent need to deal with large quantities of cooling water. Power generation (nuclear, hydropower and thermal as well) consumes 70% of the total industry demand.

In Europe, reuse in general has been driven by the problems of effluent discharges rather than preserving primary resources. Companies have been encouraged to adopt water reuse by tougher discharge regulations and the increased cost of end-of-pipe treatment. In the future, an increase in water reuse and multi-use can be expected as part of industrial restructuring, while direct recycling also appears to be increasing.

In developing countries the principal reason for reuse is the lack of primary water resources rather than the problem of disposal.

For industrial applications, saving primary water resources is important because they are limited. However, despite the availability of practical technology and studies to demonstrate its advantages, the actual savings and application of reuse are very limited, probably because of the substantial investment that is required.

On the other hand, the reuse of water for agriculture is very significant. Reuse of water for agricultural purposes therefore has social and economic impacts. Moreover, water reused for agriculture sometimes is untreated. This raises the possibility of contaminants ultimately entering the food chain. Hence, effective ways of limiting contaminants in reused effluent are important.[28]

28 Genon (2007)

Reclaimed Water

Water reclamation refers to reusing wastewater produced elsewhere. It happens usually in cooling and power generation. Agricultural and urban irrigation are also important and usual application of reclaimed wastewater. In construction or in several domestic applications (fire fighting, car washing, toilet flushing) can also be targeted as areas for reclaimed water use. At non-industrial environment these applications need dual pipe and service networks, which must be separated in a safe way. Otherwise the reclaimed water must be treated in a way that produces potable water. This process is usually very expensive, so it is viable only in extreme water stressed locations.

The industrial reuse of effluents is becoming more common. The major industries using reclaimed municipal wastewater are power generation, petrochemical, mining and ore processing, and basic metal manufacturing. The predominant use is cooling. Recreational uses for wastewater are found in a number of countries in the form of artificial lakes and parks: golf courses are also watered with treated effluents. Probably the driest countries with growing population are the most likely to turn to reclaim first.[29]

The quality of water can be described by a large number of parameters, like physical, biological, chemical, bacteriological and radiological characteristics. Quality standards should be adjusted to the use of the water. Standards for drinking water have been well-defined for many years. It is common to standardise wastewater quality requirements for irrigation and other agricultural purposes as well. (For example in the US, Israel, Germany and South Africa) It is expected that since water recycling will be more and more applied, further standardisation will become necessary.[30]

Zero Discharge

Zero effluent discharge, according to UNESCO, is a key concept in matching water quality to use. It seeks to find a use for all the effluent that would be discharged by recycling it or selling it to another user. If an industry achieves this goal then its overall water consumption will be close to its withdrawal.

There are additional elements supporting the "zero" discharge strategy. Each litre of discharged wastewater pollutes 3 to 8 litres of fresh water (even if the concentration of pollutants is limited). There are regions where the industrial use of water is not possible due to the water balance. The "zero" discharge strategy would allow development of industries in arid areas.

29 Gromiec (2007)
30 Gromiec (2007)

This concept is linked to the "**cradle-to-cradle**" concept[31] whereby manufacturers provide a service to a customer who would use a product and return it back for the manufacturer to recycle. They put forward two flows of materials, biological nutrients which are biodegradable, and the remaining technological nutrients which are non-biodegradable. The earth's natural cycles will take care of the former and society needs to take care of the latter. The important point is to keep the two flows separate to avoid cross-contamination. Water is part of both cycles and not contaminating the quality of water in the biological cycle by the technological cycle is paramount for the concept to succeed. This is, of course, what happens routinely at present when, for instance, effluent is discharged to rivers. So it follows that recycling is critical and zero effluent discharge would mean that water would stay in the technological cycle once it is used by industry. Therefore, for industry to be open to and accept the changes required, the quality of the water and its use will need to be technically and economically well matched in perpetuity.

In zero discharge all the effluent should be treated, sold to other users or recycled. It is not a naive target, not a dream. The city of St. Petersburg in Florida, US is the first municipality to have zero effluent discharge to its surrounding nature.

Summary conclusions

On the basis of the papers, presentations and lively discussions at the Summit, some conclusions can be drawn:

- Across all industry sectors, the driving forces are to decrease environmental impacts and to reduce costs.
- Any water reuse strategies should put emphasis on cooling and process water, since these applications represent high share of total industrial water use.
- The advantages of reuse at company level may be purely economic. Cost savings may be realized if the costs of water and discharges are high and/or the risks associated with discharges are also minimized. Overall a general economic benefit will accrue from the reduction in externalities, the conservation of water resources, and reduced impacts on receivers.
- Major impediments to reuse include water quality, the low cost of alternatives, and the high cost of modernizing water distribution networks.
- In Europe, water reuse is driven by the need to improve on discharges and save water resource.
- The use of reclaimed water is still limited, e.g. urban parkland, golf courses, non-food crops. The same is true for storm water.
- Economic and financial measures, introduced by governments have a great influence on decisions taken by others. Their effect can be evaluated in terms of preventing externalities and the translation of such benefits into fiscal measures and incentives for the private sector.

31 McDonough, W and Braungart, M; "Cradle to Cradle: remaking the Way We Make Things", New York, North Point Press, 2002

- The definition of the lowest acceptable quality for reused water that will not affect production requires specific assessment. Potential damage to process equipment is relatively easy to assess on a case-by-case basis but impacts to workers are much harder to determine. Quality must be based on standards related to use.
- Reclamation and recycling of water are very dependent on quality. If the quality for a certain use is not available, then the water is likely wasted.

Policy challenges

In the attempt to implement more productive ways of using water in industry, it is not the technical know-how that is the main impediment but the will and the economics, both in the private and public sectors. These involve water management strategies on a broader scale. The nature of industry in a region determines these strategies.

One of the key drivers of industrial water productivity growth is the intensification of industrialisation in several developing countries and the transition of traditional business activities to services, which may lead to more pressure on water resources and natural ecosystems. As the low and middle income countries will change their industrial structure, the need of industry for water use will increase. Many water-intensive primary industries are moving to developing regions resulting in growth in water withdrawal there (China, Indonesia, India etc.). Europe shows a dramatic success in water withdrawal trend, probably thanks to measures several countries have introduced in applying more systematically recycling and reuse in manufacturing and power generation. While increasing industrial water consumption goes hand in hand with economic and industrial growth, industrial water withdrawals from freshwater resources do not need to increase in proportion of this growth.

The countries in transition are in a modernisation track, which will result in an increase in living standards and intensive technological changes in the economy. The first factor will definitely increase water demand for the households, while the second may have ambivalent impacts. The technological modernisation will result in more efficient water use of business, but the move of traditional, more water-intensive industrial activities from the most developed regions to less developed ones may find targets in the CEE/NIS regions as well. Both the growing interest of FDI in the region and the impacts of EU membership (or closer relationship of the candidate countries with the EU) may open new opportunities for fast catching-up of industrial water productivity. The EU funds for structural changes and regional cohesion may also play significant roles in the improvement of water infrastructure and municipal water services.

Reuse and recycling is driven in Europe by the problem of effluent discharge, price and value of water, and technology issues. There are several barriers in water productivity growth. For example new knowledge-intensive technologies and industrial processes are introducing totally new pollutants and neither the monitoring nor the regulation can react in time. The lack of guidelines and standards in relation to reuse waste water is also a barrier to these challenges.

There is a large number of stakeholders involved in the water stress challenges. Governments and enterprises should move hand in hand to identify problems and looking for solutions. But local municipalities should also play important roles in service provision, protecting natural resources and motivating all users of water in improving productivity. But other actors, like the academic community, international organisations, NGOs and the general public are also strongly involved. Policy formulation and the execution of strategies and action plans require ongoing dialogue and strong collaboration from all stakeholders.

Governments' strategies on water management consist of a variety of "carrot and stick" measures in order to encourage industries. In optimal cases the outcome is a win-win situation for both business and the public.

There is a wide range of measures on hand for governments. Financial instruments (tariffs, taxes, incentives and penalties etc.), regulatory framework, incentives to promote technology development and diffusion, human resource development, policy formulation and implementation, institutional setup, communication and awareness building – these are just examples of the policy instruments governments may select, combine and apply in order to reach objectives set up by development strategies and policies on a given domain (like water management). Both demand and supply side measures should be applied, and in an effective policy cycle the applied measures form a complex system, called policy mix. According to international experiences, not only a set of single policy instruments should be applied in order to respond sufficiently to the challenges, but the links and interaction of the measures, a so-called policy mix must be applied.

The most challenging nature of water management policy setting comes from the fact, that this is a very complex issue with a strong and complicated inter-connection nature, and we have very limited understanding of many important effects, causes and consequences.

Governments need to contact regularly with a large number of stakeholders both in policy formulation and implementation phases. National, regional and local policies must be harmonised and co-ordinated.

Governments should apply effective, well-functioning tools in policy formulation in order to improve the quality of their decisions and to manage successfully the risks emerging during the implementation phase of such policies.

In addition to these general challenges, in the CEE and NIS region some additional ones make the business more difficult. There is an endangered water infrastructure in many countries. The information on the current situation is mostly unknown, so the basis for policy setting is weak. But even in cases where information is available, it should be transferred into knowledge. The identification and engagement of stakeholders are also much weaker than in most of the old EU-member states.

Water management, and industrial water management, is a complex, multi-layered policy area, where growing number of active stakeholders play the game in a fast changing environment, and the social sensitivity on any water-related issues is growing. The traditional policy formulation methods and tools are inappropriate to respond this challenge. There is a need for something new!

The Summit made a contribution to the definition of appropriate measures to increase water productivity in industry and towards a common vision towards zero effluents discharge through a joint ministerial statement, as a result of the event's Ministerial round table (see Annex I).

Technology Foresight

The concept of foresight is understood and used in different ways. It is a widely shared view that foresight is a tool for preparing policy decisions and creating preferable environment and conditions for implementing policies. Some international organisations aim at promoting the application of this methodology, especially in the less developed regions. UNIDO is one of such organisations.

Technology foresight is a future oriented exercise, which combines multiple activities and purposes. Its time horizon is not standardised, it is highly depending on the areas targeted and the scope of the exercise. One of its main characters is a strong and wide-range participation of stakeholders. The exercise may aim at (or it may result in) building of new networks, platforms for social dialogue and language for such communication.

Foresight is not the only tool for assisting policy preparation and implementation: technology assessment, policy analysis, futures studies, technology forecasting and trend analysis are also widely applied. For practitioners it is a challenge to navigate among these tools and making proper selection of their application. It brings together key agents of change and various sources of knowledge in order to develop strategic visions and anticipatory intelligence.

At the early days, foresight served mostly national policy formulation process. Several countries now run their second or more cycles of national Foresight programmes. Many industrialised countries has recognised the value of this tool and launched foresight exercises.

In the past 10 years several of the EU new member states and other accession countries have run or are running foresight exercises. Most of them focussed their attention to assisting the intensive changes in the national R&D and innovation system. The national level exercises mostly aimed at identifying R&D priorities for medium term horizon.

As a new trend, since 2000, the number of multi-country exercises has also increased, the intensification of EU activity in this field has largely contributed to this process, but other international organisations, in particular UNIDO has also paid important role.

What is the reason behind the growing popularity of foresight in both developed and developing regions?

Policy makers are under a growing pressure in modern democracies, since there is fast growing demand from the society to improve the quality of their decisions (transparency and efficiency criteria). In more and more issues they have to tackle complex socio-economic problems, like the growing number of horizontal challenges, such as innovation, knowledge driven society, information revolution and environmental issues. And the transition of our societies into network based societies opens new options for social dialogue and totally new dimension of social monitoring of policy implementation. The traditional linear process of policy decision making (identification of the problems and the causes behind them; setting up priorities; defining goals and objectives; policy formulation; defining actions and budgeting; implementation; and monitoring and evaluation) has changed significantly. Nowadays it runs in a totally different environment, in a networked and networking society. Linkages between these individual steps are less linear and the time-factor plays much crucial role than earlier. Not only the quality of decisions, but their timing is important, as well. Monitoring and evaluation are not a single step, but an integral part of the whole process. It should provide inputs for policy revision and alarm the system when action is needed to adjust policy measures to objectives. The process must be open for action at any time, but actions should be based on facts and analysis, which require a strong learning capacity of institutions involved and the system as a whole.

Foresight is a useful tool in assisting effectively policy makers in replying successfully to these challenges. It helps to identify priorities for actions in the specified field(s) in an environment of always limited budget, while creates resources for a successful implementation, and build-up brand new or improve existing networks.

In contemporary societies, it is often vital to engage a range of stakeholders whose actions will be important influences on Foresight exercises and the implementation of results, even if one body (a government ministry, a Research Academy) is liable to be the most important policy actor.[32]

Content vs. structural focus of foresight

Foresight may be divided between those with a "content focus" and "structural focus". The objectives of the exercises are different[33]:

Content focus	• Priority setting • Identifying ways in which future science and technology may develop
Structural focus	• Reorienting the science & innovation system • Demonstrating the vitality of science & innovation system • Bringing new actors into the strategic debate • Building new networks and linkages across fields, sectors & markets or around problems

These two approaches may be combined in a single exercise. But while at the early age of foresight activities the content focus was more widely used, nowadays there is an increasing tendency to address structural or systemic issues directly.

Open innovation and foresight

Recent changes in the innovation process have resulted in a much more open system ("open innovation"). Enterprises are actively engaged with their suppliers and clients. Users´ contribution to strategic decisions on innovative projects has become crucial. In this system, knowledge is shared and the role of traditional knowledge organisations, like universities or national research laboratories becomes more important. One of the key success factors of the

32 Havas, Schartinger and Weber (2007)
33 Georghiou (2007)

national system of innovation is its networking capacity and capability. Foresight is a tool to improve such networking activities, so it is useful not only for public policy makers but private firms as well. This is one of the reasons why the subject of foresight exercises is broadening from technology to innovation. The pure technological focus is usually inappropriate to handle the non-technical innovation (like new business models, etc.).

The convergence of the traditional industry and innovation policies in the context of knowledge economy is a strong indication of the transition toward open innovation. But this process, as all other transition in public sector, runs slowly and in an inconsistent way. Most of the present national innovation policies, even in the OECD region, favour supply side measures (direct R&D funding, tax incentives for R&D, promoting academy-industry links, etc.) But not only market failures can argue for active public involvement into promoting firms' innovation activities. There are systemic failures such as locking to existing technologies and inadequate support infrastructure. For emerging economies, like countries in the CEE/NIS region, such systemic failures are often as major barrier as the lack of resources. In such a context, governments should focus on both macro- and microeconomic climate in order to ensure right framework conditions for innovation. An adequate supply of educated and entrepreneurially-oriented human capital, supportive institutions for R&D and knowledge transfer and policy coordination to create a favourable market and regulatory environment are as important as the direct or indirect support of concrete innovation activities.[34]

According to business experiences, the linear thinking – embodied in extrapolative business-as-usual approaches – is not very helpful when companies prepare their long-term strategies. Traditionally long-term perspectives of firms are largely developed by engineers on a technology-push basis. Narrow domain specialists are the worst at foresight. But the transition across socio-technical regimes has to be grasped. Corporate foresight is less well-documented, but there is evidence that many firms can benefit from the wider thinking about key future issues associated with foresight.[35]

Reflecting the interdependence of the actors involved in innovation, foresight exercises have widened in terms of their participants, as well as in terms of their scope. Foresight is used to promote networking – to access knowledge from a wider range of expertise and stakeholders, and to enlist participants in action – including integrating policy across domains that are traditionally compartmentalized.

Of course the turn from technology to innovation orientation in a growing number of foresight exercises doesn't imply the neglect of technology as a driver, it is rather a reflection of the need to widening up the scope by the evolution of knowledge society. This recent move of foresight from classical R&D and technology orientation toward innovation is a reaction to the convergence of innovation and industrial policy.

34 Georghiou (2007)
35 Ruff (2007)

Foresight in developing and transition economies

The countries in transition in the CEE/NIS region have some experiences in running technology foresight exercises. Based on the assessment of these activities several deficiencies could be identified:[34]

- Lack of or poor level of system capacity for strategic development;
- Lack of conducive integrated policy and institutional framework;
- Under-developed technology and innovation promotion planning capabilities;
- Short-term thinking and reactive mode action;
- Implementation failures on strategies;
- System linkage failures and poor coordination;
- Scientific institutions with strong and inflexible disciplinary focus;
- Low technology and innovation intensity in industry.

In the countries of CEE/NIS any kind of forward-looking activities are challenged by the lack of long-term vision of the society. The underdeveloped, fragmented social infrastructure with low level of networking capacity and weak civil society do not provide the necessary support for foresight exercises. The relative weakness of the business sector may result in an unbalanced representation of stakeholders (not necessarily measured in terms of the number of participants, but as in terms of their real involvement and their influence on the process). There is a danger that foresight activities in CEE/NIS can become too academy-oriented (research-motivated). The business participation should be taken seriously during the whole process.

Social dialogue in most CEE countries "*is still only weakly institutionalised and the capacity of interest organisation is progressing slowly. …The ability of the state to dictate the system of consultation and collective bargaining has been strengthened by the realities of economic reform such as large-scale privatisation, the need to impose wage limits, and high unemployment*."[36]

Foresight may demonstrate the weakness of social dialogue, networking and poor communication capabilities at organisational and social level on one side, and it may contribute to developing this culture in an effective way on the other. This aspect of foresight may be considered nowadays in CEE/NIS as one of the most important positive impacts.

Benefits of foresight

Taking foresight to be the systematic combination of long-term perspectives, wide participation, and effective policy/strategy formulation and implementation, these general attributes have numerous potential benefits to offer. The Summit identified several general and specific (in the CEE/NIS region) benefits of foresight activities, summarised in the following table.

36 "Employment and Social Change", Enlargement Futures Report Series 02, Joint Research Centre – IPTS, Report EUR 20117 EN, November 2001

	Benefits	
	General	In CEE/NIS
Policy Formulation	• Inform/help planning & priority-setting process • Diagnose weaknesses, indicate areas of strengths	• Identification of R&D priorities • Identification of priority on industrial sectors/subsectors
Policy Implementation	• Help in risk and conflict management • Legitimate policies	• Increased level of coordination among policy making bodies
Quality/Efficiency of the Process	• Allowing actors to move beyond their traditional thinking • Breaking down professional and disciplinary barriers	• Development of coherent national policies
Social Networking Development	• Promoting the establishment of networks and exchange of knowledge • Developing a shared vision	• Increased interactions between governments and other actors • Initiating a process of communication
Awareness Building	• Raising awareness of impeding problems and opportunities	• Changing the thinking on the domain - better understanding on its complex character

Many issues require multi-country cooperation in foresight. Problems may extend across borders, or may be faced in common by several countries: technological and other solutions may require shared investments (in research, standards, infrastructure, etc.) and coordinated action (e.g. in management of a resource or a problem like pollution). There may be conflicts between the countries around the issues addressed in Foresight. The longer-term focus may enable the partners to move beyond these immediate difficulties to address shared problems, and common issues arising from their common global environment.[37]

Some benefits of internationally run foresight exercises:[38]

- Cost-reduction through shared efforts;
- Easier access of high-quality expertise for training and foresight consultancy;
- Access of broader and complementary expertise in the domain the foresight is focusing;
- Special, cross-border or global problems (foresight domains) can be addressed only at international level.

37 Morato, Cortezo and Seidl da Fonseca (2007)
38 Georghiou (2007)

Summary conclusion

On the basis of the papers, presentations and lively discussions at the Summit, some conclusions can be drawn:

- Foresight is one set of tools in our armoury of policy setting. But it is no panacea, not a magic instant fix for our problems. It is not a rigid method, but a portfolio of tools linked by common philosophies, that have to be selected among and configured relative to the particular context, policy requirements, and topic.
- The uncritical transfer of foresight approaches across countries may cause serious problems. The context of an exercise is very important and imitation without understanding what objectives and contexts shaped particular practices may result in failure. It is important to grasp how a foresight philosophy can be applied under special conditions and in a particular environment, and in pursuit of specific objectives.
- One major reason for foresight exercises to fail to achieve impact is that they are not really "owned" by the government departments or other actors who would have to implement their results. It is important to achieve a mode of close interaction between the foresight practitioners and the main decision-makers from the start of the exercise. What is required is something more like a strategic partnership than a subcontracting relationship, to borrow a model from business. But this way of working is not always familiar or welcome (by policymakers or high-ranking research administrators, in particular).
- Recent changes in the innovation process has resulted in a shift of the scope of foresight exercises from technology to innovation. This broadening of the scope has opened the way for launching foresight exercises in areas traditionally not considered as technology-driven or in which technology is only one of the main drivers (industrial water management is a typical example for this). In such cases technology choice cannot be considered in isolation, and socio-economic issues are not just "impacts" or "effects".
- There is a particular role for foresight in terms of linking those responsible for the development of the technological and other knowledge needed for innovation (a) with potential users and regulators, and (b) with policymakers. This helps to bridge gaps in the innovation system, helps innovation actors identify opportunities for collaboration, and may foster innovation itself as well as attune policies more to contemporary innovation processes (e.g. "open innovation") and requirements (e.g. water-related ones).
- Increasingly it is understood that social dimensions of the "technical" issues at stake need to be addressed from the start, and not just added on later in the exercise.
- Firms can gain much from interfacing with public foresight exercises. In addition to the information that these may yield about relevant technologies and socio-economic changes, they provide intelligence about social networks and the evolving thinking, and likely activities of other stakeholders.
- Foresight may have a strong impact on improving social dialogue and managing conflicts. The exercise always create new platforms – common understanding of tasks and issues, shared language and terminology – that can enable effective interaction between professionals from different disciplines and backgrounds. A focus on longer-term common problems and shared solutions can help move cooperation past obstacles connected with short-term conflicts of interest.
- National governments are not the only actors involved. To have access to knowledge, legitimacy and effective implementation they need to engage a wide range of stakeholders

and expertise. Regional, local and municipal authorities should be encouraged to engage with national foresight exercises, and to initiate their own foresight activities which at the very least take results of national foresight into account.

- Linear, extrapolative, business-as-usual approaches are insufficient to prepare for and deal with the system transitions that characterise longer-term development. Use of alternative scenarios is one important tool here, and will typically need to be underpinned by appropriate use of multiple methods and inputs of data and expertise.

Foresight as a Tool for Industrial Water Policy

According to international experiences, any environment-related policy formulation and implementation process requires consideration of several issues. It is crucial that clear and well-defined objectives must be set, that can (and should) be translated into reliable indicators and adequate monitoring system. This system should serve to record the progress achieved during the implementation phase. Permanent data collection is essential for both checking whether the outcomes of the policy actions meet the original targets and getting the necessary information as feed-back for the revision of policies. Not only the general public, but all the main stakeholders must support the policy and its implementation. One successful way to get this support is to involve them from the very beginning into policy formulation, and than to the implementation process. Fair and effective enforcement mechanisms and their institutional background should also be set up.[39]

Since water-related challenges have a complex nature, they become socially more and more sensitive, and both the number of active stakeholders and the networking capability of the environment where such policies are formulated are growing, it seems to be obvious to apply foresight approach and methodologies more frequently in formulating water management policies. The challenges, as detailed earlier, and the general requirements of environment-related policy setting (see above) call for foresight due to its manifold interactions with societal, political and economic aspects.

Water use by industry is a topic where foresight is highly appropriate, though new technology will be only part of the solution to the problems. Foresight exercises can support demand side policies, which require shared visions of future opportunities between users and suppliers.

New technological, political, economical and social trends of wastewater management will impact the industrial sector in the CEE region. To capture this transformation process, foresight exercises are on demand to cover structural and functional scenarios as well as technology developments. Technology foresight exercises could contribute to build consensus and agreements among the key stakeholders to conduct these transformations in a sustainable manner.

Common problems are faced (in the water context as well) in identifying and engaging key stakeholders; working across different government departments; mobilising industry. Even though firms are increasingly networked and moving toward "open innovation", they are likely to have preferred partners and locations, which may be effectively exclusive of many developing countries.

Water-related foresight processes may help to disseminate awareness of the value and threats to freshwater, and the roles of various actors (including industrial firms) in protecting and conserving this resource. They can build awareness of the challenge, and also help identify,

39 "Highlights of the OECD Environmental Outlook", OECD, Paris 2001

assess, and disseminate knowledge of realistic opportunities. These would include technological options, economic incentives, and policy instruments that can facilitate development and uptake of these opportunities.

Foresight allows for "joined up" analysis of policies and processes that are generally kept separate, but that overlap closely in practice and impacts. It allows combination of the knowledge of experts and stakeholders beyond the "usual suspects". The longer-term focus can enable establishment of a common platform where short-term concerns and conflicts, and rigid positions, can be transcended, and people can collaborate in new ways. All these benefits are highly valuable inputs for successful policies in industrial water management.

Certain issues with regard to water management need trans-national approach in the phase of planning, followed by a coordinated implementation and transparent monitoring. Trans-boundary problems need trans-national cooperation – water management is not an exception, but a very good example where in many cases considerable profit can be reached only by international cooperation.

Recommendations - Water Productivity in the Industry

Based on the analysis done by different thematic panels and plenary sessions several recommendations regarding improving water productivity in the industry have been formulated to the main stakeholders: governments, business enterprises, local governments, the research community, international organisations and NGOs.

International experiences suggest that in case of proper incentives, fair regulation and consistent enforcement industry usually can cut significantly its water use.

What governments should do

Financial	• In investment policies of medium- and low-income countries only new advanced alternative technologies should be applied (imported), which have lower water consumption than the historical use by the same industry in high income countries • Identify appropriate economic instruments in order to provide incentives for innovation and more sustainable industrial practices. • Tailor-made financial support to SMEs to stimulate local initiatives • Set powerful incentives and develop adequate frameworks for industrial activities towards installing water clusters and using best available technologies
Regulatory	• Mandatory and voluntary standards, regulations and guidelines; • Water quality monitoring requirements • Set effluent quality standards
Incentives for technology development and diffusion	• Support of R&D in industrial water management • Promotion for technologies with higher water efficiency • Transfer of water-related technologies • Analytical assessment (audit) of technologies, considering the full technological process from basic raw materials to the end product

Human resources	• Awareness raising about interconnectedness and urgency of water issues • Use the strategic knowledge and interests of business and financing institutions, involving also local knowledge • Training in hydrology, analysis techniques, managements skills for eco-development
Policy formulation & implementation	• Improve the knowledge base and the strategic planning capacities & capabilities • Use foresight as policy tool for preparing policy decisions & implementing policies • All the aspects of the hydrological cycle should be considered and assessed in deciding industrial water management strategies and actions • Regional cooperation results in new resources in national policy setting and managing local & regional water challenges • Implement Virtual Water Trade Analisys
Institutional setup	• Foresight and water agencies need to be provided with considerable autonomy (to retain legitimacy and enlist wide support) but also to be closely linked to senior decision makers • Initiate to organize industrial/technical clusters, co-operations among water producers/polluters • Resolving conflicts of mandates between ministries and government levels • Decentralization – processes, governance and institutions, enhancement of all stakeholders in the decision making process (in particular local actors!); • Strengthening monitoring and enforcement mechanisms; • Horizontal co-ordination
Other	• Encouraging civil society to participate in the decision-making process as well as increasing awareness socially as wide as possible • Consider application of foresight to restructuring research and innovation system, not just to work within the existing system to establish a set of priorities or key areas for R&D • Extend the focus beyond waste water towards integrated waste management • Encourage the dissemination of Best Available Technologies and Best Environmental Practices

What industry should do

Strategic considerations	• Process and product redesign is a significant approach to improve water productivity • Consider product recovery from waste materials • Incorporate sustainable water management as part of CSR (corporate social responsibility) • Make all plant personnel water and pollution conscious
Financial/ investment	• Identify ROI (return on investment) and other possible financial rationales for cleaner production • Cooperate with financial investment organisations on future visions for water technologies, water systems, water use
Technology/ innovation	• Link between industrial users of waters and specialists in pollution prevention and clean technology • Take important role in investing into R&D and innovation – searching for more efficient new water treatment and less water consuming technologies
Management	• Introduce and apply as daily practice water auditing and eco-audits and reports in general • Intensify knowledge transfer networks and build up water related industrial districts • Encouraging suppliers and purchasers to adapt best management practices (special attention should be given to SMEs)
Other	• Value water as an externality • Engage in local, regional and sectoral stakeholder dialogues

What local municipalities should do

There is considerable scope for municipalities to engage in and launch their own foresight exercises – even though they rarely have adequate resources for this. But water management issues are in large part a matter of applying technologies and knowledge at the local level, and there are many important issues in land-use policy and related planning where local authorities have a significant role to play. They should build water issues centrally into cluster studies and policies, and into land-use and industrial policies (e.g. collocation of businesses).

What research community should do

On a broader scale, research should also look at the longer term effects of climate change on supply and quality. Plans and actions that may look suitable for the short and mid-term may not fit well with longer term changes in the dynamics of the hydrological cycle in various parts of the world.

Further analyses are needed to specify the role of stakeholders in water use and water management and the conditions for success of new governance mechanisms in CEE/NIS countries. It would also be important to intensify trans-disciplinary and trans-sectoral research on water systems as well.

In addition to that, some areas have also been identified where research should be focused on:

- defining the lowest acceptable water quality for various uses
- integrated water cycle management
- effluent and storm-water reuse
- treatment processes to improve cost-efficiency
- the long-term impacts of reclaimed water.

What NGOs should do

- Initiate, support and facilitate stakeholder dialogues
- Engage in enforcement of auditing industrial production processes
- Optimise of the interplay of local, national and trans-national regulative mechanisms
- Strengthen co-operations between municipalities with industry on cluster-building

What international organisations should do

Policy setting	• Integrate water into developmental goals, given tight links to UN Millennium Goals • Foster national, sectoral and other foresight initiatives regarding water
Security	• To prevent potential conflicts between countries caused by trans-boundary abstraction and pollution • Focus on probably emerging conflict lines regarding water issues within and between EU- and non-EU-members

Co-operation

- Enhance inter-agency cooperation in foresight and water policy including EU, WHO, OECD, UNEP, UNESCO UNIDO, and development financing institutions like EIB, EBRD and World Bank
- EU directives and initiatives on water management are available instruments for cooperation of international organisations
- Distribution of information and awareness building leading to capacity building, technology transfer, innovation & investment promotion

Coordination

- To set measurable targets and to manage successfully the enforcement challenges of global and regional initiatives, action plans and programs on water and industrial water management
- Broader involvement of non-public and non-for-profit organisations into the decision making, monitoring and implementation process of cross-border water-related activities is essential.

Support

- Demonstration projects in areas of water scarcity and industrial pollution hotspots
- Foster application of "zero discharge" strategies on governmental and industrial level
- International meetings on industrial reuse dedicated to specific applications

Potential initiatives for water-related cross-border foresight exercises

Foresight exercises could be cross-regional where resources are shared or problems are similar. In the water area there is considerable scope for work on shared resources – rivers, lakes, land water, etc. Similarly, there is scope for work on common problems to do with pollution, resource depletion and on sharing resources to build on common opportunities in R&D, in promoting best practice and technology diffusion, in establishing and applying standards and quality management. Technology and innovation solutions might need to be pursued jointly – for instance to achieve critical mass in R&D and to establish more sustainable industrial ecosystems.

Some areas for potential cross-country foresight on water management in the CEE/NIS region have been identified, take the following as an indicative list:

- Coastal flooding and defence
- Fluvial flooding
- Water infrastructures (drains, reservoirs), linked to foresight for urban development and living patterns
- Emission treatment systems
- Reducing industrial water consumption (putting this issue as a key theme in industrial foresight quite generally)
- Shared resources (rivers, lakes, land-water etc.)

The broadening of the technological and industrial focus of foresight towards other water-relevant sectors (agriculture, public sphere, households) has also been emerged in the discussions.

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Annex I:
Ministerial Round Table

The MINISTERIAL ROUND TABLE, one of the main components of the Summit, focused on the future of sustainable water availability and quality in the CEE/NIS region. The Ministerial consultations addressed the preparation of a draft statement promoting a zero discharge concept and incentives at the regional level. The Joint Ministerial Statement was adopted by 12 countries' high level representatives, as presented in the box below.

JOINT MINISTERIAL STATEMENT:
"TOWARDS ZERO DISCHARGE OF INDUSTRIAL POLLUTANTS PRESENT IN WASTEWATER"

As was discussed and adopted by the Ministers and Heads of delegations participating in the Ministerial Round Table on the future of sustainable water availability and quality in the region of Central and Eastern Europe (CEE) and Newly Independent States (NIS) at the Technology Foresight Summit 2007

1. We, the Ministers and Heads of delegation who have issued this statement, recognize the importance of the issues discussed during the Ministerial Round Table at the Technology Foresight Summit 2007 in the context of the unique value of water for people living in the Central and Eastern Europe (CEE) and Newly Independent States (NIS) region, as well as the urgent need to increase water productivity, its optimal use, re-use and recycling. We note that industry, a significant water user, has a primary responsibility for the rational use of scarce water resources. We urge the industrial sector to apply adequate technologies to save water in production, reduce water pollution, adopt adequate waste water treatment technologies and optimise water re-use and recycling.

Challenges

2. We recognize, in particular, that economic and social development goes hand in hand with responsible industrial growth and competitiveness; that freshwater is a precious resource which supports all terrestrial life; and that industry is among the major water users and has a key role to play in its stewardship, yet can cause serious damage through discharging polluting effluents.

3. We further recognize that this stewardship would be best served if all industrial effluents are reused and recycled, thus minimizing polluting discharges to water bodies (**"zero discharge"**). Water pollution and shortages are a threat to industry, communities and ecosystems. New industrial technologies for water reuse and recycling, and new business models such as chemical leasing, offer a remarkable opportunity to eliminate industrial waste generation and polluting effluent discharge permanently.

4. We are conscious of the need to optimize industrial freshwater intake from rivers, lakes and aquifers; of the need to increase industrial water productivity in terms of the value added by industrial production, relative to the volume of water used; and of the need to minimize water pollution by industry.

5. We are aware furthermore of the need to promote "**zero discharge"** at both enterprise and local district level, and the need to provide effective mechanisms for promotion, such as information exchange and economic incentives.

Call for action

National governments

6. We, as representatives of our national governments, commit ourselves to promoting **"zero discharge"** of polluting effluents from industry to watercourses. In addition, we call on the Governments to strengthen the powers of river basin organizations and local authorities to regulate industrial discharges; and assist industrial sectors in finding cost-effective ways to move towards **"zero discharge"**.

Local and regional authorities including river basin organizations

7. We further call upon our local and regional authorities to work together with industrial sectors and individual enterprises to develop and help them move towards **"zero discharge"** as well as to encourage local information exchange on water and waste recycling and, where feasible, to create local or district-based facilities for industrial effluent treatment and reuse. We call upon river basin organizations to support and track the progress towards **"zero discharge"** in their catchment areas, and to record the related benefits of water quality improvement and ecosystem response wherever possible.

Academia, research institutions and industrial enterprises

8. We appeal to academia and research institutions to contribute to the implementation of the **"zero discharge"** concept through capacity-building, development of technologies, and innovation. Furthermore, we call upon industrial enterprises to move towards **"zero discharge"** individually or jointly through shared effluent recycling facilities and waste reuse strategies.

United Nations Industrial Development Organization

9. Finally, we call upon the United Nations Industrial Development Organization to support the **"zero discharge"** initiatives and information exchange worldwide, and to monitor the progress of its Member States in implementing **"zero discharge"**.

Annex II.
Fair of the Future

A fair on industry-related water technologies of the future took place as one component of the Summit. The Water Technology Fair of the Future gave the opportunity to high-tech companies and R&D institutions to present the industry-led future trends and perspectives, prototypes, products, processes and markets regarding sustainable use of water by industry. In this context, the participants could present their solutions to reduce or avoid pollution of water resources in a long run. The Fair consisted of exhibitions, presentations and discussions.

A total of 19 companies from UK, Italy, Germany, Hungary, Belarus, Belgium and Netherlands represented the following stakeholders:

High-tech firms producing equipment and instrumentation for water recycling, treatment, quality control and monitoring

Companies and R&D institutes supplying equipment based on:

- o technologies not using water,
- o technologies using less water,
- o technologies not polluting water,
- o to other sectors using water as an input

Organizations providing services in the field (consultancy, designing.)

Annex III.
Side Events of the Summit

1. An awareness raising seminar on Technology Foresight as a tool for high-level decision makers was conducted in cooperation together with the Institute for Prospective Technological Studies (IPTS), DG Research, European Commission, as one side event of the Summit. A total of 17 managers and high-level decision makers from the CEE/NIS region participated in the 3-day seminar.

2. Another side event was the presentation of e-posters covering topics such as technology foresight for policy making and future of water productivity in the industry. Selected e-posters are expected to be submitted for publication to the journals "International Journal of Foresight and Innovation Policy" and "Foresight" (published by the High School of Economics, Russian Federation).

3. Special public information campaign has followed the developments of Summit's organization and implementation, including 2 press conferences for launching the Summit (in Austria) and at its opening (in Hungary). A total of 20 announcements on the Summit in the media were posted by different European publishers.

Information support to the Summit was also provided, among others, by "The Economist" on-line and hard copy journal, Global Water Intelligence magazine, Austrian Federal Economic Chamber, Federal Ministry of Agriculture, Forestry, Environment and Water Management; Theodore Puskas Foundation, a number of Austrian and Hungarian media and other profecionals institutions and publishers.

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